Part 1 - The exchange of information between partners in the value chain of Industrie 4.0 (Version 3.0RC01)
Imprint

Publisher
Federal Ministry for Economic Affairs
and Energy (BMWi)
Public Relations
10119 Berlin
www.bmwi.de

Text and editing
Plattform Industrie 4.0
Bertolt-Brecht-Platz 3
10117 Berlin

Design and production
The Plattform Industrie 4.0 secretariat, Berlin

Status
November 2020

Illustrations
Plattform Industrie 4.0; Anna Salari, designed by freepik (Title)
# Table of Content

1  Preamble .................................................................................................................. 15

   1.1  Editorial Notes ....................................................................................................... 16

   1.2  Scope of this Document ....................................................................................... 16

   1.3  Structure of the Document ................................................................................... 16

   1.4  Principles of the Work .......................................................................................... 17

2  Terms, Definitions and Abbreviations ..................................................................... 18

   2.1  Terms & Definitions .............................................................................................. 19

   2.2  Abbreviations used in Document ......................................................................... 23

   2.3  Abbreviations of Metamodel ............................................................................... 24

3  Basic Concepts and Leading Picture ....................................................................... 25

   3.1  Basic Concepts ...................................................................................................... 26

   3.2  Leading Picture ..................................................................................................... 26

4  The Metamodel of the Administration Shell ............................................................. 28

   4.1  Introduction .......................................................................................................... 29

   4.2  Types and Instances ............................................................................................. 29

      4.2.1  Life Cycle with Asset Types and Instances .................................................... 29

      4.2.2  Example ......................................................................................................... 30

      4.2.3  Asset Administration Shell Types and Instances ............................................ 31

   4.3  Composite I4.0 Components ................................................................................ 32

   4.4  Identification of Elements .................................................................................... 34

      4.4.1  Overview ....................................................................................................... 34

      4.4.2  What Identifiers Exist? ................................................................................... 34

      4.4.3  Identifiers for Assets and Administration Shells ............................................. 35

      4.4.4  Which Identifiers to use for which Elements ................................................. 35

      4.4.5  How are New Identifiers Created? ................................................................... 37

      4.4.6  Best Practice for Creating URI Identifiers ..................................................... 37

      4.4.7  Creating a Submodel Instance based on an Existing Submodel Template ...... 39

      4.4.8  Can New or Proprietary Submodels be Formed? .......................................... 39

      4.4.9  Usage of Short ID for Identifiable Elements ................................................... 39

   4.5  Events .................................................................................................................... 40

      4.5.1  Overview ...................................................................................................... 40

      4.5.2  Brief Use Cases for Events Used in Asset Administration Shells ................. 40

      4.5.3  Input and Output Directions of Events ......................................................... 42

      4.5.4  Types of Events ............................................................................................... 42

      4.5.5  Possible Future Attributes of an Event ......................................................... 43
Preamble

7.7.3 Example Overview ................................................................. 153
7.7.4 Identifiables and Referables ................................................ 155
7.7.5 Example Submodel with Property etc. .................................... 155
7.7.6 Example Property of a Submodel with SemanticId .................... 157
7.7.7 Examples Submodel Element Collections .................................. 157
7.7.8 Example Asset ...................................................................... 158
7.7.9 Example File ......................................................................... 160
7.7.10 Example Operation and Capabilities ....................................... 162
7.7.11 Example References ............................................................. 163
7.7.12 Example Qualifier ................................................................. 164
7.7.13 Example Concept Description ................................................ 166
7.7.14 Example Data Specification .................................................. 169
7.7.15 Example Event ..................................................................... 169
7.7.16 Example HasDictionaryEntry for Model ................................. 170

7.8 AutomationML ....................................................................... 170
7.8.1 General ............................................................................... 170
7.8.2 Rules .................................................................................. 171
7.8.3 Example Overview ................................................................. 173
7.8.4 Example Property and Concept Description .............................. 174
7.8.5 Example Attributes of Attributes ............................................ 176
7.8.6 Example Language Tagged Strings .......................................... 176
7.8.7 Example Asset ...................................................................... 176
7.8.8 Example RefSemantic ............................................................. 177
7.8.9 Example References ............................................................... 178
7.8.10 Example ReferenceElement .................................................. 179
7.8.11 Example File ........................................................................ 179
7.8.12 Example Operation ............................................................... 179
7.8.13 Example Qualifier ................................................................. 180
7.8.14 Example Concept Descriptions .............................................. 180
7.8.15 Example View .................................................................... 181
7.8.16 Example Submodels of kind=Template ................................... 182

8 Filtering of Information in Export and Import ............................... 183

9 Tools for the Asset Administration Shell .................................... 185
9.1 Open Source Tools .................................................................. 186

10 Summary and Outlook ............................................................. 187

Annex A. Concepts of the Administration Shell ............................. 190
i. General .................................................................................... 190
ii. Relevant Sources and Documents .......................................... 190
iii. Basic Concepts for Industrie 4.0 ................................................................. 190
iv. The Concept of Properties ........................................................................... 191
v. The Concept of Submodels ........................................................................... 192
vi. Basic Structure of the Asset Administration Shell ....................................... 193
vii. Requirements ............................................................................................... 195

Annex B. AASX Package File Format – Background Information ....................... 203
i. Selection of the Reference Format for the Asset Administration Shell Package Format ............................................................... 203

Annex C. Templates for UML Tables .................................................................... 204

Annex D. Legend for UML Modelling ................................................................ 205
i. OMG UML General ...................................................................................... 205
ii. Notes to Graphical Representation ................................................................ 209

Annex E. Metamodel UML with Inherited Attributes ........................................... 212

Annex F. XML Schemas and Complete Example .................................................. 217
i. General ........................................................................................................... 217
ii. AAS IEC61360 Datatype .............................................................................. 230
iii. AAS Attribute Based Access Control Model ............................................... 234
iv. XML Example ............................................................................................. 238

Annex G. JSON Schema and Complete Example .................................................. 250
i. JSON Schema for the Asset Administration Shell Environment .................... 250
ii. JSON Example ............................................................................................ 286

Annex H. RDF Schema and Complete Example .................................................... 299
i. RDF Data Model for the Asset Administration Shell .................................... 299
ii. RDF Schema for the Asset Administration Shell ......................................... 354
iii. RDF Example ............................................................................................. 391

Annex I. AutomationML and Complete example .................................................. 423
i. Introduction .................................................................................................. 423
ii. AutomationML Libraries for Asset Administration Shell ............................. 423
iii. RefSemantic Values and Roles for AAS ......................................................... 451
iv. AutomationML Example ............................................................................. 455

Annex J. OPC UA Companion Specification ......................................................... 502

Annex K. Metamodel Changes ............................................................................ 504
i. Metamodel Changes V3.0RC01 w/o Security Part ....................................... 504
ii. Metamodel Changes V3.0RC01 – Security Part ........................................... 510
iii. Metamodel Changes V2.0.1 w/o Security Part ............................................. 511
iv. Metamodel Changes V2.0.1 – Security Part ................................................ 511
v. Metamodel Changes V2.0 w/o Security Part ................................................ 512
vi. Metamodel Changes V2.0 – Security Part ................................................... 516
Table of Tables

Table 1 Life cycle phases and roles of asset type and instance ........................................................... 29
Table 2 Identifiables, attributes and allowed identifiers ........................................................................... 35
Table 3 Proposed structure for URIs .......................................................................................................... 37
Table 4 Example URN and URL-based Identifiers of the Administration Shell ........................................ 38
Table 5 Categories for Data Elements ....................................................................................................... 70
Table 6 Basic Types used in Metamodel ..................................................................................................... 88
Table 7 Concept Description with IEC612360 Data Specification Template for Properties and Ranges ........ 97
Table 8 Concept Description with IEC612360 Data Specification Template for other Data Elements, Relationships Elements and Capabilities ................................................................. 98
Table 9 Concept Description with IEC612360 Data Specification Template for other Submodel Elements .... 99
Table 10 Other Elements with semanticId .................................................................................................. 100
Table 11 Distinction of different data format for the AAS ........................................................................ 124
Table 12 Minimal XML for top level structure ......................................................................................... 132
Table 13 Using XSD Model Groups .......................................................................................................... 133
Table 14 Minimal JSON for top level structure ......................................................................................... 137
Table 15 Exemplary minimal JSON for References .................................................................................. 138
Table 16 Exemplary ReferenceElement in JSON ...................................................................................... 139
Table 17 Exemplary GlobalReference in JSON ......................................................................................... 141
Table 18 Turtle excerpt of an AssetAdministrationShell class ............................................................... 143
Table 19: A SHACL Shape for the AssetAdministrationShell and its asset attribute .............................. 144
Table 20 RML TriplesMap snippet for parsing XML to RDF ..................................................................... 145
Table 21 Exemplary Submodel stating its semantic ID and containing one SubmodelElement .................. 146
Table 22 Exemplary MultiLanguage description of a Submodel ............................................................... 147
Table 23 RDF serialization of attribute values in different languages .................................................... 147
Table 24 ConceptDescription Example in RDF ...................................................................................... 147
Table 25 Example Filtering of Information in XML .................................................................................. 184
Table 26 JSON schema ............................................................................................................................. 250
Table 27 JSON example ............................................................................................................................ 286
Table 28 Changes w.r.t. V2.0 w/o Security ............................................................................................. 504
Table 29 New Elements in Metamodel V3.0RC01 w/o Security ............................................................... 505
Table 30 New, Changed or Removed Constraints w/o Security ............................................................... 505
Table 31 Changes Metamodel w.r.t. V2.0 Security .................................................................................. 510
Table 32 New Elements in Metamodel V2.1 w.r.t. V2.0 Security .............................................................. 510
Table 33 New, Changed or Removed Constraints w/o Security ............................................................... 510
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 34</td>
<td>Changes w.r.t. V2.0.1 w/o Security</td>
<td>511</td>
</tr>
<tr>
<td>Table 35</td>
<td>New Elements in Metamodel V2.0.1 w/o Security</td>
<td>511</td>
</tr>
<tr>
<td>Table 36</td>
<td>New, Changed or Removed Constraints w/o Security</td>
<td>511</td>
</tr>
<tr>
<td>Table 37</td>
<td>Changes Metamodel w.r.t. V2.0 Security</td>
<td>511</td>
</tr>
<tr>
<td>Table 38</td>
<td>New Elements in Metamodel V2.1 w.r.t. V2.0 Security</td>
<td>512</td>
</tr>
<tr>
<td>Table 39</td>
<td>New, Changed or Removed Constraints w/o Security</td>
<td>512</td>
</tr>
<tr>
<td>Table 40</td>
<td>Changes w.r.t. V1.0 w/o Security</td>
<td>512</td>
</tr>
<tr>
<td>Table 41</td>
<td>New Elements in Metamodel V1.0 w/o Security</td>
<td>513</td>
</tr>
<tr>
<td>Table 42</td>
<td>New, Changed or Removed Constraints w/o Security</td>
<td>515</td>
</tr>
<tr>
<td>Table 43</td>
<td>Changes Metamodel w.r.t. V1.0 Security</td>
<td>516</td>
</tr>
<tr>
<td>Table 44</td>
<td>New Elements in Metamodel w.r.t. Security</td>
<td>516</td>
</tr>
<tr>
<td>Table 45</td>
<td>New, Changed or Removed Constraints w/o Security</td>
<td>517</td>
</tr>
</tbody>
</table>

**Table of Figures**

- Figure 1 Use Case File Exchange between Value Chain Partners | 26
- Figure 2 File Exchange between two value chain partners | 27
- Figure 3 Exemplary types and instances of assets represented by multiple AAS | 30
- Figure 4 Exemplary relations between metamodel of AAS, AAS types and AAS instances | 32
- Figure 5 Extract from Metamodel for Composite I4.0 Components | 33
- Figure 6 The Administration Shell needs a unique Identifier, as well as the asset being described (Modified figure from [4]) | 35
- Figure 7 Motivation of exemplary identifiers and idShort | 40
- Figure 8 Forward and Reverse Events | 41
- Figure 9 Tracking of Changes via Events | 41
- Figure 10 Value Push Events across Clouds | 42
- Figure 11 Overview Metamodel of the Asset Administration Shell | 46
- Figure 12 Metamodel package overview | 47
- Figure 13 Metamodel of HasExtension | 49
- Figure 14 Metamodel of Referables | 50
- Figure 15 Metamodel of Identifiables | 52
- Figure 16 Metamodel for Identifier | 53
- Figure 17 Metamodel of HasKind | 54
- Figure 18 Metamodel of Administrative Information | 55
- Figure 19 Metamodel for Semantic References (HasSemantics) | 56
- Figure 20 Metamodel of Qualifiables | 56
- Figure 21 Metamodel of Constraint Types | 57
Figure 22 Metamodel of Constraint Types ................................................................. 57
Figure 23 Metamodel of Qualifiers ............................................................................. 58
Figure 24 Metamodel of Formulas ............................................................................ 59
Figure 25 Example Formula “Machine Status not Running” ..................................... 59
Figure 26 Metamodel of HasDataSpecification ......................................................... 60
Figure 27 Metamodel for HasDataSpecification ....................................................... 60
Figure 28 Metamodel AssetAdministrationShell ...................................................... 61
Figure 29 Metamodel of Asset .................................................................................. 62
Figure 30 Metamodel of Asset Information ............................................................... 62
Figure 31 Metamodel of Submodel .......................................................................... 64
Figure 32 Metamodel for Submodel ......................................................................... 65
Figure 33 Metamodel Overview for Submodel Element Subtypes ............................ 66
Figure 34 Metamodel of Annotated Relationship Elements .................................... 67
Figure 35 Metamodel of Basic Events ...................................................................... 67
Figure 36 Metamodel of Capabilities ....................................................................... 68
Figure 37 Metamodel of Blobs ................................................................................ 68
Figure 38 Metamodel for Data Elements .................................................................. 69
Figure 39 Metamodel of Entities ............................................................................ 71
Figure 40 Metamodel of Events ............................................................................. 72
Figure 41 Metamodel for File Submodel Element ................................................... 72
Figure 42 Metamodel of Multi Language Properties .............................................. 73
Figure 43 Metamodel of Operations ....................................................................... 74
Figure 44 Metamodel of Properties ....................................................................... 75
Figure 45 Metamodel of Ranges ............................................................................. 76
Figure 46 Metamodel of Reference Elements ......................................................... 77
Figure 47 Metamodel of Relationship Elements ..................................................... 77
Figure 48 Metamodel for Submodel Element Collections ....................................... 78
Figure 49 Metamodel of Concept Descriptions ....................................................... 79
Figure 50 Metamodel of Views ............................................................................. 80
Figure 51 Metamodel for References and Keys ...................................................... 81
Figure 52 Built-In Types of XML Schema Definition 1.1 (XSD) ............................... 87
Figure 53 Data Type LangStringSet ....................................................................... 89
Figure 54 Concept of Data Specification Templates ................................................ 89
Figure 55 Data Specification Template for defining Property Descriptions conformant to IEC 61360 ................................................................. 90
Figure 56 Example Property from ECLASS ............................................................ 93
Figure 57 Example Property Description with Value List from ECLASS ............... 93
Figure 58 Example Value Description from ECLASS ............................................. 93
Figure 59 Example Value Description from ECLASS Advanced ............................ 93
Figure 96 Overview OPC UA Server with Max Rotation Speed .................................................. 154
Figure 97 Identifiables and Referables in OPC UA .................................................................. 155
Figure 98 Example Submodel TechnicalData (Extract) ............................................................. 156
Figure 99 OPC UA Structure Submodel ..................................................................................... 156
Figure 100 Example UAExpert Max. Rotation Speed Property ................................................. 157
Figure 101 Example MaxRotationSpeed Property as part of Submodel TechnicalData .............. 157
Figure 102 Structure CollectionType and OrderedCollectionType ......................................... 158
Figure 103 Example Submodel Documentation with Collection for OperatingManual .............. 158
Figure 104 Example ServoDCMotor as Asset ........................................................................... 159
Figure 105 Example UAExpert Asset ServoMotor ................................................................. 159
Figure 106 Structure Asset Administration Shell with Asset and Submodels ............................... 159
Figure 107 OPC UA Types for Submodel Elements File and Blob ............................................ 161
Figure 108 Example OperationManual as AASFileType .......................................................... 161
Figure 109 Example OperatingManual File in UAExpert ......................................................... 161
Figure 110 Example Operation Scan ....................................................................................... 163
Figure 111 Example Operation Scan in UAExpert ................................................................. 163
Figure 112 Example References shown for the reference to a submodel ................................. 164
Figure 113 Qualifier Type in OPC UA ....................................................................................... 165
Figure 114 Example Qualifiers for Submodel .......................................................................... 165
Figure 115 Example Lifecycle Qualifier for Submodel Technical Data ..................................... 165
Figure 116 Example ConceptDescription Max. Rotation Speed (Extract) ............................... 167
Figure 117 ConceptDescription MaxRotationSpeed in OPC UA Server ................................ 167
Figure 118 Example Data Specification Template IEC61360 .................................................... 169
Figure 119 Event Type in OPC UA ......................................................................................... 170
Figure 120 HasDictionaryEntry for Submodel ....................................................................... 170
Figure 121 Example in Automation ML Editor ........................................................................ 174
Figure 122 Example Property MaxRotationSpeed ................................................................... 175
Figure 123 Example DataSpecificationContent of Concept Description MaxRotationSpeed conformant to template DataSpecificationIEC61360Template ...................................................... 175
Figure 124 Example Identification with two subattributes ....................................................... 176
Figure 125 Example for attribute value in multiple languages .............................................. 176
Figure 126 Example Asset in Instance Hierarchy ..................................................................... 177
Figure 127 Example for RefSemantic and semanticId of the Property “MaxRotationSpeed” .... 178
Figure 128 Example for serialized reference as value for attribute semanticId ......................... 179
Figure 129 Example for ReferenceElement with Interface .................................................... 179
Figure 130 Example File .......................................................................................................... 179
Figure 131 Example Operation “SelectProgram” with input variables ................................... 180
Figure 132 Example Qualifier “PredicateRelation” with qualifier value “GREATER_THAN_0” for a Property ... 180
Figure 133 Example Concept Description using predefined data specification template IEC61360 ........................................ 181
Figure 134 Example Embedded Data Specification IEC61360 of Concept Description for Property “MaxRotationSpeed” ................................................................. 181
Figure 135 Example SafetyView .................................................................................................................. 182
Figure 136 Example for System Unit Class with a Submodel template for Technical Data ...................................... 182
Figure 137 Example Filtering for Export and Import .................................................................................... 182
Figure 138 Important concepts of Industrie 4.0 attached to the asset [2] [23]. I4.0 Component to be formed by Administration Shell and Asset ........................................................................... 191
Figure 139 Exemplary definition of a property in the IEC CDD ..................................................................... 192
Figure 140 Examples of different domains providing properties for submodels of the Administration Shell .......... 193
Figure 141 Basic structure of the Asset Administration Shell ........................................................................... 194
Figure 142 Class ............................................................................................................................................ 205
Figure 143 Inheritance/Generalization ........................................................................................................ 205
Figure 144 Multiplicity ............................................................................................................................... 206
Figure 145 Ordered Multiplicity ................................................................................................................ 206
Figure 146 Association ............................................................................................................................... 206
Figure 147 Composition (composite aggregation) ....................................................................................... 206
Figure 148 Aggregation ............................................................................................................................. 207
Figure 149 Navigable Attribute Notation for Associations ........................................................................ 207
Figure 150 Dependency ............................................................................................................................ 207
Figure 151 Abstract Class .......................................................................................................................... 207
Figure 152 Package ................................................................................................................................... 207
Figure 153 Imported Package .................................................................................................................... 208
Figure 154 Enumeration ........................................................................................................................... 208
Figure 155 Data Type ............................................................................................................................... 208
Figure 156 Primitive Data Type ............................................................................................................... 208
Figure 157 Note ......................................................................................................................................... 208
Figure 158 Constraint ............................................................................................................................... 209
Figure 159 Graphical Representations of Composite Aggregation/Composition ............................................ 209
Figure 160 Graphical Representation of Shared Aggregation .................................................................... 210
Figure 161 Graphical Representation of Generalization/Inheritance .......................................................... 210
Figure 162 Graphical Representation for Enumeration with Inheritance .................................................... 211
Figure 163 Core Model with inherited Attributes ....................................................................................... 213
Figure 164 Operation with inherited Attributes .......................................................................................... 214
Figure 165 Access Control with inherited attributes ................................................................................ 215
Figure 166 Submodel Element Collection with inheritance ........................................................................ 216
Figure 167 Example Servo Motor in OPC UA (Extract) ............................................................................. 503
1 Preamble
1.1 Editorial Notes

This document was produced from November 2019 to November 2020 by the sub working group “Asset Administration Shell” of the Platform Industrie 4.0 Working Group “Reference Architectures, Standards and Norms “.

The second version V2.0 of this document was produced August 2018 to November 2019 by the sub working group “Asset Administration Shell” of the Platform Industrie 4.0 Working Group “Reference Architectures, Standards and Norms “. Version 2.0.1 was published in May 2020.

The first version of this document was produced September 2017 to July 2018 by a joint working group with members from ZVEI SG “Models and Standards” and Plattform Industrie 4.0 Working Group “Reference Architectures, Standards and Norms “. The document was subsequently validated by the platform’s Working Group ““Reference Architectures, Standards and Norms “.

For better readability, in compound terms the abbreviation "I4.0" is consistently used for "Industrie 4.0". Used on its own "Industrie 4.0" continues to be used.

This specification is versioned using Semantic Versioning 2.0.0 (semver) and follows the semver specification [48].

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 RFC2119 RFC8174.

1.2 Scope of this Document

The aim of this document is to make selected specifications of the structure of the Administration Shell in such a way that information about assets and I4.0 Components can be exchanged in a meaningful way between partners in a value creation network.

This part of this document therefore focuses on the question of how such information needs to be processed and structured. In order to make these specifications, the document formally stipulates a few structural principles of the Administration Shell. This part does not describe technical interfaces of the Administration Shell or other systems to exchange information, protocols or interaction patterns.

This document focuses on:

- Exchange format for the transport of information from one partner in the value chain to the next
- Metamodel for specifying information of an Asset Administration Shell and its submodels
- Identifiers
- Access Control
- Mappings to suitable technologies to be used in different life cycle phases of a product

This document assumes some familiarity with the concept of the Asset Administration Shell. For convenience some of the concepts are repeated in the Annex A. The main stakeholders addressed in this document are architects and software developers aiming to implement a digital twin using the Asset Administration Shell in an interoperable way. Additionally, the content can also be used as input for discussions with international standardization organisations and further cooperations.

1.3 Structure of the Document

Clause 2 provides terms and definitions as well as abbreviations, both for abbreviations used in the document and for abbreviations that may be used for elements of the metamodel defined in this document.

Clause 3 summarises relevant, existing content from the standardization of Industrie 4.0. In other words, this clause provides an overview and explains the motives, and is not absolutely necessary for an understanding of the subsequent definitions.

Clause 4 stipulates sufficient structural principles of the Administration Shell in a formal manner in order to ensure an exchange of information between the Administration Shells. An excerpt of a UML diagram is drafted for this purpose. A more comprehensive UML discussion which does not set standards can be found in the annex. Security topics are discussed in Clause 5.
Preamble

Clause 5 describes the promotion of attribute based access models for information security.

Clause 6 describes, how the information of one or more Administration Shells could be packed into a compound file format (AASX). Background information with respect to this format can be found in Annex B.

Clause 7 provides detailed definitions for the exchange of information compliant to this specification in existing data formats like XML, AutomationML, OPC UA information models, JSON or RDF. An explanation is provided for each of these data formats stating how information is to be represented (metamodel), and an example of a representation is provided.

Clause 8 deals with filtering information before exchange with external partners.

In Clause 9 hints on existing open source tools that can be used for editing, implementing or managing Asset Administration Shells are given.

Finally, Clause 10 summarizes the content and gives an outlook on future work.

The Annex contains details w.r.t. the mappings done in Clause 6 (Annex F to Annex J) plus additional background information on asset administration shell (Annex A). In the Annex also information about UML (Annex D) and the tables used to specify UML classes (Annex C) are contained.

Metamodel changes compared to previous versions are described in Annex K. For developers there are also selected metamodel diagrams including all inherited attributes provided in Annex E.

1.4 Principles of the Work

The work is based on the following principle: keep it simple but do not simplify if it affects interoperability.

For creating a detailed specification of the Administration Shell according to the scope of part 1 (→Clause 1.2), result papers published by Plattform Industrie 4.0, the Trilateral cooperation with France and Italy and international standardization results were analysed and taken as source of requirements for the specification process. As many ideas as possible from the discussion papers were considered.

The partners represented in the Plattform Industrie 4.0 and associations such as the ZVEI, the VDMA, VDI/ VDE and Bitkom, ensure that there is broad sectoral coverage, both in process, hybrid and factory automation and in terms of integrating information technology (IT) and operational technology (OT).

Design alternatives were intensively discussed within the working group. An extensive feedback process with the so called "sounding board" of this document series, with the Plattform's working groups and with associated partners were engaged in the discussion of the design alternatives and the final content of the specification.

Guiding principle for the specification was to provide detailed information, which can be easily implemented also by small and medium sized enterprises.
2 Terms, Definitions and Abbreviations
2.1 Terms & Definitions

Forward notice:

Definition of terms are only valid in a certain context. This glossary applies to the context of this document.

access control
protection of system resources against unauthorized access; a process by which use of system resources is regulated according to a security policy and is permitted by only authorized entities (users, programs, processes, or other systems) according to that policy

[SOURCE: IEC TS 62443-1-1]

application
software functional element specific to the solution of a problem in industrial-process measurement and control

Note: An application can be distributed among resources and may communicate with other applications.

[SOURCE: IEC TR 62390:2005-01, 3.1.2]

asset
physical or logical object owned by or under the custodial duties of an organization, having either a perceived or actual value to the organization

Note: In the case of industrial automation and control systems, the physical assets that have the largest directly measurable value can be the equipment under control.

[SOURCE: IEC TS 62443-1-1:2009, 3.2.6]

asset administration shell (AAS)
standardized digital representation of the asset, corner stone of the interoperability between the applications managing the manufacturing systems. It identifies the Administration Shell and the assets represented by it, holds digital models of various aspects (submodels) and describes technical functionality exposed by the Administration Shell or respective assets.

Note: Asset Administration Shell and Administration Shell are used synonymously.

[SOURCE: Glossary Industrie 4.0]

attribute
data element of a property, a relation, or a class in information technology


class
description of a set of objects that share the same attributes, operations, methods, relationships, and semantics


capability
implementation-independent potential of an Industrie 4.0 component to achieve an effect within a domain

Note 1: Capabilities can be orchestrated and hierarchically structured.
Note 2: Capabilities can be made executable via services.
Note 3: The impact manifests in a measurable effect within the physical world
20 | Terms, Definitions and Abbreviations

component
product used as a constituent in an assembled product, system or plant

concept
unit of knowledge created by a unique combination of characteristics

digital representation
information that represents characteristics and behaviors of an entity

Note 1: Information is data that within a certain context has a particular meaning. Data is content represented in a digital and formalized manner suitable for communication, storage, interpretation or processing
Note 2: Behavior includes functionality (description and execution)

digital twin
digital representation, sufficient to meet the requirements of a set of use cases

Note: in this context, the entity in the definition of digital representation is typically an asset

identifier (ID)
identity information that unambiguously distinguishes one entity from another one in a given domain

Note: There are specific identifiers, e.g. UUID Universal unique identifier, IEC 15418 (GS1).

instance
concrete, clearly identifiable component of a certain type

Note 1: It becomes an individual entity of a type, for example a device, by defining specific property values.
Note 2: In an object-oriented view, an instance denotes an object of a class (of a type).

operation
executable realization of a function

Note 1: The term method is synonym to operation
Note 2: an operation has a name and a list of parameters [ISO 19119:2005, 4.1.3]

ontology
an explicit specification of a (shared) conceptualization

property

defined characteristic suitable for the description and differentiation of products or components

Note 1: The concept of type and instance applies to properties.
Note 2: This definition applies to properties such as described in IEC 61360/ISO 13584-42
Note 3: The property types are defined in dictionaries (like IEC component Data dictionary or ECLASS), they do not have a value. The property type is also called data element type in some standards.
Note 4: The property instances have a value and they are provided by the manufacturers. A property instance is also called property-value pair in certain standards.
Note 5: Properties include nominal value, actual value, runtime variables, measurement values, etc.
Note 6: A property can have attributes such as code, version, and revision.
Note 7: The specification of a property can include predefined choices of values.

Note: qualifier can have value associated

variable

software entity that may take different values, one at a time

Note: qualifier can have value associated

Note: variable

smart manufacturing

manufacturing approach, that improves its performance aspects with integrated and intelligent use of processes and resources in cyber, physical and human spheres to create and deliver products and services, which also collaborates with other domains within an enterprise’s value chains.

Note 1: Performance aspects include agility, efficiency, safety, security, sustainability or any other performance indicators identified by the enterprise.
Note 2: In addition to manufacturing, other enterprise domains can include engineering, logistics, marketing, procurement, sales or any other domains identified by the enterprise.
Note 3: this definition is, as of November 2020, under discussion within the ISO/IEC joint working group (JWG) 21. However, it gives a good indication and a citable source.

Note: submodel

models which are technically separated from each other and which are included in the asset administration shell

Note 1: Each submodel refers to a well-defined domain or subject matter. Submodels can become standardized and thus become submodels templates.
Note 2: Submodels can have different life cycles.
Note 3: The concept of template and instance applies to submodels.

Note: submodel element

element suitable for the description and differentiation of assets

Note 1: extends the definition of properties
Note 2: could comprise operations, binary objects
system
interacting, interrelated, or interdependent elements forming a complex whole

→ [SOURCE: IEC TS 62443-1-1:2009, 3.2.123]

technical functionality
functionality of the Administration Shell that is exposed by an application programming interface (API) and that is creating added value to the respective asset(s).

Note: can consist of single elements, which are also known as functions, operations, methods, skills.

→ [SOURCE: according [18]]

template
specification of the common features of an object in sufficient detail that such object can be instantiated using it

Note: object can be anything that has a type

→ [SOURCE: according ISO/IEC 10746-2]

type
hardware or software element which specifies the common attributes shared by all instances of the type


view
projection of a model or models, which is seen from a given perspective or vantage point and omits entities that are not relevant to this perspective

→ [SOURCE: Unified Modelling Language - UML]
### 2.2 Abbreviations used in Document

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAS</td>
<td>Asset Administration Shell</td>
</tr>
<tr>
<td>AASX</td>
<td>Package file format for the AAS</td>
</tr>
<tr>
<td>AML</td>
<td>AutomationML</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>BITKOM</td>
<td>Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e. V.</td>
</tr>
<tr>
<td>BLOB</td>
<td>Binary Large Object</td>
</tr>
<tr>
<td>CDD</td>
<td>Common Data Dictionary</td>
</tr>
<tr>
<td>GUID</td>
<td>Globally unique identifier</td>
</tr>
<tr>
<td>I4.0</td>
<td>Industrie 4.0</td>
</tr>
<tr>
<td>ID</td>
<td>Identifier</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IRDI</td>
<td>International Registration Data Identifier</td>
</tr>
<tr>
<td>IRI</td>
<td>Internationalized Resource Identifier</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>JSON</td>
<td>JavaScript Object Notation</td>
</tr>
<tr>
<td>MIME</td>
<td>Multipurpose Internet Mail Extensions</td>
</tr>
<tr>
<td>OPC</td>
<td>Open Packaging Conventions (ECMA-376, ISO/IEC 29500-2)</td>
</tr>
<tr>
<td>OPC</td>
<td>Open Platform Communications</td>
</tr>
<tr>
<td>OPCF</td>
<td>OPC Foundation</td>
</tr>
<tr>
<td>OPC UA</td>
<td>OPC Unified Architecture</td>
</tr>
<tr>
<td>PDF</td>
<td>Portable Document Format</td>
</tr>
<tr>
<td>RAMI4.0</td>
<td>Reference Architecture Model Industrie 4.0</td>
</tr>
<tr>
<td>RDF</td>
<td>Resource Description Framework</td>
</tr>
<tr>
<td>REST</td>
<td>Representational State Transfer</td>
</tr>
<tr>
<td>RFC</td>
<td>Request for Comment</td>
</tr>
<tr>
<td>SOA</td>
<td>Service Oriented Architecture</td>
</tr>
<tr>
<td>UML</td>
<td>Unified Modeling Language</td>
</tr>
<tr>
<td>URI</td>
<td>Uniform Resource Identifier</td>
</tr>
<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
</tr>
<tr>
<td>URN</td>
<td>Uniform Resource Name</td>
</tr>
<tr>
<td>UTC</td>
<td>Universal Time Coordinated</td>
</tr>
<tr>
<td>VDI</td>
<td>Verein Deutscher Ingenieure e.V.</td>
</tr>
<tr>
<td>VDE</td>
<td>Verband der Elektrotechnik Elektronik Informationstechnik e.V.</td>
</tr>
<tr>
<td>VDMA</td>
<td>Verband Deutscher Maschinen- und Anlagenbau e.V.</td>
</tr>
<tr>
<td>W3C</td>
<td>World Wide Web Consortium</td>
</tr>
<tr>
<td>XML</td>
<td>eXtensible Markup Language</td>
</tr>
</tbody>
</table>
### Terms, Definitions and Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZIP</td>
<td>archive file format that supports lossless data compression</td>
</tr>
<tr>
<td>ZVEI</td>
<td>Zentralverband Elektrotechnik- und Elektronikindustrie e. V.</td>
</tr>
</tbody>
</table>

#### 2.3 Abbreviations of Metamodel

The following abbreviations are not used in the document but may be used as abbreviations for the elements in the metamodel defined in this document.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAS</td>
<td>Asset Administration Shell</td>
</tr>
<tr>
<td>Asset</td>
<td>Asset</td>
</tr>
<tr>
<td>Cap</td>
<td>Capability</td>
</tr>
<tr>
<td>CD</td>
<td>Concept Description</td>
</tr>
<tr>
<td>DE</td>
<td>DataElement</td>
</tr>
<tr>
<td>DST</td>
<td>DataSpecification Template</td>
</tr>
<tr>
<td>InOut</td>
<td>input/outputVariable</td>
</tr>
<tr>
<td>In</td>
<td>inputVariable</td>
</tr>
<tr>
<td>Id</td>
<td>Identifier/id</td>
</tr>
<tr>
<td>Prop</td>
<td>Property</td>
</tr>
<tr>
<td>MLP</td>
<td>MultiLanguageProperty</td>
</tr>
<tr>
<td>Range</td>
<td>Range</td>
</tr>
<tr>
<td>Ent</td>
<td>Entity</td>
</tr>
<tr>
<td>Evt</td>
<td>Event</td>
</tr>
<tr>
<td>File</td>
<td>File</td>
</tr>
<tr>
<td>Blob</td>
<td>Blob</td>
</tr>
<tr>
<td>Opr</td>
<td>Operation</td>
</tr>
<tr>
<td>Out</td>
<td>outputVariable</td>
</tr>
<tr>
<td>Qfr</td>
<td>Qualifier</td>
</tr>
<tr>
<td>Ref</td>
<td>ReferenceElement</td>
</tr>
<tr>
<td>Rel</td>
<td>RelationshipElement</td>
</tr>
<tr>
<td>RelA</td>
<td>AnnotatedRelationshipElement</td>
</tr>
<tr>
<td>SM</td>
<td>Submodel</td>
</tr>
<tr>
<td>SMC</td>
<td>SubmodelElementCollection</td>
</tr>
<tr>
<td>SME</td>
<td>SubmodelElement</td>
</tr>
<tr>
<td>View</td>
<td>View</td>
</tr>
</tbody>
</table>
3 Basic Concepts and Leading Picture
3.1 Basic Concepts

Many concepts for Industrie 4.0 and smart manufacturing are already existing. The most important ones are summarised in the informative Annex A.

3.2 Leading Picture

The leading use case in this document is the exchange of an Asset Administration Shell including all its auxiliary documents and artifacts from one value chain partner to another. This is, in this document we do not deal with the use case of already deployed Asset Administration Shells running in a specific infrastructure but only with file exchange between partners.

Figure 1 Use Case File Exchange between Value Chain Partners

Figure 1 shows the overall picture. It depicts two value chain partners; "Supplier" is going to provide some products, "Integrator" is going to utilize this products in order to build a machine. Two kinds of Administration Shells are being provided; one for the asset being the type of a product, one for the assets being the actual product instances. "Supplier" and "Integrator" are forming two independent legal bodies (Figure 2).
The exchange of files needs to fulfill some requirements with respect to usability and security. There needs to be a bilateral agreement on security constraints to be fulfilled for the transfer and usage of the files. This is explained in more detail in Clause 5.

For usability a container format for exchanging files is used and a corresponding structure is defined (see Clause 6). This predefined structure helps the consumer to understand the content of the single files. This is important because an AssetAdministration Shell specification can be spread across several files. Additionally, the container may contain auxiliary files references by the AAS or even executable code.
4 The Metamodel of the Administration Shell
4.1 Introduction

This clause specifies the information metamodel of the Asset Administration Shell. Before doing so, some general aspects of the handling of asset types and instances are described (see Subclause 4.2 Types and Instances). Another very important aspect of the AAS is the identification aspect, see Subclause 4.3. In Subclause 4.5 aspects of event handling are discussed. In Subclause 4.3 it is described which elements to use for modelling composite I4.0 Components.

An overview of the metamodel of the Asset Administration Shell is given in Subclause 4.6. In Subclause 4.7 the classes are described in detail together with all their attributes.

The metamodel for security aspects of the Administration Shell is described in Clause 5.

The legend for understanding the UML diagrams and the table specification of the classes are found in Annex B and Annex D.

4.2 Types and Instances

4.2.1 Life Cycle with Asset Types and Instances

Industrie 4.0 utilizes an extended understanding of asset, comprising elements such as factories, production systems, equipment, machines, components, produced products and raw materials, business processes and orders, immaterial assets (such as processes, software, documents, plans, intellectual property, standards), services and human personnel, and more.

The RAMI4.0 model [3] features one, generalized life-cycle axis, which was derived from IEC 62890. The basic idea is to distinguish for all assets within Industrie 4.0 between possible types and instance. This makes it possible to apply the type/instance distinction for all elements such as material type/material instance, product type/product instance, machine type/machine instance and more. Business related information will be handled on the 'Business' layer of the RAMI4.0 model. The business layer also covers order details and workflows, again with asset types/instances.

### Table 1 Life cycle phases and roles of asset type and instance

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>Valid from the ideation/ conceptualization to first prototypes/ test. The 'type' of an asset is defined, and distinguishing properties and functionalities are defined and implemented. All (internal) design artefacts are created, such as CAD data, schematics, embedded software, and associated with the asset type.</td>
</tr>
<tr>
<td><strong>Usage</strong></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Ramping up production capacity. The 'external' information associated to the asset is created, such as technical data sheets, marketing information. The selling process starts.</td>
</tr>
<tr>
<td><strong>Instance</strong></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>Asset instances are created/ produced, based on the asset type information. Specific information about production, logistics, qualification and test are associated with the asset instances.</td>
</tr>
<tr>
<td><strong>Usage</strong></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Usage phase by the purchaser of the asset instances. Usage data is associated with the asset instance and might be shared with other value chain partners, such as the manufacturer of the asset instance. Also included: maintenance, re-design, optimization and decommissioning of the asset instance. The full life-cycle history is associated with the asset and might be archived/ shared for documentation.</td>
</tr>
</tbody>
</table>

Table 1 gives an overview of the different life cycles phases and the role of type and instance in these phases: The most important relationship is between asset types and asset instance. This relationship should be maintained throughout the life of the asset instances. By this relationship, updates to the asset types can be forwarded to the asset instances, either automatically or on demand.
30 | The Metamodel of the Administration Shell

Note: for the distinction of ‘type’ and ‘instance’, the term ‘kind’ is used in this document.

The second class of relationships are feedback loops/ information within the life-cycle of the asset type and instance. For product assets, for example, information on usage and maintenance of product instances may be used to improve the manufacturing of products as also the (next) product type.

The third class of relationships are feedforward/ information exchange with assets of other asset classes. For example, sourcing information from business assets can influence design aspects of products; or, the design of the products affects the design of the manufacturing line.

Note: For an illustration of the second/ third class of relationships confer the NIST model, as well.

A fourth class of relationships are between asset of different hierarchy levels. For example, these could be the (dynamic) relationships between manufacturing stations and products being currently produced. These could be also the decompositions of production systems in physical, functional or safety hierarchies. By this class of relationships, automation equipment is explained as a complex, interrelated graph of automation devices and products, performing intelligent production and self-learning/ optimization tasks.

4.2.2 Example

The following figure gives an example for the handling of asset types and asset instances, and for the handling of some exemplary information as well. Further explanation will follow in the next clauses.

Figure 3 Exemplary types and instances of assets represented by multiple AAS

There shall be a concrete asset type of a temperature sensor and two uniquely identifiable physical temperature sensors of this type. The intention is to provide a separate AAS for the asset type as well as for every single asset instance.

In the example, the first sensor has the unique ID “0215551AA_T1” and the second sensor has the unique ID “0215551AA_T2”. The AAS for the first sensor has the unique URI “http://admin-shell.io/T1” and the AAS for the second sensor has the unique URI “http://admin-shell.io/T2”. The kind of both is “Instance”. The example shows that the measured temperature at operation time of the two sensors is different: for T1 it is 60 °C, for T2 it is 100 °C. For the time-being we ignore the relationship “derivedFrom” of the two AAS “T1” and “T2” with AAS “http://admin-shell.io/T0215551AA”.

Note: The example is simplified for ease of understanding and does only roughly comply to the metamodel as it is specified in Clause 4. The id handling is simplified as well: the names of the classes correspond to the unique global identifier of the AASs.

Note: In the context of Platform Industrie 4.0 types and instances typically refer to “asset types” and “asset instances”. When referring to types or instances of an AAS this is explicitly denoted as “AAS types” and “AAS instances” to not mix up both. AAS types are synchronously used with the term “AAS template”.

Note: Please refer to Clause 2 for the IEC definition of types and instances. For the scope of this document, there is no full equivalency between these definitions and the type/ instance concepts of object oriented programming (OO).
The Metamodel of the Administration Shell | 31

Note: Even though the HTTP scheme is used in the example, the URIs do not need to be valid URLs and therefore do not need to point to accessible content.

Note: The unit can be obtained by the semantic reference of the element “measuredTemperature”. For simplicity this is not shown in the example.

These two asset instances do have a lot of information they share: the information of the asset type (in this example a sensor type). For this asset type an own AAS is created. The unique ID for this AAS is “http://admin-shell.io/T0215551AA”, the unique id of the sensor type is “0215551AA”. The kind in this case is “Type” and not “Instance”. The information that is the same for all instances of this temperature sensor type is the ProductClass (“Component”), the manufacturer (“Bosch”) and the English Description “=’precise and fast temperature measurement” as well as the value range “-40 °C / 140 °C”.

Now the two AAS of the two asset instances may refer to the AAS of the asset type “0215551AA” using the relationship attribute “derivedFrom”.

4.2.3 Asset Administration Shell Types and Instances

In the previous clause, type and instances of assets were explained. Obviously the question then comes up how to harmonize AAS as well as AAS types. In our example, it can be seen that the attributes “asssetId” and “kind” as well as the global identifier (id, represented as name of the class) are present for all AAS. However, if there is no standard, it is not clear that the semantics of “id”, “asssetId” and “kind” are the same for all AAS and it is not clear, which of the attributes are mandatory and which are specific for the asset (type or instance). This is illustrated in Figure 4.

This is the purpose of this document: The definition of a metamodel that defines which attributes are mandatory and which are optional for all AAS. The Platform Industrie 4.0 metamodel for AssetAdministration Shells is defined in Clause 4.

Note: This approach ensures that requirement IAS-#19 is fulfilled. Another approach could have been to define two metamodels: one for asset types and one for asset instances. However, the large set of similarities motivated to go with one metamodel.

Note: The metamodel itself does not prescribe mandatory submodels. This is another step of standardization similar to the prescription of submodels of AAS Type level.

Note: An AAS type shall be realized based on the metamodel of an AAS as defined in this document. This Metamodel is referred to as the “AAS Metamodel”.

Note: It is not mandatory to define an AAS type before defining an AAS (instance). An AAS instance that does not realize an AAS type shall be realized based on the Metamodel of an AAS as defined in this document.
4.3 Composite I4.0 Components

As described in Clause 4.2.1 there is a class of relationships between assets of different hierarchy levels. By this class of relationships, automation equipment is explained as a complex, interrelated graph of automation devices and products, performing intelligent production and self-learning/optimization tasks.

Details and examples for composite I4.0 Components can be found in [12].

The following modelling elements in the AAS metamodel can be used to realize such composite I4.0 Components:

- **RelationshipElement** – used to describe relationships between assets and other elements
- **Asset/billOfMaterial** – A complex asset is composed out of other entities and assets. These entities and assets being part of the asset are specified in the bill of material.

Note: The submodel template defining the structure of such a bill of material is not predefined by the AAS metamodel but is assumed to contain Entity elements.

- Not every entity (Entity) that is part of the bill of material of an asset has necessarily its own asset administration shell. As described in [12] self-managed entities are distinguished from co-managed entities (Entity/entityType).
  - Self-Managed Entities have their own AAS. This is why a reference to this asset is specified as well (Entity/asset). Additionally, further property statements (compare to [15]) can be added to the asset that are not specified in the AAS of the asset itself because they are specified in relation to the complex I4.0 Component only.
  - For co-managed entities there is no separate AAS. The relationships and property statements of such entities are managed within the AAS of the composite I4.0 Component.

Figure 5 shows an extract of the metamodel that is introduced later containing the elements being the most important to describe composite I4.0 Components.
The Metamodel of the Administration Shell | 33

Figure 5 Extract from Metamodel for Composite I4.0 Components
4.4 Identification of Elements

4.4.1 Overview

Identifiers are needed according to [4] for the unique identification of many different elements within the domain of smart manufacturing. For this reason, they are a fundamental element of a formal description of the Administration Shell. Especially, identification is at least required for:

- Asset Administration Shells,
- assets,
- submodel instances and submodel templates,
- property definitions/concept descriptions in external repositories, such as ECLASS or IEC CDD

Identification will take place for two purposes:

1. to uniquely distinguish all elements of an Administration Shell, and
2. to relate elements to external definitions, such as submodel templates and property definitions, in order to bind a semantics to these data and functional elements of an Administration Shell.

4.4.2 What Identifiers Exist?

In [4], [20] two standard-conforming global identification types are defined:

a) IRDI - ISO29002-5, ISO IEC 6523 and ISO IEC 11179-6 [20] as an Identifier scheme for properties and classifications. They are created in a process of consortium-wise specification or international standardization. To this end, users sit down together and feed their ideas into the consortia or standardization bodies. Properties in ISO, IEC help to safeguard key commercial interests. Repositories like ECLASS and others make it possible to standardise a relatively large number of Identifiers in an appropriately short time.

b) IRI – IRI (Rfc 3987) or URI and URL according to RFC 3986 as identification of assets, Administration Shells and other (probably not standardized, but globally unique) properties and classifications.

The following is also permitted:

c) Custom - Internal custom Identifiers such as GUIDs (globally unique Identifiers), which a manufacturer can use for all sorts of in-house purposes within the Administration Shell.

This means that the URIs/URLs and internal custom Identifiers can represent and communicate manufacturer-specific information and functions in the Administration Shell and the 4.0 infrastructure just as well as standardized information and functions. One infrastructure can serve both purposes.

CLSID are URIs for GUIDs. They start with a customer specific schema. So Custom should really only be used if the customer specific identifier is no IRDI nor an IRI.

Besides the global Identifiers, there are also Identifiers that are unique only within a defined namespace, typically its parent element. These Identifiers are also called local identifiers. Example: Properties within a submodel have local identifiers.

Besides absolute URIs there are also relative URIs.

See also DIN SPEC 91406 [43] for further information on identification.

---

1 https://tools.ietf.org/html/rfc3987
3 https://en.wikipedia.org/wiki/Universally_unique_identifier
**The Metamodel of the Administration Shell | 35**

### 4.4.3 Identifiers for Assets and Administration Shells

For the domain of smart manufacturing, the assets need to be uniquely identified worldwide [4] [20] by the means of identifiers (IDs). The Administration Shell has a unique ID, as well.

Figure 6 The Administration Shell needs a unique Identifier, as well as the asset being described (Modified figure from [4])

An Administration Shell represents exactly one asset, with a unique asset ID. In a batch based production, the batches will become the assets and will be described by a respective Administration Shell. If a set of assets shall be described by an Administration Shell, a unique ID for the composite asset needs to be created [12].

The ID of the asset needs to comply with the restrictions for global Identifiers according to [4][20]. If the asset is featuring further identifications, serial numbers and alike, they are not to be confused with the unique global Identifiers of the asset itself⁴.

### 4.4.4 Which Identifiers to use for which Elements

Not every Identifier is applicable for every element of the UML model representing the asset administration shell. The following table therefore puts constraints on the various entities, which implement "Identifiable" or "hasSemantics". Attributes relate to the metamodel in Clause 4.6 and Clause 4.7.

**Table 2 Identifiables, attributes and allowed identifiers**

<table>
<thead>
<tr>
<th>Identifiable</th>
<th>Attribute</th>
<th>Allowed Identifiers (recommended or typical)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset AdministrationShell</td>
<td>id</td>
<td>IRI (URL)</td>
<td>mandatory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Typically, URLs will be used</td>
</tr>
</tbody>
</table>

⁴ Such additional local identifiers are contained in the submodel “assetIdentificationModel”.
### The Metamodel of the Administration Shell

<table>
<thead>
<tr>
<th>Identifiable</th>
<th>Attribute</th>
<th>Allowed Identifiers (recommended or typical)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>idShort</td>
<td>string</td>
<td>mandatory³</td>
</tr>
</tbody>
</table>
| Asset                 | id        | IRI                                         | mandatory  
|                       |           |                              | Typically, URLs will be used [4] |
|                       | idShort   | string                                      | mandatory |
| Submodel with kind =  | id        | IRDI, IRI (URI)                             | mandatory  
| Template              |           |                              | IRDI, if the defined submodel is standardized and an IRDI was applied for it |
|                       | idShort   | string                                      | mandatory  
|                       |           |                              | Typically used as idShort for the submodel of kind Instance as well |
|                       | semanticId| IRDI, IRI (URI)                             | optional  
|                       |           |                              | The semantic id might refer to an external information source, which explains the formulation of the submodel (for example an PDF if a standard) |
| Submodel with kind =  | id        | IRI (URI), Custom                           | mandatory |
| Instance              | idShort   | string                                      | mandatory  
|                       |           |                              | Typically, the idShort or English short name of the submodel template referenced via semanticId |
|                       | semanticId| IRDI, IRI (URI)                             | recommended  
|                       |           |                              | Typically, the semantic is an external reference to an external standard defining the semantics of the submodel. |
| SubmodelElement       | idShort   | string                                      | mandatory  
|                       |           |                              | Typically the English short name of the element referenced via semanticId |
|                       | semanticId| IRDI, IRI (URI), Custom                     | recommended  
|                       |           |                              | link to a ConceptDescription or the concept definition in an external repository via a global id |
| ConceptDescription    | id        | Custom or IRDI                              | mandatory  
|                       |           |                              | ConceptDescription needs to have a global id. If the concept description is a copy from an external dictionary like ECLASS or IEC CDD it may use the same global id as it is used in the external dictionary. |
|                       | idShort   | string                                      | mandatory  
|                       |           |                              | e.g. same as English short name |
|                       | isCaseOf   | IRDI, IRI (URI)                             | optional  |

³ Note: In version V1.0 of this specification idShort was optional for Identifiables. This changed in V2.0: now idShort is mandatory for all Referables.
4.4.5 How are New Identifiers Created?

Following the different identification types from Clause 4.4.3, it can be stated:

(a) IRDIs are assumed to be already existing by an external specification and standardization process, when it comes to the creation of a certain Administration Shell. For bringing such IRDI Identifiers into life, refer to Clause 4 of the document [4].

(b) URIs and URLs can easily be formed by developers themselves, also on the fly when creating a certain Administration Shell. All that is needed is a valid authority, for example of the company, and to make sure that the way in which the domain (e.g. admin-shell.io) is organised ensures that the path appended to the host name is reserved in a semantically unique way for these Identifiers. In this way, each developer can create an arbitrary URI or URL by combining the host name and some chosen path, which only needs to be unique in the developer's organisation.

(c) Custom identifiers can also be easily formed by developers themselves. All that is necessary is a corresponding programmatic functionality to be retrieved. It is necessary to ensure that internal custom identifiers can be clearly distinguished from (a) or (b).

(d) Local identifiers can also be created on the fly. They have to be unique within their namespace.

4.4.6 Best Practice for Creating URI Identifiers

The approach for semantics and interaction for I4.0 components [17] suggests the use of the following structure for URIs\(^6\), which is slightly modified here. The idea is to always structure URIs following a scheme of different elements. However, this is just a recommendation and not mandatory to be used.

Table 3 Proposed structure for URIs

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
<th>Syntax component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation</td>
<td>Legal body, administrative unit or company issuing the ID</td>
<td>A</td>
</tr>
<tr>
<td>Organisational subunit/</td>
<td>Sub entity in organisation above, or released specification or publication of</td>
<td>P</td>
</tr>
<tr>
<td>Submodel / Domain-ID</td>
<td>Submodel of functional or knowledge-wise domain of asset or Administration</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Shell, the Identifier belongs to.</td>
<td></td>
</tr>
</tbody>
</table>

\(^6\) URLs are also URIs
### The Metamodel of the Administration Shell

<table>
<thead>
<tr>
<th>Version</th>
<th>Version number in line with release of specification or publication of Identifier</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision</td>
<td>Revision number in line with release of specification or publication of Identifier</td>
<td>P</td>
</tr>
<tr>
<td>Property / Element-ID</td>
<td>Property or further structural element ID of the Administration Shell</td>
<td>P</td>
</tr>
<tr>
<td>Instance number</td>
<td>Individual numbering of the instances within release of specification or publication</td>
<td>P</td>
</tr>
</tbody>
</table>

In the table, syntax component "A" refers to authority of RFC 3986 (URI) and namespace identifier of RFC 2141 (URN); "P" refers to path of RFC 3986 (URI) and namespace specific string of RFC 2141 (URN).

```plaintext
<AAS URI> ::= <scheme> ":" <authority> [ <path> ]

<scheme> ::= a valid URI scheme

<authority> ::= <Organisation>

<path> ::= <subunit> <domain> <release> <element>

<subunit> ::= [ ("/" | ":") <Organisational Subunit/Document ID/Document subunit> ]*

<domain> ::= [ ("/" | ":") <Submodel / Domain-ID> ]

<release> ::= [ ("/" | ":") <Version> [ ("/" | ":") <Revision> ]* ]

<element> ::= [ ("/" | ":" | ":") ( <Property/Element-ID> [ <Instance number> ] )* ]
```

Using this scheme, valid URNs and URLs can be created, both being URIs. For the use of Administration Shells, URLs are preferred as well, as functionality (such as REST services) can be bound to the Identifiers. Examples of such Identifiers are given in Table 4.

### Table 4 Example URN and URL-based Identifiers of the Administration Shell

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Description</th>
<th>Property class</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Administration Shell ID | ID of the Administration Shell | Basis | urn:zvei:SG2:aas:1:1:demo11232322  
http://www.zvei.de/SG2/aas/1/1/demo11232322 |
| Submodel ID (Type) | Identification of type of submodel | Selected submodels are basis, others free | urn:GMA:7.20:contractnegotiation:1:1  
http://www.vdi.de/gma720/contractnegotiation/1/1 |
| Submodel ID (Instance) | Identification of the instance of the submodel | Free | urn:GMA:7.20:contractnegotiation:1:1#001  
http://www.vdi.de/gma720/contractnegotiation/1/1#001 |
http://www.zvei.de/SG2/aas/1/1/demo11232322/maxtemp |
| Property/parameter/status instance IDs (not used by metamodel) | Identification of the property, parameter and status instance | Domain-specific | urn:PROFIBUS:PROFIBUS-PA:V3-02:Parameter:1:1:MaxTemp#0002  
http://www.zvei.de/SG2/aas/1/1/demo11232322/maxtemp#0002 |
4.4.7 Creating a Submodel Instance based on an Existing Submodel Template

In order to instantiate an existing submodel template, there should be a public specification of the submodel template, e.g. via publication by Plattform Industrie 4.0. As a special case, instantiating a submodel from a non-public submodel template, such as a manufacturer specification, is also possible.

As of October 2020, there are no finally published standardized submodel templates available, but some examples are described in [6], which provides simple tables listing properties in a predefined hierarchy.

In each submodel template, the Identifiers of property definitions to be used as semantic references are already predefined. An instantiation of such a submodel merely requires the creation of properties each with a semantic reference to the property definition and attach a value.

What remains is to create an Identifier of the submodel instance itself, which is in the regular case a URI/URL.

4.4.8 Can New or Proprietary Submodels be Formed?

It is in the interest of Industrie 4.0 for as many submodels as possible, including free and proprietary submodels, to be formed (→ [4], “Free property sets”). A submodel can be formed at any time for a specific Administration Shell of an asset. For this purpose, the provider of the Administration Shell can form in-house Identifiers for the type and instance of the submodel in line with Section 4.4.5. All I4.0 systems are called on to ignore submodels and properties that are not individually known, and simply to “overlook” them. For this reason, it is always possible to deposit proprietary – e.g. manufacturer-specific or user-specific – information, submodels or properties in an Administration Shell.

Note: it is in the intention of the Administration Shell, that proprietary information is included as well. For example, to link to company-wide identification schemes or information required for company-wide data processing. By this, a single infrastructure can be used to transport standardized and proprietary information at the same time; this conveys the introduction (and later standardization) of new information elements as well.

4.4.9 Usage of Short ID for Identifiable Elements

The Administration Shell fosters the use of worldwide unique identifiers to a large degree. However, in some cases, this may lead to inefficiencies. An example might be referring to a property, which is part of a submodel which is part of an Administration Shell and each of these identified by global Identifiers [4]. For example, in an application featuring a resource oriented architecture (ROA), a worldwide unique resource locator (URL) might be composed of a series of segments, which in turn do not need to be worldwide unique:
In order to allow such efficient addressing of elements by an API of an Administration Shell, idShort is provided for a set of classes of the metamodel, which inherit from abstract class Referable, in order to refer to such dependent elements (→ 4.6). However, an external system addressing resources of an Administration Shell is required to check the respective semantics, i.e. the value of semanticId, first, before accessing elements by id or idShort (→ 4.7.2).

4.5 Events

4.5.1 Overview

Events are a very versatile mechanism of the AAS. In the following sections, first some use-cases for events are described. Different types of events are summarized in order to depict requirements. A SubmodelElement “Event” is introduced, which is able to declare events of an AAS. The general format of event messages is specified.

4.5.2 Brief Use Cases for Events Used in Asset Administration Shells

- An integrator has purchased a device. Later in time, the supplier of the device provides a new firmware. The integrator wants to detect the offer of a new firmware and wants to update the firmware after evaluating its suitability ("forward events"). The mechanism is, that a dependent AAS ("D4") detects events from a parent or type AAS ("D1"), which is described by the derivedFrom relation.
- An integrator/operator operates a motor purchased from a supplier. During operation, condition monitoring incidents occur. Both parties agree on a business model providing availability. So, the supplier wants to monitor device statuses which are further in the value chain ("reverse events").
An operator is operating a certain I4.0 component over time. Changes occasionally occur to these I4.0 components from different systems. For documentation and auditing, changes to this I4.0 component shall be tracked. This can be achieved by recording events over time.

An operator is operating different I4.0 components, which are deployed to manufacturer clouds. The operator wants to integrate data from these components, according to DIN SPEC 92222. Therefore, information needs to be forwarded to the operator cloud ("value push").
### 4.5.3 Input and Output Directions of Events

It may be relevant to distinguish between input and output directions of an event with respect to the observed model, the respective Referable.

<table>
<thead>
<tr>
<th>Direction</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>The event is monitoring the Referable it is attached to. An outer message infrastructure, e.g. by OPC UA or MQTT or AMQP, will transport these events to other AASs and further outer systems and users.</td>
</tr>
<tr>
<td>Input</td>
<td>The software entity, which implements the respective Referable, can handle incoming events. These incoming events will be delivered by an outer message infrastructure, e.g. by OPC UA or MQTT or AMQP, to the software entity of the Referable.</td>
</tr>
</tbody>
</table>

### 4.5.4 Types of Events

According to the above use-cases, different types of events are possible. The following table gives an impression on possible event types. Each event type will be identified by a `semanticId` and will feature a specialized payload.

<table>
<thead>
<tr>
<th>Group</th>
<th>Direction</th>
<th>Motivation / conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural changes of the AAS</td>
<td>Out</td>
<td>• CRUD(^8) of Submodels, Assets, SubmodelElements and such</td>
</tr>
<tr>
<td></td>
<td>In</td>
<td>• Detect updates on parent/ type/ <code>derivedFrom</code> AAS</td>
</tr>
<tr>
<td>Updates of Properties and dependent attribute</td>
<td>Out</td>
<td>• update of values of SubmodelElements&lt;br&gt;• timestamped updates and time series update&lt;br&gt;• explicit triggering of an update event</td>
</tr>
<tr>
<td>Operation of AAS</td>
<td>Out</td>
<td>• monitoring of (long-lasting) execution of <code>OperationElement</code> and updating events while execution</td>
</tr>
</tbody>
</table>

\(^7\) see below  
\(^8\) Create, Retrieve, Update, Delete
The Metamodel of the Administration Shell | 43

| Monitoring, conditional, calculated events | Out | • e.g. when voiding some limits (e.g. stated by Qualifiers with expression semantics) |
| Infrastructure events | Out | • Booting, Shutdown, out of memory .. of software entity of respective Referable (AAS, Submodel) |
| Repository events | In/ Out | • Change of semantics of IRDIs (associated concept definition) |
| Security events | Out | • logging events |
| | | • access violations, non-fitting roles & rights, denial of service, .. |
| Alarms & events | Out | • alarms and events management analog to distributed control systems (DCS) |

**Custom event types**

In any case, it is possible to define custom event types by using a proprietary, but worldwide unique, semanticId for this event type. Such customized events can be sent or received by the software entity of the respective Referable, based on arbitrary conditions, triggers or behavior. However, the general format of the event messages needs to comply this specification, but the payload might be completely customized.

**Event scopes**

Events can be stated with an observableReference to the Referables of AAS, Submodels, SubmodelElementCollections and SubmodelElements. These Referables are defining the scope of the events, which are to be received or sent.

<table>
<thead>
<tr>
<th>Event attached to ...</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAS</td>
<td>This event is monitoring/ representing all logical elements of an Administration Shell, such as AAS, Asset, Views, Submodels.</td>
</tr>
<tr>
<td>Submodel</td>
<td>This event is monitoring/ representing all logical elements of the respective Submodel und all logical dependents.</td>
</tr>
<tr>
<td>SubmodelElementCollection</td>
<td>This event is monitoring/ representing all logical elements of the respective SubmodelElementCollection und all logical dependents.</td>
</tr>
<tr>
<td>SubmodelElement (others)</td>
<td>This event is monitoring/ representing a single atomic SubmodelElement, e.g. a data element which might include the contents of a Blob or File.</td>
</tr>
</tbody>
</table>

**4.5.5 Possible Future Attributes of an Event**

Up to now the metamodel offers a very simple modeling of an event. Besides the inherited attributes that are available for every Referable, only one attribute for referencing the data or other elements being observed is added. This is expected to be a good starting point.

For future extensions other attributes like explained in the following tables might be added to the normative part of this specification.

**Attributes of the event element**

<p>| Class: | EventElement (non- normative, only for discussion) |
| Explanation: | Defines the necessary information for sending or receiving events. |
| Inherits from: | SubmodelElement |</p>
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>idShort+</td>
<td>Identification of the element itself. Provides a unique identification for a possible event flow scheduling.</td>
<td>string</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>semanticId+</td>
<td>Semantic identification of the event type.</td>
<td>Reference</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>observableReference</td>
<td>Reference to the Referable, which defines the scope of the event. Can be AAS, Submodel, SubmodelElementCollection or SubmodelElement.</td>
<td>Reference</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>direction</td>
<td>Can be { Input, Output }.</td>
<td>Enum</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>state</td>
<td>Can be { On, Off }.</td>
<td>Enum</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>messageTopic</td>
<td>Information for the outer message infrastructure for scheduling the event to the respective communication channel.</td>
<td>string</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>messageBroker</td>
<td>Information, which outer message infrastructure shall handle messages for the EventElement. Refers to a Submodel, SubmodelElementCollection, which contains DataElements describing the proprietary specification for the message broker.</td>
<td>Reference</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>lastUpdate</td>
<td>Timestamp in UTC, when the last event was received (input direction) or sent (output direction).</td>
<td>xsd:dateTime</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>minInterval</td>
<td>For input direction, reports on the maximum frequency, the software entity behind the respective Referable can handle input events. For output events, specifies the maximum frequency of outputting this event to an outer infrastructure. Might be not specified, that is, there is no minimum interval.</td>
<td>xsd:dateTime</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>maxInterval</td>
<td>For input direction: not applicable. For output direction: maximum interval in time, the respective Referable shall send an update of the status of the event, even if no other trigger condition for the event was not met. Might be not specified, that is, there is no maximum interval.</td>
<td>xsd:dateTime</td>
<td>attr</td>
<td>0..1</td>
</tr>
</tbody>
</table>
The Metamodel of the Administration Shell | 45

Attributes of the event message

Events sent or received by AAS always comply to a general format. Exception: events exchanged in the course of an I4.0 interaction pattern.

<table>
<thead>
<tr>
<th>Class:</th>
<th>EventMessage (non-normative, only for discussion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Defines the necessary information of an event instance sent out or received.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>source</td>
<td>Reference to the source EventElement, including identification of AAS, Submodel, SubmodelElements.</td>
<td>Reference</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>sourceSemanticId</td>
<td>semanticId of the source EventElement, if available</td>
<td>Reference</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>observableReference</td>
<td>Reference to the Referable, which defines the scope of the event. Can be AAS, Submodel, SubmodelElementCollection or SubmodelElement.</td>
<td>Reference</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>observableSemanticId</td>
<td>semanticId of the Referable, which defines the scope of the event, if available. See above.</td>
<td>Reference</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>topic</td>
<td>Information for the outer message infrastructure for scheduling the event to the respective communication channel.</td>
<td>string</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>subject</td>
<td>ABAC-Subject, who/which initiated the creation</td>
<td>string</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>timestamp</td>
<td>Timestamp in UTC, when this event was triggered.</td>
<td>string</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>payload</td>
<td>Event specific payload. Detailed in annex.</td>
<td>string</td>
<td>attr</td>
<td>0..1</td>
</tr>
</tbody>
</table>
Figure 11: Overview Metamodel of the Asset Administration Shell
In this clause an overview of the main concepts of the Asset Administration Shell metamodel is presented.

The main parts of an Asset Administration Shell (AAS) are one the one hand side the information about the asset it is representing (AssetInformation) as well as its submodels. Optionally, views may be part of the AAS. Views define a set of elements selected for a specific stakeholder. For details see Clause 4.7.3.

An AAS represents exactly one asset. Asset types and asset instances are distinguished by setting the attribute “AssetInformation/assetkind”. For details see Clause 4.7.2.5.

Note: the UML modelling uses so-called abstract classes for denoting reused concepts like “HasSemantics”, “Qualifiable” etc.
In case of an AAS of an instance asset, a reference to the AAS representing the corresponding asset type or another asset instance it was derived from may be added (derivedFrom). The same holds true for AAS of an asset type: also, types can be derived from other types.

An asset typically may be represented by several different identification properties like for example the serial number, its RFID code etc. Such external identifiers are defined as identifier key value pairs (AssetInformation SpecificAssetId). For details see Clause 4.7.5. Additionally, a global asset identifier should be assigned to the asset (AssetInformation globalAssetId) in production and operation phase.

AASs, assets, submodels and concept descriptions need to be globally uniquely identifiable (Identifiable). Other elements like for example properties just need to be referable within the model and thus only need a local identifier (idShort from Referable). For details on identification see Clause 4.3. For details on Identifiable and Referable see Clause 4.7.2.3.

Submodels consist of a set of submodel elements. Submodel elements may be qualified by a so-called Qualifier. For details see Clause 4.7.5.

There are different subtypes of submodel elements like properties, operations, collections etc. For details see Clause 4.7.5. A typical submodel element is shown in the overview figure: a property. A property is a data submodel element that has a value of simple type like string, date etc. For details on properties see Clause 4.7.8.5.

Every submodel element needs a semantic definition (semanticId in HasSemantics). The submodel element might either refer directly to a corresponding semantic definition provided by an external reference (e.g. to an ECLASS or IEC CDD property definition) or it may reference a concept description (ConceptDescription). For details see Clause 4.7.2.7.

A concept description may be derived from another property definition of an external standard or another concept description (ConceptDescription isCaseOf). isCaseOf is a more formal definition of sourceOfDefinition that is just text.

In this case most of the attributes are redundant because these are defined in the external standard. It is about usability to add attributes for information like preferredName, unit etc. Consistency w.r.t. to the referenced submodel element definitions should be ensured by corresponding tooling.

Data Specification Templates can be used (DataSpecification) to define a named set of additional attributes (besides those predefined by the metamodel) for an element. For the concept description of properties typically the Data Specification Template following IEC 61360 is used providing for example an attribute “preferredName”. For denoting recommended Data Specification Templates to be used the <<template>> dependency is used. For details see Clause 4.7.2.8.

Data Specification Templates like the template for IEC 61360 property definitions (DataSpecificationIEC61360) are explicitly predefined and recommended to be used by the Plattform Industrie 4.0. For details see Clause 4.8.2. If proprietary templates are used, interoperability with other AAS cannot be ensured.

Besides submodel elements including properties and concept descriptions also other identifiable elements may use additional templates (HasDataSpecification). Data Specification Templates are selected at design time. For details see Clause 4.7.2.12.

Submodel elements and the submodels themselves may have additional qualifiers (Qualifiable). Per Qualifiable there might be more than one qualifier. For details see Clause 4.7.2.8.

Additionally, Views can be defined within an AAS. Views may consist of any elements that are referable (containedElement). A “Safety View”, for example, contains all properties or operations that are safety relevant and need special treatment. For details see Clause 4.7.9. A View definition can also be used in different life cycle stages. For example, there could be a view for engineering and all referenced artefacts are deleted before delivering the AAS to the customer.

For every AAS, security aspects need to be considered (security). In this document the aspect of access control is covered in more detail. So-called access permission rules are defined, that define which permission a specific authenticated subject has on which object. For details see Clause 5.

Figure 12 gives a complete picture of all elements defined in the metamodel excluding security. Information on the Security part is found in Clause 5.
4.7 Metamodel Specification Details: Designators

4.7.1 Introduction

In this clause the classes of the metamodel are specified in detail. In Annex B the template used to describe the classes and relationships is explained. In Annex D some of the diagrams are shown together with all its inherited attributes to give a complete overview.

For understanding the specifications, it is crucial to understand the common attributes first (Clause 4.7.2). They are reused throughout the specifications of the other classes (“inherits from”) and define important concepts like identifiable, qualifiable etc. They are abstract, i.e. there is no object instance of such classes.

Another important concept is the concept of referencing and how a reference is represented in the UML diagrams and the tables. This is explained in Clause 4.7.11 and Annex D ii.

4.7.2 Common Attributes

4.7.2.1 Extensions (HasExtensions)

Figure 13 Metamodel of HasExtension

<table>
<thead>
<tr>
<th>Class:</th>
<th>HasExtensions &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Element that can be extended by proprietary extensions.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>extension</td>
<td>An extension of the element.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Single extension of an element.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>HasSemantics</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>name*</td>
<td>An extension of the element.</td>
</tr>
</tbody>
</table>
The metamodel of the Administration Shell

### 4.7.2.2 Referable Attributes

**Figure 14 Metamodel of Referables**

The metamodel distinguishes between elements that are identifiable, referable or none of both.

Referable elements can be referenced via the `idShort`. For details on how to do referencing see clause 4.7.11.

Not every element of the metamodel is referable. There are elements that are just attributes of a referable.

For non-identifiable referables the `idShort` shall be unique in its name space (Constraint AASd-022). A name space is defined as follows in this context: The parent element(s) an element is part of and that is either referable or identifiable is the name space of the element. Examples: A submodel is the name space for the properties contained in it. The name space of a submodel element being contained in a submodel element collection is the submodel element collection.

### Class: Referable <<abstract>>

- **Explanation**: An element that is referable by its `idShort`. This id is not globally unique. This id is unique within the name space of the element.
- **Inherits from**: HasExtensions

### Attribute (*=mandatory)

- **Explanation**: In case of identifiables this attribute is a short name of the element. In case of referable this id is an identifying string of the element within its name space.
- **Type**: string
- **Kind**: attr
- **Card.**: 1

**Constraint AASd-022**: `idShort` of Referables shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. I.e. `[a-zA-Z][a-zA-Z0-9_]++`
<table>
<thead>
<tr>
<th><strong>Class:</strong></th>
<th>Referable &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constraint AASd-003:</strong></td>
<td><em>idShort</em> shall be matched case-insensitive.</td>
</tr>
<tr>
<td><strong>Constraint AASd-022:</strong></td>
<td><em>idShort</em> of non-identifiable referables shall be unique in its namespace.</td>
</tr>
<tr>
<td><strong>Note:</strong></td>
<td>In case the element is a property and the property has a semantic definition (HasSemantics) conformant to IEC61360 the <em>idShort</em> is typically identical to the short name in English.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>displayName</strong></th>
<th>Display name. Can be provided in several languages.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>If no display name is defined in the language requested by the application, then the display name is selected in the following order if available:</strong></td>
<td></td>
</tr>
<tr>
<td>- the preferred name in the requested language of the concept description defining the semantics of the element</td>
<td></td>
</tr>
<tr>
<td>- If there is a default language list defined in the application, then the corresponding preferred name in the language is chosen according to this order.</td>
<td></td>
</tr>
<tr>
<td>- the English preferred name of the concept description defining the semantics of the element</td>
<td></td>
</tr>
<tr>
<td>- the short name of the concept description</td>
<td></td>
</tr>
<tr>
<td>- the <em>idShort</em> of the element</td>
<td></td>
</tr>
<tr>
<td><strong>LangStringSet</strong></td>
<td>Attr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>category</strong></th>
<th>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Note:</strong></td>
<td>The category is not identical to the semantic definition (HasSemantics) of an element. The category e.g. could denote that the element is a measurement value whereas the semantic definition of the element would denote that it is the measured temperature.</td>
</tr>
<tr>
<td><strong>string</strong></td>
<td>attr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>description</strong></th>
<th>Description or comments on the element.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The description can be provided in several languages.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If no description is defined, then the definition of the concept description that defines the semantics of the element is used.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Additional information can be provided, e.g. if the element is qualified and which qualifier types can be expected in which context or which additional data specification templates are provided.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LangStringSet</strong></td>
<td>attr</td>
</tr>
</tbody>
</table>
### 4.7.2.3 Identifiable Attributes

#### An identifiable element

An identifiable element is a referable with a globally unique identifier (*Identifier*). To reference an identifiable only the global id (*identification/id*) shall be used because the *idShort* is not unique for an identifiable. Identifiables may have administrative information like version etc.

Referable elements not being identifiable can be referenced, but for doing so the context of the element is needed. A referable not being identifiable has a short identifier (*idShort*) that is unique just in its context, its name space.

#### Metamodel of Identifiables

![Metamodel of Identifiables](image)

#### Attributes

<table>
<thead>
<tr>
<th>Class</th>
<th>Identifiable &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation:</strong></td>
<td>An element that has a globally unique identifier.</td>
</tr>
<tr>
<td><strong>Inherits from:</strong></td>
<td>Referable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>administration</td>
<td>Administrative information of an identifiable element.</td>
<td>AdministrativeInformation</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>Note: Some of the administrative information like the version number might need to be part of the identification.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identification*</td>
<td>The globally unique identification of the element.</td>
<td>Identifier</td>
<td>attr</td>
<td>1</td>
</tr>
</tbody>
</table>
### 4.7.2.4 Identifier Attributes

#### Figure 16 Metamodel for Identifier

Information about identification can be found in Clause 4.4. In Clause 4.4.4 constraints and recommendation on when to use which type of Identifier can be found.

Examples for Identifiers can be found in Clause 4.4.3 Identifiers for Assets and Administration Shells. See Clause 4.4.4 for information which identifier types are supported.

<table>
<thead>
<tr>
<th>Class:</th>
<th>Identifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Used to uniquely identify an entity by using an identifier.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>idType*</td>
<td>Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration “IdentifierType”.</td>
<td>IdentifierType</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>id*</td>
<td>Globally unique identifier of the element. Its type is defined in idType.</td>
<td>Id</td>
<td>attr</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enumeration: IdentifierType</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation: Enumeration of different types of Identifiers for global identification</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literal</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRDI</td>
<td>IRDI according to ISO29002-5 as an Identifier scheme for properties and classifications.</td>
</tr>
<tr>
<td>IRI</td>
<td>IRI according to Rfc 3987. Every URI is an IRI.</td>
</tr>
<tr>
<td>Custom</td>
<td>Custom identifiers like GUIDs (globally unique identifiers)</td>
</tr>
</tbody>
</table>
### The Metamodel of the Administration Shell

#### 4.7.2.5 Template or Instance of Model Element Attributes (HasKind)

**Figure 17 Metamodel of HasKind**

<table>
<thead>
<tr>
<th>Class</th>
<th>HasKind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>An element with a kind is an element that can either represent a template or an instance. Default for an element is that it is representing an instance.</td>
</tr>
<tr>
<td>Inherits from</td>
<td>--</td>
</tr>
<tr>
<td>Attribute</td>
<td>Kind of the element: either type or instance. Default Value = Instance</td>
</tr>
<tr>
<td>Type</td>
<td>ModelingKind</td>
</tr>
<tr>
<td>Kind</td>
<td>attr</td>
</tr>
<tr>
<td>Card.</td>
<td>0..1</td>
</tr>
</tbody>
</table>

The kind enumeration is used to denote whether an element is of kind Template or Instance.

<table>
<thead>
<tr>
<th>Enumeration</th>
<th>ModelingKind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>Enumeration for denoting whether an element is a template or an instance.</td>
</tr>
<tr>
<td>Inherits from</td>
<td>--</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
</tbody>
</table>

**Template**

Software element which specifies the common attributes shared by all instances of the template.


**Instance**

Concrete, clearly identifiable component of a certain template.

- Note: It becomes an individual entity of a template, for example a device model, by defining specific property values.
- Note: In an object oriented view, an instance denotes an object of a template (class).

Every *Identifiable* may have administrative information. Administrative information includes for example

- Information about the version of the element
- Information about who created or who made the last change to the element
- Information about the languages available in case the element contains text, for translating purposes also the master or default language may be defined

In the first version of the AAS metamodel only version information is defined for administrative information. In later versions additional attributes may be added.

Version corresponds in principle to the `version_identifier` according to IEC 62832 but is not used for concept identifiers only (IEC TS 62832-1) but for all identifiable elements. Version and revision together correspond to the version number according to IEC 62832.

*AdministrativeInformation* allows the usage of templates (*HasDataSpecification*) but there are no predefined templates in this version of the metamodel.

Note: Some of the administrative information like the version number might need to be part of the identification.

<table>
<thead>
<tr>
<th>Class:</th>
<th>AdministrativeInformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Administrative metainformation for an element like version information.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>HasDataSpecification</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>version</td>
<td>Version of the element.</td>
<td>string</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>revision</td>
<td>Revision of the element.</td>
<td>string</td>
<td>attr</td>
<td>0..1</td>
</tr>
</tbody>
</table>

*Constraint AASd-005*: A revision requires a version. This means, if there is no version there is no revision neither.
4.7.2.7 Semantic References Attributes (HasSemantics)

Figure 19 Metamodel for Semantic References (HasSemantics)

<table>
<thead>
<tr>
<th>Class</th>
<th>HasSemantics &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>Element that can have a semantic definition.</td>
</tr>
<tr>
<td>Inherits from</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>semanticId</td>
<td>Identifier of the semantic definition of the element. It is called semantic id of the element.</td>
</tr>
</tbody>
</table>

4.7.2.8 Qualifiable Attributes

Figure 20 Metamodel of Qualifiables

<table>
<thead>
<tr>
<th>Class</th>
<th>Qualifiable &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>The value of a qualifiable element may be further qualified by one or more qualifiers or complex formulas.</td>
</tr>
<tr>
<td>Inherits from</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>qualifier</td>
<td>Additional qualification of a qualifiable element. Constraint AASd-021: Every qualifiable can only have one qualifier with the same Qualifier/type.</td>
</tr>
</tbody>
</table>
4.7.2.9 Constraint Attributes

Figure 21 Metamodel of Constraint Types

| Class: | Constraint <<abstract>> |
| Explanation: | A constraint is used to further qualify or restrict an element. |
| Inherits from: | -- |

4.7.2.10 Overview of Constraint Types

See Figure 22 for defined subtypes of constraints: qualifier and formula.

Figure 22 Metamodel of Constraint Types
4.7.2.11 Qualifier Attributes

For qualifiable elements, additional qualifiers may be defined. Besides other qualifiers, a level qualifier defining the level type minimal value, maximum value, typical value and nominal value can be found in IEC 62569-1. Additional qualifier types are defined in DIN SPEC 92000 like for example expressions semantics and expression logic.

If there are no predefined qualifier types or the additional qualification is quite complex, then instead of a set of qualifiers also a formula can be defined.

<table>
<thead>
<tr>
<th>Class:</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>Constraint; HasSemantics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>type*</td>
<td>The qualifier type describes the type of the qualifier that is applied to the element.</td>
<td>QualifierType</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>valueType*</td>
<td>Data type of the qualifier value.</td>
<td>DataTypeDef</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>value</td>
<td>The qualifier value is the value of the qualifier.</td>
<td>ValueDataType</td>
<td>attr</td>
<td>0..1</td>
</tr>
</tbody>
</table>

*Constraint AASd-063*: If the semanticId of a Qualifier references a ConceptDescription then the ConceptDescription/category shall be one of following values: QUALIFIER.

*Constraint AASd-006*: If both, the value and the valueId of a Qualifier are present then the value needs to be identical to the value of the referenced coded value in Qualifier/valueId.

*Constraint AASd-020*: The value of Qualifier/value shall be consistent to the data type as defined in Qualifier/valueType.
The Metamodel of the Administration Shell | 59

<table>
<thead>
<tr>
<th>Class:</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>valueId</td>
<td>Reference to the global unique id of a coded value.</td>
</tr>
</tbody>
</table>

It is recommended to add a `semanticId` for a `Qualifier`.

### 4.7.2.12 Formula Attributes

**Figure 24 Metamodel of Formulas**

![Metamodel of Formulas](image)

In Figure 25 an example for a formula depending on the property “Status” is shown. Up to now no formula language is defined for the AAS.

*Note: With this mechanism it is not possible so far to formulate formulas containing complex objects (e.g. submodel element collections or relationship elements). It is restricted to data elements or other elements for which there is a serialization as a string available and defined.*

#### Figure 25 Example Formula “Machine Status not Running”

```xml
<aas:Formula>
  <aas:dependsOn>
    <Keys>
      <Key local="True" type="AssetAdministrationShell" idType="IRI">http://myShell</Key>
      <Key local="True" type="Submodel" idType="IdShort">Maschine</Key>
      <Key local="True" type="Property" idType="IdShort">Status</Key>
    </Keys>
    != RUNNING
  </aas:dependsOn>
</aas:Formula>
```

<table>
<thead>
<tr>
<th>Class:</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A formula is used to describe constraints by a logical expression.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>Constraint</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>dependsOn</td>
<td>A formula may depend on referable or even external global elements that are used in the logical expression. The value of the referenced elements needs to be accessible so that it can be evaluated in the formula to true or false in the</td>
<td>Reference</td>
<td>aggr</td>
<td>0..*</td>
</tr>
</tbody>
</table>
4.7.2.13 Used Templates for Data Specification Attributes (HasDataSpecification)

Figure 26 Metamodel of HasDataSpecification

<table>
<thead>
<tr>
<th>Class:</th>
<th>HasDataSpecification &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Element that can be extended by using data specification templates. A data specification template defines a named set of additional attributes an element may or shall have. The data specifications used are explicitly specified with their global id.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>dataSpecification</td>
<td>Global reference to the data specification template used by the element.</td>
</tr>
</tbody>
</table>
4.7.3 Asset Administration Shell Attributes

An Administration Shell is uniquely identifiable since it inherits from `Identifiable`.

The `derivedFrom` attribute is used to establish a relationship between two Asset Administration Shells that are derived from each other. For more detailed information on the `derivedFrom` concept see Clause 4.2 Types and Instances.

<table>
<thead>
<tr>
<th>Class:</th>
<th>AssetAdministrationShell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>An Asset Administration Shell.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>Identifiable; HasDataSpecification</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>derivedFrom</td>
<td>The reference to the AAS the AAS was derived from.</td>
</tr>
<tr>
<td>security</td>
<td>Definition of the security relevant aspects of the AAS.</td>
</tr>
<tr>
<td>assetInformation*</td>
<td>Meta information about the asset the AAS is representing.</td>
</tr>
<tr>
<td>submodel</td>
<td>Reference to a submodel of the AAS. A submodel is a description of an aspect of the asset the AAS is representing. The asset of an AAS is typically described by one or more submodels. Temporarily no submodel might be assigned to the AAS.</td>
</tr>
<tr>
<td>view</td>
<td>A stakeholder specific view defined for the AAS.</td>
</tr>
</tbody>
</table>
4.7.4 Asset Attributes

Figure 29 Metamodel of Asset

The Asset can be referenced via globalAssetId of the AssetAdministrationShell/assetInformation.

Class: Asset

Explanation: An Asset describes meta data of an asset that is represented by an AAS and is identical for all AAS representing this asset. The asset has a globally unique identifier.

Inherits from: Identifiable; HasDataSpecification

Attribute (*=mandatory) | Explanation | Type | Kind | Card.
---|---|---|---|---

4.7.5 Asset Information Attributes

Figure 30 Metamodel of Asset Information

Class: AssetInformation

Explanation: In AssetInformation identifying meta data of the asset that is represented by an AAS is defined. The asset may either represent an asset type or an asset instance. The asset has a globally unique identifier plus – if needed – additional domain specific (proprietary) identifiers. However, to support the corner case of very first phase of lifecycle
**The Metamodel of the Administration Shell**

<table>
<thead>
<tr>
<th>Class:</th>
<th>AssetInformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>where a stabilised/constant global asset identifier does not already exist, the corresponding attribute “globalAssetId” is optional.</td>
<td></td>
</tr>
</tbody>
</table>

| Inherit from: | -- |

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>assetKind*</td>
<td>Denotes whether the Asset is of kind “Type” or “Instance”.</td>
<td>AssetKind</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>globalAssetId</td>
<td>Reference to either an Asset object or a global reference to the asset the AAS is representing. This attribute is required as soon as the AAS is exchanged via partners in the life cycle of the asset. In a first phase of the life cycle the asset might not yet have a global id but already an internal identifier. The internal identifier would be modelled via “specificAssetId”. Constraint AASd-023: AssetInformation/globalAssetId either is a reference to an Asset object or a global reference.</td>
<td>Reference</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>specificAssetId</td>
<td>Additional domain specific specific, typically proprietary Identifier for the asset like e.g. serial number etc.</td>
<td>IdentifierKeyValuePair</td>
<td>attr</td>
<td>0..*</td>
</tr>
<tr>
<td>billOfMaterial</td>
<td>A reference to a Submodel that defines the bill of material of the asset represented by the AAS. This submodel contains a set of entities describing the material used to compose the composite I4.0 Component.</td>
<td>Submodel</td>
<td>ref*</td>
<td>0..*</td>
</tr>
<tr>
<td>defaultThumbnail</td>
<td>Thumbnail of the asset represented by the asset administration shell. Used as default.</td>
<td>File</td>
<td>aggr</td>
<td>0..1</td>
</tr>
</tbody>
</table>

**Note:** Besides this asset information there still might be an identification submodel with further information. Specific asset ids mainly serve the purpose for supporting retrieval of AAS given an asset.

<table>
<thead>
<tr>
<th>Enumeration:</th>
<th>AssetKind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Enumeration for denoting whether an element is a type or an instance.</td>
</tr>
<tr>
<td>Inherit from:</td>
<td>--</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>hardware or software element which specifies the common attributes shared by all instances of the type [SOURCE: IEC TR 62390:2005-01, 3.1.25]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instance</td>
<td>concrete, clearly identifiable component of a certain type</td>
</tr>
</tbody>
</table>
The Metamodel of the Administration Shell

<table>
<thead>
<tr>
<th>Enumeration:</th>
<th>AssetKind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note 1: It becomes an individual entity of a type, for example a device, by defining specific property values.</td>
<td></td>
</tr>
<tr>
<td>Note 2: In an object oriented view, an instance denotes an object of a class (of a type).</td>
<td></td>
</tr>
</tbody>
</table>

For more information on types and instances see Clause 4.2.

<table>
<thead>
<tr>
<th>Class:</th>
<th>IdentifierKeyValuePair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>An IdentifierKeyValuePair describes a generic identifier as key-value pair.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>HasSemantics</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>key*</td>
<td>Key of the identifier</td>
</tr>
<tr>
<td>value</td>
<td>The value of the identifier with the corresponding key.</td>
</tr>
<tr>
<td>externalSubjectId</td>
<td>The (external) subject the key belongs to or has meaning to.</td>
</tr>
</tbody>
</table>

For more information on the concept of subject see Clause 5 on Attribute Based Access Control (ABAC).

4.7.6 Submodel Attributes

Figure 31 Metamodel of Submodel

<table>
<thead>
<tr>
<th>Class:</th>
<th>Submodel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A submodel defines a specific aspect of the asset represented by the AAS.</td>
</tr>
<tr>
<td></td>
<td>A submodel is used to structure the digital representation and technical functionality of an Administration Shell into distinguishable parts. Each submodel refers to a well-defined domain or subject matter. Submodels can become standardized and, thus, become submodels templates.</td>
</tr>
<tr>
<td></td>
<td>Constraint AASd-062: If the semanticId of a Property references a ConceptDescription then the ConceptDescription/category shall be one of following values: APPLICATION_CLASS.</td>
</tr>
</tbody>
</table>
The Metamodel of the Administration Shell | 65

<table>
<thead>
<tr>
<th>Class:</th>
<th>Submodel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherits from:</td>
<td>Identifiable; HasKind; HasSemantics; Qualifiable; HasDataSpecification</td>
</tr>
</tbody>
</table>

### Attribute (*=mandatory)

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A submodel consists of zero or more submodel elements.</td>
<td>SubmodelElement</td>
<td>aggr</td>
<td>0..*</td>
</tr>
</tbody>
</table>

It is recommended to add a `semanticId` for a submodel.

A submodel can be qualified (`Qualifiable`).

Submodel elements are qualifiable elements, i.e. one or more qualifier may be defined for each of them.

Submodels and submodel elements may also have data specification templates defined for them. So far no standardized data specification templates for submodels and submodel elements are defined.

In case the submodel is of `kind=Template` then the submodel elements within the submodel are presenting submodel element templates. In case the submodel is of `kind=Instance` then its submodel elements represent submodel element instances.

#### 4.7.7 Submodel Element Attributes

**Figure 32 Metamodel for Submodel**

Submodel element are qualifiable elements, i.e. one or more qualifier may be defined for each of them.

Submodel elements may also have data specification templates defined for them. A template might for example be defined to mirror some of the attributes like `preferredName` and `unit` of a property definition if the AAS does not contain a corresponding concept description. Otherwise there only is the property definition referenced by `semanticId` available for the property: the lookup of the attributes has to be realized online in a different way and is not available offline.

In case the submodel is of `kind=Template` then the submodel elements within the submodel are presenting submodel element types. In case the submodel is of `kind=Instance` then its submodel elements represent submodel element instances.

<table>
<thead>
<tr>
<th>Class:</th>
<th>SubmodelElement &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A submodel element is an element suitable for the description and differentiation of assets. It is recommended to add a <code>semanticId</code> to a <code>SubmodelElement</code>.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>Referable; HasKind; HasSemantics; Qualifiable; HasDataSpecification;</td>
</tr>
</tbody>
</table>

### Attribute (*=mandatory)

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.7.8 Overview of Submodel Element Types

Figure 33 Metamodel Overview for Submodel Element Subtypes
Submodel elements include data properties as well as operations, events and other elements needed to describe a model for an asset (see Figure 33).

### 4.7.8.1 Annotated Relationship Element Attributes

**Figure 34 Metamodel of Annotated Relationship Elements**

<table>
<thead>
<tr>
<th>Class:</th>
<th>AnnotatedRelationshipElement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation:</strong></td>
<td>An annotated relationship element is a relationship element that can be annotated with additional data elements.</td>
</tr>
<tr>
<td></td>
<td>See Constraint AASd-055</td>
</tr>
<tr>
<td><strong>Inherits from:</strong></td>
<td>RelationshipElement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>annotation</td>
<td>A reference to a data element that represents an annotation that holds for the relationship between the two elements.</td>
<td>DataElement</td>
<td>ref*</td>
<td>0..*</td>
</tr>
</tbody>
</table>

### 4.7.8.2 Basic Event Attributes

**Figure 35 Metamodel of Basic Events**
68 | The Metamodel of the Administration Shell

<table>
<thead>
<tr>
<th>Class:</th>
<th>BasicEvent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A basic event.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>Event</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>observed*</td>
<td>Reference to a referable, e.g. a data element or a submodel, that is being observed.</td>
<td>Referable</td>
<td>ref*</td>
<td>1</td>
</tr>
</tbody>
</table>

### 4.7.8.3 Capability Attributes

Figure 36 Metamodel of Capabilities

```
Capability
```

<table>
<thead>
<tr>
<th>Class:</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A capability is the implementation-independent description of the potential of an asset to achieve a certain effect in the physical or virtual world. Constraint AASd-058: If the <code>semanticId</code> of a Capability submodel element references a <code>ConceptDescription</code> then the <code>ConceptDescription/category</code> shall be <code>CAPABILITY</code>.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SubmodelElement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The `semanticId` of a capability is typically an ontology. Thus, reasoning on capabilities is enabled.

For information and examples how to apply the concept of capability and how to map it to one or more skills implementing the capability please refer to [36]. The mapping is done via a relationship element with the corresponding semantics. A skill is typically a property or an operation. In more complex cases the mapping can also be a collection or a complete submodel.

### 4.7.8.4 Blob Attributes

Figure 37 Metamodel of Blobs

```
Blob
+ value: BlobType [0..1]
+ mimeType: MimeType
```

For information on mime type see clause 4.7.8.8 on submodel element “File”. 
The Metamodel of the Administration Shell | 69

<table>
<thead>
<tr>
<th>Class:</th>
<th>Blob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A BLOB is a data element that represents a file that is contained with its source code in the value attribute. Constraint AASd-057: The semanticId of a File or Blob submodel element shall only reference a ConceptDescription with the category DOCUMENT.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td><strong>DataElement</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>The value of the BLOB instance of a blob data element. Note: In contrast to the file property the file content is stored directly as value in the Blob data element.</td>
<td>BlobType</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>mimeType*</td>
<td>Mime type of the content of the BLOB. The mime type states which file extensions the file can have. Valid values are e.g. “application/json”, “application/xls”, ”image/jpg” The allowed values are defined as in RFC2046.</td>
<td>MimeType</td>
<td>attr</td>
<td>1</td>
</tr>
</tbody>
</table>

4.7.8.5 Data Element and Overview of Data Element Types

Figure 38 Metamodel for Data Elements

A data element is a submodel element that is not further composed out of other submodel elements.

A data element is a submodel element that has a value or a predefined number of values like range data elements.

A controlled value is a value whose meaning is given in an external source (see “ISO/TS 29002-10:2009(E)”).
The type of value differs for different subtypes of data elements. Data Elements include properties and file handling and reference elements, see Figure 38.

In Table 5 categories defined for data elements except for files and blobs are defined.

<table>
<thead>
<tr>
<th>Category:</th>
<th>Applicable to:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>Property</td>
<td>A constant property is a property with a value that does not change over time.</td>
</tr>
<tr>
<td></td>
<td>MultiLanguageProperty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ReferenceElement</td>
<td>In ECLASS this kind of category has the category “Coded Value”.</td>
</tr>
<tr>
<td>PARAMETER</td>
<td>Property</td>
<td>A parameter property is a property that is once set and then typically does not change over time.</td>
</tr>
<tr>
<td></td>
<td>MultiLanguageProperty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ReferenceElement</td>
<td>This is for example the case for configuration parameters.</td>
</tr>
<tr>
<td>VARIABLE</td>
<td>Property</td>
<td>A variable property is a property that is calculated during runtime, i.e.</td>
</tr>
<tr>
<td></td>
<td>MultiLanguageProperty</td>
<td>its value is a runtime value.</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ReferenceElement</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 Categories for Data Elements

<table>
<thead>
<tr>
<th>Class:</th>
<th>DataElement &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>A data element is a submodel element that is not further composed out of other submodel elements.</td>
</tr>
<tr>
<td></td>
<td>A data element is a submodel element that has a value. The type of value differs for different subtypes of data elements.</td>
</tr>
<tr>
<td>Constraint</td>
<td>AASd-090: For data elements DataElement/category shall be one of the following values: CONSTANT, PARAMETER or VARIABLE. Exception: File and Blob data elements.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>SubmodelElement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
</table>
### The Metamodel of the Administration Shell | 71

#### 4.7.8.6 Entity Attributes

**Figure 39 Metamodel of Entities**

<table>
<thead>
<tr>
<th>Class:</th>
<th>Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation:</strong></td>
<td>An entity is a submodel element that is used to model entities. <strong>Constraint AASd-056:</strong> If the semanticId of a Entity submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: ENTITY. The ConceptDescription describes the elements assigned to the entity via Entity/statement.</td>
</tr>
<tr>
<td><strong>Inherits from:</strong></td>
<td>SubmodelElement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>statement</td>
<td>Describes statements applicable to the entity by a set of submodel elements, typically with a qualified value.</td>
<td>SubmodelElement</td>
<td>aggr</td>
<td>0..*</td>
</tr>
<tr>
<td>entityType*</td>
<td>Describes whether the entity is a co-managed entity or a self-managed entity.</td>
<td>EntityType</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>globalAssetId</td>
<td>Reference to the asset the entity is representing. <strong>Constraint AASd-014:</strong> Either the attribute <code>globalAssetId</code> or <code>specificAssetId</code> of an Entity must be set if <code>Entity/entityType</code> is set to “SelfManagedEntity”. They are not existing otherwise.</td>
<td>Reference</td>
<td>aggr</td>
<td>0..1</td>
</tr>
<tr>
<td>specificAssetId</td>
<td>Reference to an identifier key value pair representing a specific identifier of the asset represented by the asset administration shell. See Constraint AASd-014</td>
<td>IdentifierKeyValuePair</td>
<td>aggr</td>
<td>0..1</td>
</tr>
</tbody>
</table>
72 | The Metamodel of the Administration Shell

| Enumeration: | EntityType |
| Explanation: | Enumeration for denoting whether an entity is a self-managed entity or a co-managed entity. |
| Inherits from: | -- |
| Literal | Explanation |

| CoManagedEntity | For co-managed entities there is no separate AAS. Co-managed entities need to be part of a self-managed entity. |
| SelfManagedEntity | Self-Managed Entities have their own AAS but can be part of the bill of material of a composite self-managed entity. The asset of an I4.0 Component is a self-managed entity per definition. |

### 4.7.8.7 Event Attributes

**Figure 40 Metamodel of Events**

| Class: | Event <<abstract>> |
| Explanation: | An event |
| Inherits from: | SubmodelElement |
| Attribute (*=mandatory) | Explanation | Type | Kind | Card. |

### 4.7.8.8 File Attributes

**Figure 41 Metamodel for File Submodel Element**

A media type (also MIME type and content type) […] is a two-part Identifier for file formats and format contents transmitted on the Internet. The Internet Assigned Numbers Authority (IANA) is the official authority for the standardization and publication of these classifications. Media types were originally defined in Request for Comments 2045 in November 1996 as a part of MIME (Multipurpose Internet Mail Extensions) specification, for denoting type of email message content and attachments.⁹

---

⁹ Wikipedia.org, date: 2018-04-09
The Metamodel of the Administration Shell | 73

**Class:** File

**Explanation:**
A File is a data element that represents an address to a file. The value is an URI that can represent an absolute or relative path.

See Constraint AASd-057

**Inherits from:** SubmodelElement

### Attribute (*=mandatory)

<table>
<thead>
<tr>
<th>Name</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>Path and name of the referenced file (with file extension). The path can be absolute or relative.</td>
<td>PathType</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>mimeType*</td>
<td>Mime type of the content of the file. The mime type states which file extensions the file can have.</td>
<td>MimeType</td>
<td>attr</td>
<td>1</td>
</tr>
</tbody>
</table>

For handling of supplementary external files in exchanging AAS specification in aasx format see also Clause 6.3 Conventions for the Asset Administration Shell Package File Format (AASX). An absolute path is used in the case that the file exists independently of the AAS. A relative path, relative to the package root should be used if the file is part of the serialized package of the AAS.

### 4.7.8.9 Multi Language Property Attributes

**Figure 42 Metamodel of Multi Language Properties**

For handling of supplementary external files in exchanging AAS specification in aasx format see also Clause 6.3 Conventions for the Asset Administration Shell Package File Format (AASX). An absolute path is used in the case that the file exists independently of the AAS. A relative path, relative to the package root should be used if the file is part of the serialized package of the AAS.

**Class:** MultiLanguageProperty

**Explanation:**
A property is a data element that has a multi-language value.

**Constraint AASd-052b:** If the semanticId of a MultiLanguageProperty references a ConceptDescription then the ConceptDescription/category shall be one of following values: PROPERTY.

**Constraint AASd-012:** If both, the MultiLanguageProperty/value and the MultiLanguageProperty/valueId are present then for each string in a specific language the meaning must be the same as specified in MultiLanguageProperty/valueId.

**Constraint AASd-067:** If the semanticId of a MultiLanguageProperty references a ConceptDescription then DataSpecificationIEC61360/dataType shall be STRING_TRANSLATABLE.

See Constraint AASd-065
74 | The Metamodel of the Administration Shell

### MultiLanguageProperty

<table>
<thead>
<tr>
<th>Class:</th>
<th>MultiLanguageProperty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherits from:</td>
<td>DataElement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>The value of the property instance.</td>
<td>LangStringSet</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>See Constraint AASd-012</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>See Constraint AASd-065</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>valueId</td>
<td>Reference to the global unique id of a coded value.</td>
<td>Reference</td>
<td>aggr</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>See Constraint AASd-012</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>See Constraint AASd-065</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Operation Attributes

#### Figure 43 Metamodel of Operations

**Class:** Operation

**Explanation:** An operation is a submodel element with input and output variables.

**Constraint AASd-060:** If the semanticId of a Operation submodel element references a ConceptDescription then the category of the ConceptDescription shall be one of the following values: FUNCTION.

<table>
<thead>
<tr>
<th>Inherits from:</th>
<th>SubmodelElement</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>inputVariable</td>
<td>Input parameter of the operation.</td>
<td>OperationVariable</td>
<td>aggr</td>
<td>0..*</td>
</tr>
<tr>
<td>outputVariable</td>
<td>Output parameter of the operation.</td>
<td>OperationVariable</td>
<td>aggr</td>
<td>0..*</td>
</tr>
<tr>
<td>inoutputVariable</td>
<td>Parameter that is input and output of the operation.</td>
<td>OperationVariable</td>
<td>aggr</td>
<td>0..*</td>
</tr>
</tbody>
</table>

### OperationVariable

**Class:** OperationVariable

**Explanation:** An operation variable is a submodel element that is used as input or output variable of an operation.
The Metamodel of the Administration Shell | 75

| Class: | OperationVariable |
| Inherits from: | |

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>value*</td>
<td>Describes the needed argument for an operation via a submodel element of kind=Template. <strong>Constraint AASd-008</strong>: The submodel element value of an operation variable shall be of kind=Template.</td>
<td>SubmodelElement</td>
<td>aggr</td>
<td>1</td>
</tr>
</tbody>
</table>

**Note:** Operations typically specify the behavior of a component in terms of procedures. Hence, operations enable the specification of services with procedure-based interactions [32].

4.7.8.11 Property Attributes

**Figure 44 Metamodel of Properties**

| Class: | Property |
| Explanation: | A property is a data element that has a single value. **Constraint AASd-007**: If both, the Property/value and the Property/valueId are present then the value of Property/value needs to be identical to the value of the referenced coded value in Property/valueId. **Constraint AASd-052a**: If the semanticId of a Property references a ConceptDescription then the ConceptDescription/category shall be one of following values: VALUE, PROPERTY. **Constraint AASd-065**: If the semanticId of a Property or MultiLanguageProperty references a ConceptDescription with the category VALUE then the value of the property is identical to DataSpecificationIEC61360/value and the valueId of the property is identical to DataSpecificationIEC61360/valueId. **Constraint AASd-066**: If the semanticId of a Property or MultiLanguageProperty references a ConceptDescription with the category PROPERTY and DataSpecificationIEC61360/valueList is defined the value and valueId of the property is identical to one of the value reference pair types references in the value list, i.e. ValueReferencePairType/value or ValueReferencePairType/valueId, resp. |
| Inherits from: | DataElement |

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>valueType*</td>
<td>Data type of the value</td>
<td>DataTypeDef</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>value</td>
<td>The value of the property instance.</td>
<td>ValueDataType</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>Class:</td>
<td>Property</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>See Constraint AASd-065</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>See Constraint AASd-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>valueId</th>
<th>Reference to the global unique id of a coded value.</th>
<th>Reference</th>
<th>aggr</th>
<th>0..1</th>
</tr>
</thead>
<tbody>
<tr>
<td>See Constraint AASd-065</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>See Constraint AASd-007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4.7.8.12 Range Attributes

**Figure 45 Metamodel of Ranges**

Class: Range

**Explanation:** A range data element is a data element that defines a range with min and max.

- **Constraint AASd-053:** If the semanticId of a Range submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: PROPERTY.
- **Constraint AASd-068:** If the semanticId of a Range submodel element references a ConceptDescription then DataSpecificationIEC61360/dataType shall be a numerical one, i.e. REAL_* or RATIONAL_*.  
- **Constraint AASd-069:** If the semanticId of a Range references a ConceptDescription then DataSpecificationIEC61360/levelType shall be identical to the set {Min, Max}.

**Inherits from:** DataElement

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>valueType*</td>
<td>Data type of the min und max</td>
<td>DataTypeDef</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>min</td>
<td>The minimum value of the range. If the min value is missing, then the value is assumed to be negative infinite.</td>
<td>ValueDataType</td>
<td>attr</td>
<td>0..1</td>
</tr>
<tr>
<td>max</td>
<td>The maximum value of the range. If the max value is missing, then the value is assumed to be positive infinite.</td>
<td>ValueDataType</td>
<td>attr</td>
<td>0..1</td>
</tr>
</tbody>
</table>
If the semanticId of a Range Submodel element is a reference to a concept description then it is a concept description with data specification IEC61360. The value for levelType of this data specification is the set \{Min, Max\}.

### 4.7.8.13 Reference Element Attributes

**Figure 46 Metamodel of Reference Elements**

<table>
<thead>
<tr>
<th>Class:</th>
<th>ReferenceElement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A reference element is a data element that defines a logical reference to another element within the same or another AAS or a reference to an external object or entity.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>DataElement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>Reference to any other referable element of the same of any other AAS or a reference to an external object or entity.</td>
<td>Reference</td>
<td>aggr</td>
<td>0..1</td>
</tr>
</tbody>
</table>

For more information on references see Clause 4.7.11.

### 4.7.8.14 Relationship Element Attributes

**Figure 47 Metamodel of Relationship Elements**

<table>
<thead>
<tr>
<th>Class:</th>
<th>RelationshipElement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A relationship element is used to define a relationship between two referable elements.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>SubmodelElement</td>
</tr>
</tbody>
</table>

Constraint AASd-055: If the semanticId of a RelationshipElement or an AnnotatedRelationshipElement submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: RELATIONSHIP.
4.7.8.15 Submodel Element Collection Attributes

Figure 48 Metamodel for Submodel Element Collections

If `allowDuplicates`==true, then it is allowed that the collection contains several elements with the same semantics (i.e. the same `semanticId`).

If `allowDuplicates`==false, then it is not allowed that the collection contains several elements with the same semantics (i.e. the same `semanticId`).

Class: SubmodelElementCollection

Explanation: A submodel element collection is a set or list of submodel elements.

Constraint AASd-059: If the `semanticId` of a SubmodelElementCollection references a ConceptDescription then the category of the ConceptDescription shall be COLLECTION or ENTITY.

Constraint AASd-092: If the `semanticId` of a SubmodelElementCollection with SubmodelElementCollection/allowDuplicates == false references a ConceptDescription then the ConceptDescription/category shall be ENTITY.

Constraint AASd-093: If the `semanticId` of a SubmodelElementCollection with SubmodelElementCollection/allowDuplicates == true references a ConceptDescription then the ConceptDescription/category shall be COLLECTION.
**The Metamodel of the Administration Shell | 79**

<table>
<thead>
<tr>
<th>Class:</th>
<th>SubmodelElementCollection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: A set of documents is referencing a concept description of category COLLECTION. A document within this collection is described as a SubmodelElementCollection referencing a concept description of category ENTITY. Note: this means that no generic semanticId can be assigned to an element within a submodel element collection with allowDuplicates == false: every element within the entity needs a clear and unique semantics.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inherits from:</th>
<th>SubmodelElement</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Attribute ( *=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>Submodel element contained in the collection.</td>
<td>SubmodelElement</td>
<td>aggr</td>
<td>0..*</td>
</tr>
<tr>
<td>ordered</td>
<td>If ordered=false, then the elements in the collection are not ordered. If ordered=true, then the elements in the collection are ordered. Default = false</td>
<td>boolean</td>
<td>attr</td>
<td>0..1</td>
</tr>
</tbody>
</table>

Note: An ordered submodel element collection is typically implemented as an indexed array.

| allowDuplicates         | If allowDuplicates==true, then it is allowed that the collection contains several elements with the same semantics (i.e. the same semanticId). Constraint AASd-026: If allowDuplicates==false then it is not allowed that the collection contains several elements with the same semantics (i.e. the same semanticId). Default = false | boolean | attr  | 0..1  |

| 4.7.9 Concept Description Attributes |

**Figure 49 Metamodel of Concept Descriptions**

![Concept Description Metamodel](image)
### The Metamodel of the Administration Shell

<table>
<thead>
<tr>
<th>Class:</th>
<th>ConceptDescription</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation:</strong></td>
<td>The semantics of a property or other elements that may have a semantic description is defined by a concept description. The description of the concept should follow a standardized schema (realized as data specification template).</td>
</tr>
</tbody>
</table>

**Constraint AASd-051:** A ConceptDescription shall have one of the following categories: VALUE, PROPERTY, REFERENCE, DOCUMENT, CAPABILITY, RELATIONSHIP, COLLECTION, FUNCTION, EVENT, ENTITY, APPLICATION_CLASS, QUALIFIER, VIEW. Default: PROPERTY.

| Inherits from: | Identifiable; HasDataSpecification |

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>isCaseOf</td>
<td>Reference to an external definition the concept is compatible to or was derived from.</td>
<td>Reference</td>
<td>aggr</td>
<td>0..*</td>
</tr>
</tbody>
</table>

Note: Compare to is-case-of relationship in ISO 13584-32 & IEC EN 61360

Different types of submodel elements require different attributes for describing the semantics of them. This is why a concept description has at least one data specification template associated with it. Within this template the attributes needed to define the semantics are defined.

See Clause 4.8 for predefined data specification templates to be used.

#### 4.7.10 View Attributes

### Figure 50 Metamodel of Views

The large number of submodel elements within a submodel can be filtered by views, so that different user groups can only see relevant elements.

Note: Views are a projection of submodel elements for a given perspective. They are not equivalent to submodels.

<table>
<thead>
<tr>
<th>Class:</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation:</strong></td>
<td>A view is a collection of referable elements w.r.t. to a specific viewpoint of one or more stakeholders.</td>
</tr>
</tbody>
</table>

**Constraint AASd-064:** If the semanticId of a View references a ConceptDescription then the category of the ConceptDescription shall be VIEW.

| Inherits from: | Referable; HasSemantics; HasDataSpecification |
The Metamodel of the Administration Shell | 81

<table>
<thead>
<tr>
<th>Class:</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>containedElement</td>
<td>Reference to a referable element that is contained in the view.</td>
</tr>
</tbody>
</table>

It is recommended to add a **semanticId** for a view.

### 4.7.11 Referencing in Asset Administration Shells

Figure 51 Metamodel for References and Keys

Note: References are used throughout the metamodel although not directly visible.

If an element is not a part of an element but just references it, this is denoted by an * behind the Type.

E.g. asset: Asset* means that asset: Reference with Key/type=Asset for the last Key in the Reference
### The Metamodel of the Administration Shell

See Clause 7.2.1 for more information on global and model references etc.

<table>
<thead>
<tr>
<th>Class:</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Reference to either a model element of the same or another AAs or to an external entity. A reference is an ordered list of keys, each key referencing an element. The complete list of keys may for example be concatenated to a path that then gives unique access to an element or entity.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>key*</td>
<td>Unique reference in its name space.</td>
<td>Key</td>
<td>attr</td>
<td>1..*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A key is a reference to an element by its id.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>type*</td>
<td>Denote which kind of entity is referenced.</td>
<td>KeyElements</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>In case type = GlobalReference then the key represents a global unique id.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In case type = FragmentId the key represents a bookmark or a similar local identifier within its parent element as specified by the ky that precedes this key.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In all other cases the key references a model element of the same or of another AAS. The name of the model element is explicitly listed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>value*</td>
<td>The key value, for example an IRDI if the idType = IRDI.</td>
<td>string</td>
<td>attr</td>
<td>1</td>
</tr>
<tr>
<td>idType*</td>
<td>Type of the key value.</td>
<td>KeyType</td>
<td>attr</td>
<td>1</td>
</tr>
</tbody>
</table>

**Constraint AASd-080:** In case Key/type = GlobalReference idType shall not be any LocalKeyType (IdShort, FragmentId).

**Constraint AASd-081:** In case Key/type = AssetAdministrationShell Key/idType shall not be any LocalKeyType (IdShort, FragmentId).
<table>
<thead>
<tr>
<th>Enumeration:</th>
<th>KeyElements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Enumeration of different key value types within a key.</td>
</tr>
<tr>
<td>Set of:</td>
<td>ReferableElements</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
<tr>
<td>GlobalReference</td>
<td>reference to an element not belonging to an asset administration shell</td>
</tr>
<tr>
<td>FragmentReference</td>
<td>unique reference to an element within a file. The file itself is assumed to be part of an asset administration shell.</td>
</tr>
<tr>
<td>AccessPermissionRule</td>
<td>Access Permission Rule</td>
</tr>
<tr>
<td>AnnotatedRelationshipElement</td>
<td>Annotated relationship element</td>
</tr>
<tr>
<td>Asset</td>
<td>Asset</td>
</tr>
<tr>
<td>AssetAdministrationShell</td>
<td>Asset Administration Shell</td>
</tr>
<tr>
<td>BasicEvent</td>
<td>Basic Event</td>
</tr>
<tr>
<td>Blob</td>
<td>Blob</td>
</tr>
<tr>
<td>Capability</td>
<td>Capability</td>
</tr>
<tr>
<td>ConceptDescription</td>
<td>Concept Description</td>
</tr>
<tr>
<td>ConceptDictionary</td>
<td>Concept Dictionary</td>
</tr>
<tr>
<td>DataElement</td>
<td>Data Element.</td>
</tr>
<tr>
<td></td>
<td>Note: Data Element is abstract, i.e. if a key uses “DataElement” the reference may be a Property, a File etc.</td>
</tr>
<tr>
<td>Entity</td>
<td>Entity</td>
</tr>
<tr>
<td>Event</td>
<td>Event</td>
</tr>
<tr>
<td></td>
<td>Note: Event is abstract</td>
</tr>
<tr>
<td>File</td>
<td>File</td>
</tr>
<tr>
<td>MultiLanguageProperty</td>
<td>Property with a value that can be provided in multiple languages</td>
</tr>
<tr>
<td>Operation</td>
<td>Operation</td>
</tr>
<tr>
<td>Property</td>
<td>Property</td>
</tr>
<tr>
<td>Range</td>
<td>Range with min and max</td>
</tr>
<tr>
<td>ReferenceElement</td>
<td>Reference</td>
</tr>
<tr>
<td>RelationshipElement</td>
<td>Relationship</td>
</tr>
<tr>
<td>Submodel</td>
<td>Submodel</td>
</tr>
<tr>
<td>SubmodelElement</td>
<td>Submodel Element</td>
</tr>
<tr>
<td></td>
<td>Note: Submodel Element is abstract, i.e. if a key uses “SubmodelElement” the reference may be a Property, a SubmodelElementCollection, an Operation etc.</td>
</tr>
<tr>
<td>SubmodelElementCollection</td>
<td>Collection of Submodel Elements</td>
</tr>
<tr>
<td>View</td>
<td>View</td>
</tr>
<tr>
<td>Enumeration:</td>
<td>ReferableElements</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Explanation:</td>
<td>Enumeration of all referable elements within an asset administration shell</td>
</tr>
<tr>
<td>Set of:</td>
<td>IdentifiableElements</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
<tr>
<td>AccessPermissionRule</td>
<td>Access Permission Rule</td>
</tr>
<tr>
<td>AnnotatedRelationshipElement</td>
<td>Annotated relationship element</td>
</tr>
<tr>
<td>Asset</td>
<td>Asset</td>
</tr>
<tr>
<td>AssetAdministrationShell</td>
<td>Asset Administration Shell</td>
</tr>
<tr>
<td>BasicEvent</td>
<td>Basic Event</td>
</tr>
<tr>
<td>Blob</td>
<td>Blob</td>
</tr>
<tr>
<td>Capability</td>
<td>Capability</td>
</tr>
<tr>
<td>ConceptDescription</td>
<td>Concept Description</td>
</tr>
<tr>
<td>ConceptDictionary</td>
<td>Concept Dictionary</td>
</tr>
<tr>
<td>DataElement</td>
<td>Data Element.</td>
</tr>
<tr>
<td></td>
<td>Note: Data Element is abstract, i.e. if a key uses “DataElement” the reference may be a Property, a File etc.</td>
</tr>
<tr>
<td>Entity</td>
<td>Entity</td>
</tr>
<tr>
<td>Event</td>
<td>Event</td>
</tr>
<tr>
<td></td>
<td>Note: Event is abstract</td>
</tr>
<tr>
<td>File</td>
<td>File</td>
</tr>
<tr>
<td>MultiLanguageProperty</td>
<td>Property with a value that can be provided in multiple languages</td>
</tr>
<tr>
<td>Operation</td>
<td>Operation</td>
</tr>
<tr>
<td>Property</td>
<td>Property</td>
</tr>
<tr>
<td>Range</td>
<td>Range with min and max</td>
</tr>
<tr>
<td>ReferenceElement</td>
<td>Reference</td>
</tr>
<tr>
<td>RelationshipElement</td>
<td>Relationship</td>
</tr>
<tr>
<td>Submodel</td>
<td>Submodel</td>
</tr>
<tr>
<td>SubmodelElement</td>
<td>Submodel Element</td>
</tr>
<tr>
<td></td>
<td>Note: Submodel Element is abstract, i.e. if a key uses “SubmodelElement” the reference may be a Property, a SubmodelElementCollection, an Operation etc.</td>
</tr>
<tr>
<td>SubmodelElementCollection</td>
<td>Collection of Submodel Elements</td>
</tr>
<tr>
<td>View</td>
<td>View</td>
</tr>
<tr>
<td>Enumeration:</td>
<td>IdentifiableElements</td>
</tr>
</tbody>
</table>
### The Metamodel of the Administration Shell | 85

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Enumeration of all identifiable elements within an asset administration shell that are not identifiable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set of:</td>
<td>--</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
<tr>
<td>Asset</td>
<td>Asset</td>
</tr>
<tr>
<td>AssetAdministrationShell</td>
<td>Asset Administration Shell</td>
</tr>
<tr>
<td>ConceptDescription</td>
<td>Concept Description</td>
</tr>
<tr>
<td>Submodel</td>
<td>Submodel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enumeration</th>
<th>KeyType</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>Enumeration of different key value types within a key.</td>
</tr>
<tr>
<td>Set of:</td>
<td>LocalKeyType, IdentifierType</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
<tr>
<td>IdShort</td>
<td>idShort of a referable element</td>
</tr>
<tr>
<td>FragmentId</td>
<td>Identifier of a fragment within a file</td>
</tr>
<tr>
<td>IRDI</td>
<td>IRDI according to ISO29002-5 as an Identifier scheme for properties and classifications.</td>
</tr>
<tr>
<td>IRI</td>
<td>IRI according to Rfc 3987. Every URI is an IRI.</td>
</tr>
<tr>
<td>Custom</td>
<td>Custom identifiers like GUIDs (globally unique identifiers)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enumeration</th>
<th>LocalKeyType</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>Enumeration of different key value types within a key.</td>
</tr>
<tr>
<td>Literal</td>
<td>Explanation</td>
</tr>
<tr>
<td>IdShort</td>
<td>idShort of a referable element</td>
</tr>
<tr>
<td>FragmentId</td>
<td>Identifier of a fragment within a file</td>
</tr>
</tbody>
</table>

**IdentifierType** is defined in Clause 4.7.2.4.

### 4.7.12 Templates, Inheritance, Qualifiers and Categories

On a first glance there seem to be some overlapping between the concept of data specification templates, inheritance, qualifiers and categories. In this clause the commonalities and differences are explained and hints for good practices are given.

In general extension of the metamodel by inheritance is allowed. As an alternative also templates might be used.

- Templates should only be used if different instances of the class follow different schemas and the templates for the schemas are not known at design time. Templates might also be used if the overall metamodel is not yet stable enough or a tool does support templates but not (yet) the complete metamodel.
- However: when using non-standardized proprietary data specification templates interoperability cannot be ensured and thus should be avoided whenever possible.
- In case all instances of a class follow the same schema then inheritance and/or categories should be used.
- Categories can be used if all instances of a class follow the same schema but have different constraints depending on its category. Such a constraint might specify that an optional attribute is mandatory for this...
category (like for example the unit that is mandatory for properties representing physical values). Realizing the same via inheritance would lead to multiple inheritance what is to be omitted.

- Qualifiers are used if the semantics of the element is the same independent of its qualifiers. It is only the quality or the meaning of the value for the element that differs.

4.7.13 Data Types

4.7.13.1 Predefined Basic Data Types

The predefined types used to define the metamodel use the names and the semantics of XML Schema Definition (XSD)\(^\text{10}\). Additionally, the type “langString” with the semantics as defined in the Resource Description Framework (RDF)\(^\text{11}\) is used. “langString” is a string value tagged with a language code.

**Constraint AASd-100**: An attribute with data type ”string” is not allowed to be empty.

\(^{10}\) see: [https://www.w3.org/XML/Schema](https://www.w3.org/XML/Schema)

\(^{11}\) see: [https://www.w3.org/TR/rdf11-concepts/](https://www.w3.org/TR/rdf11-concepts/)
4.7.13.2 Data Types

Types that are used for specific data specification templates are listed in the corresponding clause of the data specification. The meaning and format of xsd types is specified in https://www.w3.org/XML/Schema.

Table 6 lists additional data types used in the metamodel. Figure 53 specifies LangStringSet as set of elements of rdf type “langString”.

---

Figure 52 Built-In Types of XML Schema Definition 1.1 (XSD)
<table>
<thead>
<tr>
<th>Type</th>
<th>Basic Type</th>
<th>Value Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>DataTypeDef</td>
<td>string</td>
<td>integer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>datatype</td>
</tr>
<tr>
<td></td>
<td></td>
<td>unsignedByte</td>
</tr>
<tr>
<td>Id</td>
<td>string</td>
<td><a href="https://cust/123456">https://cust/123456</a> 0173-1#02-BAA120#008</td>
</tr>
<tr>
<td>MimeType</td>
<td>string</td>
<td>application/pdf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>image/jpeg</td>
</tr>
<tr>
<td>PathType</td>
<td>string</td>
<td>\Specification.pdf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C:\local\Specification.pdf</td>
</tr>
<tr>
<td>QualifierType</td>
<td>string</td>
<td>ExpressionSemantic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>life cycle qual</td>
</tr>
<tr>
<td>ValueDataType</td>
<td>any xsd atomic type as specified via DataTypesDef</td>
<td>“This is a string value” 10 1.5 2020-04-01 True</td>
</tr>
</tbody>
</table>
The Metamodel of the Administration Shell | 89

Figure 53 Data Type LangStringSet

<table>
<thead>
<tr>
<th>Class:</th>
<th>LangStringSet &lt;&lt;DataType&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A set of strings, each annotated by the language of the string. The meaning of the string in each language shall be the same.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>langString</td>
<td>A string in a specified language.</td>
<td>langString</td>
<td>aggr</td>
<td>1..*</td>
</tr>
</tbody>
</table>

4.8 Predefined Data Specification Templates

4.8.1 Concept of Data Specification Templates

Figure 54 Concept of Data Specification Templates

Note: The Data Specification Templates do not belong to the metamodel of the Asset Administration Shell. In serializations that choose specific templates the corresponding data specification content may be directly incorporated.

It is required that a data specification template has a global unique id so that is can be referenced via HasDataSpecification/dataSpecification.

A template consists of the DataSpecificationContent containing the additional attributes to be added to the element instance that references the data specification template and meta information about the template itself (this is why DataSpecification inherits from Identifiable). In UML these are two separated classes.

4.8.2 Predefined Templates for Property and Value Descriptions

Conformant to the rules in Clause 7.2.4 the following data specification template needs to be referenced via the id


(in hasDataSpecification/dataSpecification).
This namespace has the qualifier “IEC:” Examples: IEC:DataSpecificationIEC61360/preferredName or IEC:DataSpecificationIEC61360/levelType/Min or IEC:LevelType/Min

Note: The data specification template is not identical to the data specification content as shown in Figure 55.

**Figure 55 Data Specification Template for defining Property Descriptions conformant to IEC 61360**

---

**Class:** DataSpecificationIEC61360 <<Template>>

**Explanation:** Content of data specification template for concept descriptions conformant to IEC 61360.

Although the IEC61360 attributes listed in this template are defined for properties and values and value lists only it is also possible to use the template for other definition. This is shown in the tables Table 7, Table 8, Table 9 and Table 10.
The Metamodel of the Administration Shell | 91

<table>
<thead>
<tr>
<th>Class:</th>
<th>DataSpecificationIEC61360 &lt;&lt;Template&gt;&gt;</th>
</tr>
</thead>
</table>

| Constraint AASd-075: For all ConceptDescriptions using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) values for the attributes not being marked as mandatory or optional in tables Table 7, Table 8, Table 9 and Table 10, depending on its category are ignored and handled as undefined. |

Inherits from: | DataSpecificationContent |

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>preferredName</td>
<td>Preferred name</td>
<td>LangStringSet</td>
<td>aggr</td>
<td>1</td>
</tr>
</tbody>
</table>

Constraint AASd-076: For all ConceptDescriptions using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) at least a preferred name in English shall be defined.

| shortName | Short name | LangStringSet | aggr | 0..1 |

| unit | Unit | string | aggr | 0..1 |

| unitId | Unique unit id | Reference | aggr | 0..1 |

| sourceOfDefinition | Source of definition | string | aggr | 0..1 |

| symbol | Symbol | string | aggr | 0..1 |

| dataType | Data Type | DataTypeIEC61360 | aggr | 0..1 |

Constraint AASd-070: For a ConceptDescription with category PROPERTY or VALUE using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) - DataSpecificationIEC61360/dataType is mandatory and shall be defined.

Constraint AASd-071: For a ConceptDescription with category REFERENCE using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) - DataSpecificationIEC61360/dataType is STRING by default.

Constraint AASd-072: For a ConceptDescription with category DOCUMENT using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) - DataSpecificationIEC61360/dataType shall be one of the following values: STRING or URL.

Constraint AASd-073: For a ConceptDescription with category QUALIFIER using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) - DataSpecificationIEC61360/dataType is mandatory and shall be defined.

| definition | Definition in different languages | LangStringSet | aggr | 0..1 |

Constraint AASd-074: For all ConceptDescriptions except for ConceptDescriptions of category VALUE using data
**The Metamodel of the Administration Shell**

<table>
<thead>
<tr>
<th>Class:</th>
<th>DataSpecificationIEC61360 &lt;&lt;Template&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>specification template IEC61360 (<a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>) - DataSpecificationIEC61360/definition is mandatory and shall be defined at least in English.</td>
</tr>
<tr>
<td>valueFormat</td>
<td>Value Format</td>
</tr>
<tr>
<td>valueList</td>
<td>List of allowed values</td>
</tr>
<tr>
<td>value</td>
<td>Value</td>
</tr>
<tr>
<td>valueId</td>
<td>Unique value id</td>
</tr>
<tr>
<td>levelType</td>
<td>Set of levels.</td>
</tr>
</tbody>
</table>
The Metamodel of the Administration Shell | 93

Figure 56 Example Property from ECLASS

![Example Property from ECLASS](image)

Figure 57 Example Property Description with Value List from ECLASS

![Example Property Description with Value List from ECLASS](image)

Figure 58 Example Value Description from ECLASS

![Example Value Description from ECLASS](image)

Figure 59 Example Value Description from ECLASS Advanced

![Example Value Description from ECLASS Advanced](image)
The Type “ValueList” lists all the allowed values for a concept description for which the allowed values are listed in an enumeration. The value list is a set of value reference pairs.

**Figure 60 Type “ValueList”**

<table>
<thead>
<tr>
<th>Class:</th>
<th>ValueList &lt;&lt;DataType&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A set of value reference pairs.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>valueReferencePairType</td>
<td>A pair of a value together with its global unique id.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>ValueReferencePair &lt;&lt;DataType&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A value reference pair within a value list. Each value has a global unique id defining its semantic.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>
### The Metamodel of the Administration Shell | 95

<table>
<thead>
<tr>
<th>Class:</th>
<th>ValueReferencePair &lt;&lt;DataType&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>value*</td>
<td>the value of the referenced concept definition of the value in valueId.</td>
</tr>
<tr>
<td>valueId*</td>
<td>Global unique id of the value.</td>
</tr>
</tbody>
</table>

For the meaning of the content attributes of the IEC61360 data specification template please refer to IEC 61360 and/or ECLASS.

The data specification template can be used to describe properties and values, both.

See Figure 61 for how data specification templates are related to concept descriptions (showing all inherited attributes as well). In a similar way data specification templates for other elements in the information model can be defined and used.
The following tables recommend using specific categories to distinguish which kind of concept is described. They also give advice which attributes need to be filled for which category of concept description. These tables are not part of the specification because in a way the existing data specification template for describing concept descriptions for properties and coded values is misused to also describe other concepts. In later versions of the standards and this specification, there might be data specifications for concept descriptions better suited for the purpose.
The Metamodel of the Administration Shell | 97

<table>
<thead>
<tr>
<th>Category of Concept Description</th>
<th>VALUE</th>
<th>PROPERTY</th>
<th>PROPERTY</th>
<th>PROPERTY</th>
<th>PROPERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category of SubmodelElement</td>
<td>CONSTANT</td>
<td>VARIABLE</td>
<td>PARAMETER</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

- **preferredName**: m mandatory, o = optional, (m) = conditionally mandatory or recommended to be added
- **shortName**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **unitId**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **sourceOfDefinition**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **symbol**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **dataType**: STRING_TRANSLATABLE
- **definition**: STRING_TRANSLATABLE
- **valueFormat**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **valueList**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **value**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **valueId**: component mandatory in at least one language. Preferable an English preferred name should always be defined.
- **levelType**: [Min, Max]

**Table 7 Concept Description with IEC612360 Data Specification Template for Properties and Ranges**

---

12 m= mandatory, o = optional, (m) = conditionally mandatory or recommended to be added
13 Mandatory in at least one language. Preferable an English preferred name should always be defined.
14 Except STRING_TRANSLATABLE. In this case MultiLanguageProperty shall be used.
15 Except STRING_TRANSLATABLE. In this case MultiLanguageProperty shall be used.
16 Except STRING_TRANSLATABLE. In this case MultiLanguageProperty shall be used.
Table 8 Concept Description with IEC612360 Data Specification Template for other Data Elements, Relationships Elements and Capabilities

17 m= mandatory, o = optional, (m) = conditionally mandatory or recommended to be added
18 Template only used until explicit template for defining the corresponding types of elements are available.
19 Mandatory in at least one language. Preferable an English preferred name should allways be defined.
The Metamodel of the Administration Shell | 99

<table>
<thead>
<tr>
<th>Attribute</th>
<th>SubmodelElement</th>
<th>SubmodelElement</th>
<th>Operation</th>
<th>Event</th>
<th>Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>preferredName</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>shortName</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
</tr>
<tr>
<td>unit</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>unitId</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>sourceOfDefinition</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>symbol</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>dataType</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>definition</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>valueFormat</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>valueList</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>value</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>valueId</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>levelType</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 9 Concept Description with IEC612360 Data Specification Template for other Submodel Elements

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Submodel</th>
<th>Qualifier</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>category</td>
<td>APPLICATION_CLASS</td>
<td>QUALIFIER</td>
<td>VIEW</td>
</tr>
</tbody>
</table>

\(^{20}\) Mandatory in at least one language. Preferrable an English preferred name should always be defined.
### Table 10 Other Elements with semanticId

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Submodel</th>
<th>Qualifier</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>preferredName</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>shortName</td>
<td>(m)</td>
<td>(m)</td>
<td>(m)</td>
</tr>
<tr>
<td>unit</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>unitId</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>sourceOfDefinition</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>symbol</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>dataType</td>
<td>--</td>
<td>m</td>
<td>--</td>
</tr>
<tr>
<td>definition</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>valueFormat</td>
<td>--</td>
<td>o</td>
<td>--</td>
</tr>
<tr>
<td>valueList</td>
<td>--</td>
<td>o</td>
<td>--</td>
</tr>
<tr>
<td>value</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>valueId</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>levelType</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

#### 4.8.3 Predefined Templates for Unit Concept Descriptions

Conformant to the rules in Clause 7.2.4 the following data specification template should be referenced via the id “https://admin-shell.io/DataSpecificationTemplates/DataSpecificationTemplates/DataSpecificationPhysicalUnit/1/0” (in hasDataSpecification/dataSpecification).

The recommendation is to use “IEC:” as namespace qualifier as already discussed in Clause 4.8.2.

Examples: `IEC:DataSpecificationPhysicalUnit/unitName` or `IEC:DataSpecificationPhysicalUnit/definition`

Units are used in data specification templates for properties when defining the `unitId` (`IEC:DataSpecificationIEC61250/unitId`, see Figure 62). The unit value corresponds then to the `unitName` as specified in the concept description referenced via `unitId`.

The data specification template for concept descriptions for units (see Figure 62) is defined conformant to IEC61360-1 and ISO13854-42 and is following the xml schema UnitML. An example unit is shown in Figure 63.
The Metamodel of the Administration Shell | 101

Figure 62 Data Specification Template for Physical Units (DataSpecificationPhysicalUnit) and its Usage

Figure 63 Example of a concept description for a unit: 1/min (from ECLASS)
As the AAS is a central point for data access, there is the need to support fine grained access control that supports multiple roles as well as separate access control policies for individual nodes or submodels in the AAS. Access Control is based on Identity Management and can only be successfully implemented in a secure environment. These aspects as well as concepts to support data usage control and data provenance tracking are going to be developed further in the future, hence not described in detail in this chapter. For this document, focus lies on the supported access control model and support for X.509v3 certificates.

5.1 Passing Access Permissions

When having a look at the leading picture (Figure 1 in Clause 3.2) also security aspects have to be considered when transferring information from one value chain partner to the next.

When AAS content is passed from one partner to another, this is typically related to a change in the access control domain of the partners involved (supplier, integrator, operator), i.e. the scope of the validity of access control policies.

Therefore, for the example that the supplier passes on data to the integrator, the following typical steps are carried out:

- Step A1-A2: The supplier makes a choice which data is to be passed on (see Clause 8), and thus determines the content of the AASX package (see Clause 6).
- Step A2-A3: The AAS package is transferred to the integrator.
- Step A3-A4: The integrator receives the package and imports the content into his security domain. During this step, the integrator has to establish access rights according to the requirements in his own security domain.

ABAC is a very flexible approach, that also encompasses role-based access as a role can be considered as one attribute in this context. Other attributes might be the time-of-day, the location of the asset, the originating address and others.

In addition to the AAS content itself, also the defined access permissions have to be transferred between the partners due to the following two reasons:

1. Access permissions to information elements of an AAS must be established in each access control domain.
2. One partner must be able to pass a suggestion which access permissions should be established for the asset that is described in the AAS.

An example for the requirement (2):

A robot manufacturer suggests that for the robot the following roles shall be defined: machine setter, operator and a maintenance role. Note that the roles have to be expressed by means of attributes of the AAS representing the robot. He also suggests permissions for these roles, e.g. an installer (integrator) does have write-access to the program of the robot, but an operator does not.

The above example motivates that the access permission rules need to be passed from one access control domain to the other. The passing on of the access permission rules is implemented by following means:

- Definition of access permissions: The detailed access permission (e.g. read, write, delete, create, invoke method etc.) are defined in a domain specific submodel (see defaultPermissions and selectablePermissions in Clause 5.3.5).
- Definition of the access permission rules, based on the defined access permissions. These are defined as part of access control (see Clause 0).
- Association of access permission rules to each information element (object) of the AAS. This means is realized by the information structure of the AAS, itself (see PermissionsPerObject in Clause 5.3.4).

Effective access permissions are determined based on the access permission rules. Each submodel element in the AAS shall have rules that defines its access permissions for each subject. The subject is assumed to be already authenticated.

If a submodel element does not have these rules, it will automatically use the table for the element where it is included (“inheritance from above”). The most upper object is the AAS itself, i.e. the AAS is the starting point for the inheritance.
The Metamodel of the Asset Administration Shell w.r.t. Security | 103

As indicated before, subject identification, rule definitions and also permissions could be different for the receiving party as it may be in a different access control domain. When the receiving party establishes access permissions during step A3-A4, it must merge the passed-on access definitions (permissions and access permission rules) to the existing definitions in its access control domain.

In [19] examples and more background information on attribute access control and access control in general can be found. The classes and their attributes are defined in Clause 5.3.

5.2 Overview Metamodel of Administration Shell w.r.t. Security

Security-related attributes are part of any AAS. In this version of the specification, two sets of security-related attributes are considered:

- **Access Control**: The objective of access control is to protect system resources (here: AAS content) against unauthorized access. The protection measures are specified in access control policies whose scope of validity is defined by security domains dedicated to access control.

- **Digital Certificates**: Among others, the objective of digital certificates is to prove the ownership of a public key. In an AAS, X.509 certificates are used.

In this version of this specification mainly the aspect of access permission is dealt with and further described below.

Note 1: Further specifications on security aspects and security related AAS submodel elements will follow in future versions of this document.

Note 2: The implementation of access control in an I4.0 System needs support by dedicated infrastructure services, e.g. for identity management, digital certificate management, authentication and access control enforcement. This is work under progress and will be specified in further parts of the “AAS in details” document series. Hence, the security-related attributes specified in this version shall be considered as preliminary.

The underlying concept applied for access control is the concept of attribute-based access control (ABAC). In general, the ABAC request flow is described in [22]. Originally, ABAC relies upon the data-flow model and language model of the OASIS eXtensible Access Control Markup Language (XACML) specifications.

OASIS XACML includes concepts such as:

- **Policy administration point (PAP)**: The system entity that creates a policy set.

- **Policy decision point (PDP)**: The system entity that evaluates an applicable policy and renders an authorization decision.

- **Policy enforcement point (PEP)**: The system entity that performs access control, by making decision requests and enforcing authorization decisions.

- **Policy information point (PIP)**: The system entity that acts as a source of attribute values.

The general request flow is depicted in Figure 117:

- A subject is requesting access to an object (1). In the context of an AAS, an object is typically a submodel or a property or any other submodel element connected to the asset.

- The implemented access control mechanism of the AAS evaluates the access permission rules (2a) that include constraints that need to be fulfilled w.r.t. the subject attributes (2b), the object attributes (2c) and the environment conditions (2d).

- After the evaluation a decision is taken and enforced upon the object (3), i.e. the access to the submodel element is permitted or declined.

---

In Figure 119 an overview of the information model of the AAS w.r.t. the above two security aspects is given. The focus is on access control.

An object in the context of ABAC corresponds typically to a submodel or to a submodel element. The object attributes again are modelled as submodel elements.

Subject Attributes need to be accessed either via an external policy information point (PIP) or they are defined as properties within a special submodel of the AAS. A typical subject attribute is its role. The role is the only subject attribute defined when ABAC is applied as role-based access control.

Optionally, environment conditions can be defined. In role-based access control, no environment conditions are defined. Environment conditions can be expressed via formula constraints. To be able to do so the values needed should be defined as property or reference to data within a submodel of the AAS.
The Metamodel of the Asset Administration Shell w.r.t. Security

Figure 65 Overview Metamodel Security of AAS
By means of access control policies (e.g. in terms of access permission rules), it is defined which subject is allowed to access which objects\(^{22}\) within the AAS. It is assumed that the subject is already authenticated. Objects can be any referable elements, i.e. they include submodels, assets, concept descriptions, views etc. More general it can be specified whether

\[^{22}\text{The term “object” is used because it is more generic and in future also other objects like for example attributes of classes may be included besides elements.}\]
an authenticated subject is allowed or denied accessing an object a.s.o. “Access” might be one of the specified permissions on an element of the AAS. Which permissions are selectable is not defined by the metamodel of the AAS. The selectable permissions are defined via a submodel \((\text{selectablePermissions})\). The same holds for the subject attributes \((\text{SelectableSubjectAttributes})\). The default subject attributes and default permissions are used if they are not overwritten by the owner of the AAS. As for permissions the used authenticated subject attributes are defined in submodel \(\text{selectableSubjectAttributes}\).

Access rights may be constrained further. For example, a policy rule may specify that the role “maintenance engineer” (to be more precise: an authenticated subject with subject attribute “role = ‘maintenance engineer’”) is only allowed to write configuration parameters if the machine (the asset) is not running. See Figure 25 in Clause 4.7.2.8 for a formal expression of this access rule based on the property “Status”.

Object Attributes are handled in a different way. It is assumed that any property of the object in focus can additionally take over the role of an object attribute. Therefore, there is no special submodel for default or selectable object attributes. Figure 67 gives an overview of all elements defined for security issues in the metamodel.

Figure 67 Security Overview Packages

5.3 Metamodel Specification Details: Designators

5.3.1 Introduction

In this clause the classes of the metamodel related to security are specified in detail. It is an extension of the metamodel as described in Clause 4.7.

For understanding the extension the basics and common abstract classes need to be understood (see especially Clause 4.7.2, Clause 4.7.11 and Clause 4.7.12).
5.3.2 Security Attributes

In general, it has to be considered how to enable the first configuration of the AAS w.r.t. security. This would include setting the authorization provider endpoint etc.

Attributes of certificates are defined in X509. A required extension of an ASN1 certificate can be registered via an OID.
Attributes of certificates are defined in X509. A required extension of an ASN1 certificate can be registered via an OID.

<table>
<thead>
<tr>
<th>Class:</th>
<th>Certificate &lt;&lt;abstract&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Certificate</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>policyAdministrationPoint*</td>
<td>The access control administration policy point of the AAS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>BlobCertificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Certificate provided as BLOB</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>Certificate</td>
</tr>
<tr>
<td>Attribute (*=mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>blobCertificate*</td>
<td>Certificate as BLOB.</td>
</tr>
<tr>
<td>containedExtension</td>
<td>Extensions contained in the certificate.</td>
</tr>
<tr>
<td>lastCertificate*</td>
<td>Denotes whether this certificate is the certificated that fast added last.</td>
</tr>
</tbody>
</table>
5.3.4 Access Control Policy Point Attributes

![Metamodel for Access Control Policy Points](image)

<table>
<thead>
<tr>
<th>Class:</th>
<th>AccessControlPolicyPoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Container for access control policy points.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>policyAdministrationPoint*</td>
<td>The access control administration policy point of the AAS.</td>
<td>PolicyAdministrationPoint</td>
<td>aggr</td>
<td>1</td>
</tr>
<tr>
<td>policyDecisionPoint*</td>
<td>The access control policy decision point of the AAS.</td>
<td>PolicyDecisionPoint</td>
<td>aggr</td>
<td>1</td>
</tr>
<tr>
<td>policyEnforcementPoint*</td>
<td>The access control policy enforcement point of the AAS.</td>
<td>PolicyEnforcementPoint</td>
<td>aggr</td>
<td>1</td>
</tr>
<tr>
<td>policyInformationPoints</td>
<td>The access control policy information points of the AAS.</td>
<td>PolicyInformationPoints</td>
<td>aggr</td>
<td>0..1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>PolicyAdministrationPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Definition of a security policy administration point (PAP).</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>localAccessControl</td>
<td>The policy administration point of access control as realized by the AAS itself. <strong>Constraint AASs-009:</strong> Either there is an external policy administration point endpoint defined <em>(PolicyAdministrationPoint/externalPolicyDecisionPoints=true)</em> or the AAS has its own access control.</td>
<td>AccessControl</td>
<td>aggr</td>
<td>0..1</td>
</tr>
</tbody>
</table>
### Class: PolicyAdministrationPoint

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>externalAccessControl</td>
<td>If <code>externalAccessControl</code> True then an Endpoint to an external access control defining a policy administration point to be used by the AAS needs to be configured.</td>
<td>boolean</td>
<td>attr</td>
<td>1</td>
</tr>
</tbody>
</table>

The definition of the Policy Administration point is taken from [22]. The PAP is responsible for managing administering policies and also includes access control for the policies itself. Policies are deployed to the PDP for evaluation of access control decisions.

### Class: PolicyInformationPoints

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>internalInformationPoint</td>
<td>Reference to a Submodel defining information used by security access permission rules.</td>
<td>Submodel</td>
<td>ref*</td>
<td>0..*</td>
</tr>
<tr>
<td>externalInformationPoints*</td>
<td>If <code>externalInformationPoints</code> True then at least one Endpoint to external available information needs to be configured for the AAS.</td>
<td>boolean</td>
<td>aggr</td>
<td>1</td>
</tr>
</tbody>
</table>

The definition of policy information point (PIP) is taken from [22]. The difference between external and internal information points is whether the AAS needs access via an endpoint to an external source of information or whether the AAS stores the needed information itself. There might also be external and internal information points for an AAS to be considered for decision taking.

### Class: PolicyEnforcementPoints

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>externalPolicyEnforcementPoint*</td>
<td>If <code>externalPolicyEnforcementPoint</code> True then an Endpoint to external available enforcement point taking needs to be configured for the AAS.</td>
<td>boolean</td>
<td>aggr</td>
<td>1</td>
</tr>
</tbody>
</table>

The definition of policy enforcement point (PEP) is taken from [22]. The PEP is the gateway that regulates access control decisions and is located directly where data access in technically enabled (e.g., all REST interfaces must be access controlled by a PEP). The PEP does not compute access decisions itself but forwards these decision requests to the Policy Decision Point.
The definition of policy decision point (PDP) is taken from [22]. The PDP computes access decisions by evaluating the applicable decision points and meta policies. One of the main functions of the policy decision point is to mediate or deconflict decision policies according to meta policies. Either the decision taking is done within the AAS. Then, the AAS is autonomous and independent from an external access control system. Or the decision taking is done outside the AAS. Then, the AAS needs to be able to access this external endpoint for decision taking.

5.3.5 Local Access Control Attributes

Figure 71 Metamodel for Access Control

<table>
<thead>
<tr>
<th>Class:</th>
<th>PolicyDecisionPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Defines the security policy decision points (PDP).</td>
</tr>
<tr>
<td>Inherits from:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>externalPolicyDecisionPoints*</td>
<td>If externalPolicyDecisionPoints True then Endpoints to external available decision points taking into consideration for access control for the AAS need to be configured.</td>
<td>boolean</td>
<td>aggr</td>
<td>1</td>
</tr>
</tbody>
</table>

The definition of policy decision point (PDP) is taken from [22]. The PDP computes access decisions by evaluating the applicable decision points and meta policies. One of the main functions of the policy decision point is to mediate or deconflict decision policies according to meta policies. Either the decision taking is done within the AAS. Then, the AAS is autonomous and independent from an external access control system. Or the decision taking is done outside the AAS. Then, the AAS needs to be able to access this external endpoint for decision taking.

5.3.5 Local Access Control Attributes

Figure 71 Metamodel for Access Control

<table>
<thead>
<tr>
<th>Class:</th>
<th>AccessControl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Access Control defines the local access control policy administration point.</td>
</tr>
<tr>
<td>Access Control has the major task to define the access permission rules.</td>
<td></td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>accessPermissionRule</td>
<td>Access permission rules of the AAS describing the rights assigned to (already AccessPermissionRule [0..*]</td>
<td>AccessPermi ssionRule</td>
<td>aggr</td>
<td>0..*</td>
</tr>
</tbody>
</table>
The Metamodel of the Asset Administration Shell w.r.t. Security

<table>
<thead>
<tr>
<th>Class:</th>
<th>AccessControl</th>
</tr>
</thead>
<tbody>
<tr>
<td>authenticated) subjects to access elements of the AAS.</td>
<td></td>
</tr>
<tr>
<td>selectableSubjectAttributes</td>
<td>Reference to a submodel defining the authenticated subjects that are configured for the AAS. They are selectable by the access permission rules to assign permissions to the subjects. Default: reference to the submodel referenced via <code>defaultSubjectAttributes</code>.</td>
</tr>
<tr>
<td>defaultSubjectAttributes*</td>
<td>Reference to a submodel defining the default subjects’ attributes for the AAS that can be used to describe access permission rules. The submodel is of kind=Template.</td>
</tr>
<tr>
<td>selectablePermissions*</td>
<td>Reference to a submodel defining which permissions can be assigned to the subjects. Default: reference to the submodel referenced via <code>defaultPermissions</code></td>
</tr>
<tr>
<td>defaultPermissions*</td>
<td>Reference to a submodel defining the default permissions for the AAS.</td>
</tr>
<tr>
<td>selectableEnvironmentAttributes</td>
<td>Reference to a submodel defining which environment attributes can be accessed via the permission rules defined for the AAS, i.e. attributes that are not describing the asset itself. Default: reference to the submodel referenced via <code>defaultEnvironmentAttributes</code></td>
</tr>
<tr>
<td>defaultEnvironmentAttributes</td>
<td>Reference to a submodel defining default environment attributes, i.e. attributes that are not describing the asset itself. The submodel is of kind=Template. At the same type the values of these environment attributes need to be accessible when evaluating the access permission rules. This is realized as a policy information point.</td>
</tr>
</tbody>
</table>
Attributes for Access Permission Rule

Figure 72 Metamodel for Access Permission Rule

Class: AccessPermissionRule

Explanation: Table that defines access permissions per authenticated subject for a set of objects (referable elements).

Inherits from: Referable; Qualifiable

Attribute (*=mandatory) | Explanation | Type | Kind | Card.
---|---|---|---|---
targetSubjectAttributes* | Target subject attributes that need to be fulfilled by the accessing subject to get the permissions defined by this rule. | SubjectAttributes | aggr | 1
permissionsPerObject | Set of object-permission pairs that define the permissions per object within the access permission rule. | PermissionsPerObject | aggr | 0..*

Class: PermissionsPerObject

Explanation: Table that defines access permissions for a specified object. The object is any referable element in the AAS. Additionally, object attributes can be defined that further specify the kind of object the permissions apply to.
### The Metamodel of the Asset Administration Shell w.r.t. Security

<table>
<thead>
<tr>
<th>Class:</th>
<th>PermissionsPerObject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>object*</td>
<td>Element to which permission shall be assigned.</td>
</tr>
<tr>
<td>targetObjectAttributes</td>
<td>Target object attributes that need to be fulfilled so that the access permissions apply to the accessing subject.</td>
</tr>
<tr>
<td>permission</td>
<td>Permissions assigned to the object. The permissions hold for all subjects as specified in the access permission rule.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>ObjectAttributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>A set of data elements that describe object attributes. These attributes need to refer to a data element within an existing submodel.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>objectAttribute*</td>
<td>Reference to a data element that further classifies an object.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class:</th>
<th>Permission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation:</td>
<td>Description of a single permission.</td>
</tr>
<tr>
<td>Inherits from:</td>
<td>--</td>
</tr>
<tr>
<td>Attribute (mandatory)</td>
<td>Explanation</td>
</tr>
<tr>
<td>permission*</td>
<td>Reference to a property that defines the semantics of the permission. <strong>Constraint AASs-010:</strong> The property referenced in <code>Permission/permission</code> shall have the category “CONSTANT”. <strong>Constraint AASs-011:</strong> The property referenced in <code>Permission/permission</code> shall be part of the submodel that is referenced within the “selectablePermissions” attribute of “AccessControl”.</td>
</tr>
<tr>
<td>kindOfPermission*</td>
<td>Description of the kind of permission. Possible kind of permission also include the denial of the permission. Values: - Allow - Deny</td>
</tr>
</tbody>
</table>
## The Metamodel of the Asset Administration Shell w.r.t. Security

### Class: Permission

- NotApplicable
- Undefined

### Class: SubjectAttributes

**Explanation:** A set of data elements that further classifies a specific subject.

**Inherits from:** --

### Attribute (*=mandatory)

<table>
<thead>
<tr>
<th>SubjectAttribute*</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A data element that further classifies a specific subject.</td>
<td>DataElement</td>
<td>aggr</td>
<td>1..*</td>
</tr>
<tr>
<td></td>
<td>Constraint AASs-015: The data element SubjectAttributes/subjectAttribute shall be part of the submodel that is referenced within the “selectableSubjectAttributes” attribute of “AccessControl”.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Enumeration: PermissionKind

**Explanation:** Enumeration of the kind of permissions that is given to the assignment of a permission to a subject.

<table>
<thead>
<tr>
<th>Literal</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allow</td>
<td>Allow the permission given to the subject.</td>
</tr>
<tr>
<td>Deny</td>
<td>Explicitly deny the permission given to the subject.</td>
</tr>
<tr>
<td>NotApplicable</td>
<td>The permission is not applicable to the subject.</td>
</tr>
<tr>
<td>Undefined</td>
<td>It is undefined whether the permission is allowed, not applicable or denied to the subject.</td>
</tr>
</tbody>
</table>
6 Package File Format for the Asset Administration Shell (AASX)
Package File Format for the Asset Administration Shell (AASX)

6.1 General

In some use cases it is necessary to exchange the full or partial structure of the Asset Administration Shell with or without associated values and/or make the information persistent (e.g. store it in a file server). This would mean that it is necessary to define a file format that can hold and store this information. Therefore, a package file format for the Asset Administration Shell (AASX) is defined based on the following requirements:

- Generic package file format to include the Asset Administration Shell structure, data and other related files
- Main use cases are the exchange between organizations/partners and storage/persistency of the Asset Administration Shells’ information.
- Without any legal restriction and no royalties. Preferably based on an international standard with high guarantees of future maintainability of that format
- Existence of APIs to create, read and write this format
- Digital signatures & encryption capabilities must be provided
- Policies for authenticity and integration of package files

The following process in Figure 73 is defined for creating and consuming AASX packages.

**Figure 73 Process for generating and consuming AASX packages**

The process starts by serializing the existing AAS (e.g. D1 and E1) into files (according to the serialization mechanisms described in this document), as well as exporting other supplementary files (which are files mentioned in the structure of the AAS, such as manuals, CAD files, etc.). All of these files will be packaged together into the AASX ZIP file format and will be followed by several security steps that defines the policies for modifiability, encryption and digitally signing of the files inside the AASX. The final AASX can then be transported from the AASX producer (in this case partner A) to the AASX consumer (partner B), by digital media such as e-mail, USB-Sticks, etc. The consumer needs first to validate and verify the incoming AASX, unpack the contained files and then import them to generate the new AAS in the consumer environment. The process will be explained in detail in the following sub-sections.

6.2 Basic Concepts of the Open Packaging Conventions

The packaging model specified by the Open Packaging Conventions describes **packages**, **parts**, and **relationships**. Packages hold parts, which hold content and resources, such as **files**. Every file in a package has a unique URI-compliant file name along with a specified content-type expressed in the form of a MIME media type.

---

23 Role-based policies to access this package is not defined, as this is a feature of the systems that host the AASs (see section 5)

24 The term “file” will be used instead of “part”.
Relationships are defined to connect the package to files, and to connect various files in the package. The definition of the relationships (along with the files’ names) is the logical model of the package. The resource that is a source of a relationship must be either the package itself or a data component (file) inside of the package. The target resource of a relationship can be any URI-addressable resource inside or outside of the package. It is possible to have more than one relationship that share the same target file (see example 9–6 in ISO/IEC 29500-2: 2012).

The physical model maps these logical concepts to a physical format. The result of this mapping is a physical package format (a ZIP archive format) in which files appear in a directory-like hierarchy (adapted from [27] and [28]).

6.3 Conventions for the Asset Administration Shell Package File Format (AASX)

The Asset Administration Shell Package (AASX) format derives from the Open Package Conventions standards, consequently inheriting its characteristics. Nevertheless, some conventions shall be defined for the AASX:

- Package format and rules according to ISO/IEC 29500-2:2012. Any derivate format from this standard (such as the AASX format) requires the definition of a logical model, physical model and a security model. Those specific conventions are described in the next subsections.
- File extension for the AASX format: .aasx
- MIME-type for the AASX format: application/asset-administration-shell-package
- Icon for the AASX.
- The AASX format can be identified by the file extension and MIME type. Content-wise, it is possible to identify it when reading the first relationship file /_rels/rels (as defined in Open Packaging Conventions) and looking for a relationship type http://admin-shell.io/aasx/relationships/aasx-origin (which is the entry point for the logical model of the Asset Administration Shell).
- The following paths and filenames in the package are already reserved by the Open Packaging Conventions specification and therefore shall not be used for any derivative format: /[Content_Types].xml; /_rels/rels; /<file_path>/_rels/<filename>.rels (where <filename> is a file in the package that is source of relationships and <file_path> is the path to that file).
- It is not mandatory to open the AASX format in any existing Office Open XML / Open Packaging Conventions compatible office-application (e.g. Microsoft Office, LibreOffice), because the required relationships and files for the different office “models” may not be present (e.g. http://schemas.openxmlformats.org/officeDocument/2006/relationships/officeDocument for “docx” document).

6.4 ECMA-376 Relationships

As mentioned before, it is necessary to define a logical model for formats on top of Open Packaging Conventions. Figure 74 defines a set of relationship types (URIs) and the corresponding source files as a part of the logical model for the AASX format. In addition (not shown in Figure 74), a specific relationship instance has also a unique ID and a target resource (URI of a target file inside or outside the package).

---

25 The current MIME-type is provisional and needs to be requested officially.
Figure 74 Relationship Types for AASX Packages

The relationship types for thumbnail, core-properties, digital-signatures (origin, signature and certificate) are defined by Open Packaging Conventions, so no need to reinvent. The other relationship types were specifically defined to support the AASX package format. Here a short description on each relationship type of Figure 74:

- **thumbnail** – Optional. Required to define a thumbnail for that package (e.g. picture of the administrated device). The thumbnail picture can be shown instead of the package’s icon based on the extension and/or MIME type.

- **core-properties** – Optional. There is a schema for describing the package through “core properties,” which uses selected Dublin Core metadata elements in addition to some Open Packaging Conventions-specific elements. The core-properties do not describe the Administration Shell, but the package itself. Some elements of the core-properties may be similar/equal to elements of the Administration Shell. Some core-properties are: Title, Subject, Creator, Keywords, Description, LastModifiedBy, Revision, LastPrinted, Created, Modified, Category, Identifier, ContentType, Language, Version, ContentStatus.

- **digital-signature/origin, digital-signature/signature and digital-signature/certificate** – Optional. Required if you need to sign files and relationships inside the package. Their relationships basically target files that contain the data on signatures (e.g. certificate, digests, …). See the description later in this document about digital signatures.

- **aasx-origin** – Mandatory. This relationship targets an aasx-origin file which shall be an empty file or a plain text file containing the text “Intentionally empty”. It is the entry-point for all aas specific relationships and files inside the package. The source of the aasx-origin relationship must be the package root.

- **aas-spec** – Mandatory: Targets the file (“aasenv”) that contains the structure/specification of one or more identifiable elements (such as AAS, Submodel or ConceptDescription), according to the XML or JSON format defined in this document. The source of the aas-spec relationship must be the aasx-origin file.

- **aas-suppl** – Optional. Targets any additional file, which is referenced (not stored as blob) from within the data of an AAS via File element (see Clause 4.7.8.8). The source of any aas-suppl relationship must be the file containing the AAS structure/specification.

**Note:** Not every File element inside the specification of an Submodel may target a file stored within the same AASX package. Only a relative URI reference (absolute-path or relative-path reference) shall be interpreted as a reference to a supplementary file within the AASX package.

---

26 To avoid the long names of the relationship types, we will use the short name along the text.
Package File Format for the Asset Administration Shell (AASX) | 121

6.5 File Name Conventions

Using the ECMA-375 relationships (6.4) allows to locate files within the AASX package independently from the file name. For example, one package producer might store an aas-spec file in /aasx/device.xml, the other one in /asset-admin-shell/productX123.xml, but both use the same relationship type to target that file. To have a more consistent approach, the following conventions are defined for naming files inside the AASX package:

- `/aasx/` shall be the common prefix for all files containing AASX package specific information.
- `/aasx/aasx-origin` shall be the target of the aasx-origin relationship without content (empty file).
- `/aasx/data.<extension>` shall be the target of the aas-spec relationship, where `<extension>` is “xml” or “json”, based on the type of serialization.
- It is also possible to have a serialization of the same data in both serialization formats (xml, json) stored in the same AASX package. In this case, the different serialization formats can be stored in parallel using the aforementioned extensions and appropriate ECMA-376 Content Types (MIME type). In this case, for both of these files the appropriate aas-suppl relationships, targeting the supplementary files, must be created.

An example of an AASX package is shown in Figure 75. It shows the content of the AASX package listed in a tree view using the relationship types defined in Figure 74 and following the file name conventions as defined above. In this example, it is assumed that the AAS specification files are serialized into XML.

**Figure 75 Example of an AASX package content showing file names in a tree view (left) and ECMA-376 relationship types (right)**

In addition to the AASX specific files, files common to all ECMA-376 packages - such as relationship parts (*.rels) and the Content Types stream ([Content_Types].xml) - must be contained in an AASX package in its physical representation as a .zip archive. For more information on these files, please refer to the ECMA-376 specification.

6.6 Digital Signatures

A digital signing feature is already provided by the Open Packaging Conventions specification [27]. Hence, this signing framework for packages can also be used for AASX packages. To ensure the integrity of the AAS data, all relevant files within the package (aasx-origin file, AAS structure specification file, supplementary files) and the associated relationship parts shall be signed.
6.7 Encryption

The Open Packaging Conventions specification (ISO/IEC 29500-2:2012) mentions that “ZIP-based packages shall not include encryption as described in the ZIP specification. Package implementers shall enforce this restriction [M3.9]”27. However, an Open Packaging Conventions package may be encrypted with other means and some applications using this package format as the basis for a more specific format, may use encryption during interchange or DRM for distribution [24].

An example is the Office Document Cryptography Structure (MS-OFFCRYPTO) used by derivate office formats. Some used technologies may be covered by Patents from Microsoft and therefore it isn’t recommended for the AASX format. Digital Rights Management (DRM) can also be used to encrypt content elements in a package with specific access rights granted to authorize users (see the implementation in the system.io.packaging namespace [31]).

Regarding encryption and confidentiality, the following rules shall be followed:

1. Decide if there is a need of including confidential content in a package. If there is no reason, then the confidential content should not be included.
2. If encryption is desired for a temporary communication act (e.g. e-mail exchange, …) or if a AASX needs to be stored somewhere so that it can be opened later by the same entity, then encryption methods can be used for that specific mean (e.g. use BitLocker when storing the AASX in Windows-based systems that support it, use S/MIME for exchanging encrypted e-mails between entities, etc.).
3. For all other use cases28 where encryption is required for some or all of the content of the AASX:
   - Encryption methods can be used for individual files in the AASX package, as soon as the “encrypted” version replaces the original file in the package, the MIME type of the encryption format is known, and the MIME type must be listed in the [Content-Type].xml. The relationships as defined in this document remain the same, whenever content is encrypted or not. Note that Open Packaging Conventions related files as well as relationship files shall not be encrypted, and digital signing must be performed after encryption. One example of an encryption standard is the Secure MIME (S/MIME), where the encrypted content should be stored in application/pkcs7-mime format as defined in RFC 5652 and use the file extension *.p7m.
   - Besides encrypting the content of the package (individual files) it is possible to encrypt the full package (e.g. also using Secure MIME and saving the encrypted package in application/pkcs7-mime file format). In this case, the signature of the content of the package must be done before the encryption.

27 The reason for this might be related to the transparency requirement for the package format as well as license requirements of PKWARE. For the ISO/IEC 21320-1 (Document Container File: Core) there is the following statement: “Encryption of individual files and of the central directory is prohibited. Hence this profile of ZIP_PK is more transparent than its parent format.” [30]

28 A use case could be to encrypt a submodel and only provide the access to the unencrypted data after paying a fee.
7 Mappings to Data Formats to Share I4.0-Compliant Information
7.1 General

It should be possible to share information between different systems throughout the area covered by the entire RAMI4.0 model [1][2]. OPC UA has been targeted as a format for information models in the domain of production operations, but there is a need for other formats for the other areas and the interrelationships between them.

This document describes the Asset Administration Shell together with its submodels in different data formats.

### Table 11 Distinction of different data format for the AAS

<table>
<thead>
<tr>
<th>Data format</th>
<th>Purpose / motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPC UA Information models</td>
<td>Access to all information of the administration data and sharing of live data within production operations. Access for higher-level factory systems to this information.</td>
</tr>
<tr>
<td>AutomationML</td>
<td>Sharing of type and instance information about assets, particularly during engineering. Transfer of this information into the operational phase (cf. OPC UA and the corresponding mapping)</td>
</tr>
<tr>
<td>XML, JSON</td>
<td>Serialisation of this information for the purpose of technical communication between phases.</td>
</tr>
<tr>
<td>RDF</td>
<td>Mapping of this information to enable full use of the advantages of semantic technologies.</td>
</tr>
</tbody>
</table>

The specifications of the preceding clause are now specifically transferred to the individual data exchange formats.

7.2 General Rules

7.2.1 Model and Global References

In the following we distinguish between global and model keys. They are defined as follows:

- A **global key** is a key with idType <> IdShort.
- A **model key** is a key with type <> GlobalReference, i.e. it references a model element within the same AAS or within another AAS.

---

29 The abbreviated use of the word “data formats” includes the use of conceptual advantages such as information models, schemes, transmission protocols, etc.

30 Only data formats considered in this document so far are mentioned in the figure.
Mappings to Data Formats to Share I4.0-Compliant Information

- A similar distinction is done for references:
  - A **model reference** is a reference key chain in which the last key is a model key.
  - A **global reference** is a reference key chain in which the last key is a global key with type = GlobalReference.

### 7.2.2 Encoding

For blobs the following encoding is required: base64 string.

### 7.2.3 Serialization of Values of Type “Reference”

In some mapping or serializations, the Type “Reference” is converted into a single string. In this case we recommend using the following serialization:

```
<Reference> ::= <Key>{, <Key>}*
<Key> ::= (<KeyType>)<KeyIdType><KeyValue>
<KeyType> ::= value of AAS:Key
<KeyIdType> ::= value of AAS:Key/idType
<KeyValue> ::= value of AAS:Key/value
```

Note 2: An IRI may contain also special symbols like "(" , "," and "]". For being able to distinguish beginning and end of a new key a blank is added before the new key.

Examples:

- (ConceptDescription)[IRDI]0173-1#02-BAA120#008
- (GlobalReference)[IRDI]0173-1#01-AFZ615#016
- (Submodel)[IRI]http://example.com/demo/aas/1/11234859590,(Property)[IdShort]Temperature

### 7.2.4 Semantic Identifiers for Metamodel and Data Specifications

To enable the unique identification of concepts as used and defined in the metamodel of the asset administration shell rules for creating such identifiers are defined.

The following grammar is used to create valid identifiers:

```
<Namespace> ::= ( <AAS Namespace>|<Data Specification Namespace> )
<Namespace Qualifier> ::= <AAS Namespace Qualifier>|<Data Specification Qualifier>
<AAS Namespace> ::= <Shell-Namespace>"/aas/"<Version>
<Data Specification Namespace> ::= <Shell-Namespace>"/DataSpecifications/"<idShort of Data Specification><Version>
<Shell-Namespace> ::= “https://admin-shell.io/”
<Version> ::= <Digit>+"/"<Digit>+["/"<Character>+]
<Digit> ::= 0| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
<Character> ::= an unreserved character permitted by DIN SPEC 91406
```

? ::= zero or one
+ ::= one or more
Mappings to Data Formats to Share I4.0-Compliant Information

Up to now two data specification templates are defined. For every data specification it needs to be defined which data specification namespace to use.

\[
\text{<AAS Namespace Qualifier>} ::= \text{“AAS:”}
\]
\[
\text{<Data Specification Qualifier>} ::= \text{defined per Data Specification}
\]

A concrete unique identifier is defined as follows:

\[
\text{<AAS Unique Concept Identifier>} ::= (\text{<Namespace>} | \text{<Namespace Qualifier>})\text{/}<AAS Concept Identifier>
\]
\[
\text{<AAS Concept Identifier>} ::= \text{<AAS Class Name>[(<AAS Attribute>|<AAS Enumeration>)\*]}
\]
\[
\text{<AAS Attribute>} ::= (/<AAS Attribute Name>\*\*)
\]
\[
\text{<AAS Enumeration>} ::= [(/\text{<AAS Attribute Name>]*)/<AAS Enumeration Value>]
\]

Examples for valid unique AAS Concept Identifiers:

- https://admin-shell.io/aas/2/0/AssetAdministrationShell/administration/version
- AAS:AssetAdministrationShell/administration/version
- AAS:/Asset/kind/Instance

The application of the pattern is explained in the following:

The concept identifier of a Class follows the pattern:

\[
\text{<AAS Class name>}
\]

This also holds for abstract classes and types including Enumerations.

Examples: AAS:View, AAS:Submodel, AAS:Qualifier, AAS:Reference, AAS:MimeType, AAS:IdentifierType

Attributes of Classes are separated by “/”. Also inherited attributes can be referenced like this if the concrete referable is important in the context.

Basic Pattern:

\[
\text{<AAS Class name>“/”<AAS Attribute Name>}
\]

Examples\(^{31}\): AAS:Referable/idShort or AAS:Property/idShort or AAS:Asset/assetIdentificationModel or AAS:Qualifier/semanticId or AAS:Identifier/id

This also holds for attributes of attributes if the cardinality of the attributes involved is not greater than 1:

\[
\text{<AAS Class Name>“/”<AAS Attribute Name>[(“/”<AAS Attribute Name>)*]}
\]

Examples: AAS:Submodel/identification/id or AAS:Identifiable/administration/version

This also holds for values of enumerations

\[
\text{<AAS Class Name>[(“/”<AAS Attribute Name>)*]“/”<AAS Enumeration Value>}
\]

Examples: AAS:Submodel/identification/idType/IRDI or AAS:Identifiable/identification/idType/IRDI or AAS:Identifier/idType/IRDI or AAS:IdentifierType/IRDI

In case of an attribute with cardinality greater than 1 no further attributes or enumeration values can be added.

---

\(^{31}\) For simplicity most examples use the namespace qualifier and not the full path of the namespace.
Mappings to Data Formats to Share I4.0-Compliant Information | 127

**Note:** Although the attribute name in UML is always singular even if the cardinality is > 1 the attribute name is annotated by the plural "s".

Examples:  
AAS:Operation/InputVariables or AAS:AssetAdministrationShell/submodels or AAS:SubmodelElementCollection/submodelElements

AAS:AssetAdministrationShell/submodels/administration/version or AAS:Submodel/Property/idShort are no valid concept identifier.

A concrete example how these rules are applied is given in Annex I.iii: the identifiers are used as values for the RefSemantic attribute in AutomationML Mapping of the Asset Administration Shell. These identifiers are also used in OPC UA (Clause 0) to describe the semantics of the metamodel via the OPC UA HasDictionaryEntry reference type.

For specific serializations and mappings additional identifiers might be needed. For example for a set of asset administration shells or a set of available assets or concept descriptions etc. Here, the AAS metamodel and specification does not give any recommendations.

Data Specification Handling is special. Data Specification Templates do not belong to the metamodel of the AAS. However, only the predefined data specification templates as specified in this specification are supported in the serializations. For these the corresponding name space qualifier are defined individually.

Examples: IEC:DataSpecificationIEC61360/preferredName (see Clause 4.8.2) or IEC:DataSpecificationIEC61360/unit (see Clause 4.8.3).

For the data specification itself the AAS namespace is used: AAS:DataSpecificationIEC61360

In xml and JSON data specifications are embedded into the schema itself using the attribute "embeddedDataSpecification". For these no concept identifier shall be used. I.e.

AAS:ConceptDescription/embeddedDataSpecification

is not a valid concept identifier. AAS:DataSpecificationContent is a valid concept identifier.

### 7.2.5 Embedded Data Specifications

This specification predefines data specifications that can be used within an AAS to ensure interoperability.

Thus, some serializations or mapping support exactly these data specifications defined in this specification and no others although the metamodel as such is more flexible and would also support proprietary data specifications.

In this case of restricted data specifications to be used the notation is that of "embedded data specifications". In Figure 77 the realization is explained: instead of a set of external global references to externally defined data specifications a set of pairs consisting of an external global reference to a data specification as well as the data specification content itself is directly "embedded". In this realization the data specification content belongs to the schema etc. whereas in the general concept the data specification including its content are not part of the schema. This is similar to the concept of semanticIds: either it is an external global reference to an external concept dictionary or it is a reference to a concept descriptions within the schema. However, for semanticId we only allow exactly one reference, whereas for data specifications a set of data specifications references is allowed.
7.3 Unified example

The following example is used to demonstrate the main features of the data formats as explained in the following clauses for different data formats. Intention is to motivate the equivalency of information in different representations. The examples themselves can be found in the annex.

It shows an AAS with three submodels: TechnicalData, OperationalData and Documentation. The asset, an motor, that it is representing has the global ID “http://example.com/assets/KHBVZJSQKIY”.

The TechnicalData submodel contains data that is available at engineering time: the maximum rotation speed measured in 1/min. Its semanticId is 0173-1#02-BAA120#008. It is an ECLASS IRDI. However, in this example a copy of the ECLASS entry values are copied to a corresponding concept description with the same IRDI. The unit “1/min” has also a unique id, “0173-1#05-AAA650#002”.

The third submodel “Documentation” contains a pdf document, the operating manual.
Mappings to Data Formats to Share I4.0-Compliant Information

Figure 78 Unified Example for ExampleMotor
7.4 XML

7.4.1 General

In the following clauses an overview of the main concepts of the Asset Administration Shell XML serialization is presented. For import and export scenarios the metamodel of an Asset Administration Shell needs to be serialized. A serialization format is XML. The information is divided in three parts. The first part discusses the rules, in the second part are examples for some specific rules and in the third part the schema and a complete example is shown in the annex.

7.4.2 Introduction

eXtensible Markup Language (XML) is very well suited to deriving information from an IT system, perhaps to process it manually, and then to feed it into another IT system. It therefore meets the needs of the information sharing scenario defined in Section 0. XML provides for the possibilities of scheme definitions which can be used to syntactically validate the represented information in each step. For this reason, this document provides basic scheme definitions to permit a validation of information which is shared.

The XML schema definitions are divided into three different files:

- Core definitions for the Asset Administration Shell and its export container: aas.xsd
  - Namespace: "http://www.admin-shell.io/aas/3/0"
- IEC61360 datatype definition: iec61360.xsd
  - Namespace: "http://www.admin-shell.io/IEC61360/3/0"
- Attributed based access control definition: aas_abac.xsd
  - Namespace: "http://www.admin-shell.io/aas/abac/3/0"

The namespace reflects the current version (3.0) of the specification.

Subsequently, an example in XML is provided.

7.4.3 XML Mapping Rules

The main concepts of the XML schema and the resulting XML serialization are explained by the following rules. Rules 1 through 6 are general rules, while rules 7 through 11 are specific to References.

1. XSD global Types are used for modeling

   For reusability XSD global types will be used for modeling. There will be a naming convention `<informationModelName>+'_t'`

2. If present, names are taken from the information model.

   For comprehensibility reasons the XML key names should be the same as the representing Element in the metamodel.

3. All identifiables have an aggregation on root level.

   The identifiables are AssetAdministrationShells, Assets, Submodels, ConceptDescriptions. To reduce redundant instances, they are located exclusively in the top-level aggregation.

4. Repeating elements and their types will get the same names of their instances in plural. Exception: `SubmodelElementCollection`, here the name remains “value”.

   If the element has a cardinality of n>1 a parent element will be used with the name of the element in plural. For example, each element in the aggregation `assets` needs to be an `asset`.

5. Identifiables which are not in the top-level aggregations are only references to the corresponding instances in one of the top-level aggregations.

---

32 see: https://www.w3.org/TR/2008/REC-xml-20081126/
This rule completes the concept of rule 3. There should be no redundant identifiable in the serialized metamodel.

(6) element a language tag “lang” is added.

For internationalization purposes this rule is necessary.

(7) The attributes of a key in a reference except for the value itself are realized as XML attributes.

(8) Data Specification Templates are directly added to the Concept Description because up to now only property descriptions are supported. Additionally, a new element EmbeddedDataSpecification is introduced that has two attributes: one for the global reference to the data specification identifier and one for the content of the data specification.

(9) Attribute based access control is added as a separate XML schema that is linked by AssetAdministrationShell/security

7.4.4 Adding Data Specification Templates

In this clause it is described how to extend the schema with new data specification templates.

Please note: proprietary extensions should be avoided. Proprietary extensions can only be used if the user or receiver of the AAS bilaterally knows about the extensions and can support them as well. The other way around there is no problem: Internally, extensions can be used if senders only provide AAS without these proprietary extensions.

For extensions the following three steps need to be done (compare with data specification template for IEC61360):

1. Create schema with data type for new data specification (example yourDataSpecification_t). For proprietary data specifications an own name space (example: http://yournamespace with prefix yourNS) needs to be defined and all data specifications of the same name space should be added to this file (example yourNS.xsd).

2. Extend complex type dataSpecificationContent_t in AAS_dataSpecificationContent.xsd with new type defined in step 1.

```xml
<complexType name="dataSpecificationContent_t">
  <choice>
    <element name="dataSpecificationIEC61360" type="IEC61360:dataSpecificationIEC61630_t"/>
    <element name="yourDataSpecification" type="yourNS:yourDataSpecification_t"/>
  </choice>
</complexType>
```

3. Add new schema (if not yet contained) to the schema declaration section of AAS_dataSpecificationConent.xsd

```xml
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.admin-shell.io/AAS/dataSpecificationContent" elementFormDefault="qualified"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:tns="http://www.admin-shell.io/AAS/dataSpecificationContent"
  xmlns:IEC61360="http://www.admin-shell.io/IEC61360/3/0"
  xmlns:yourNS="http://yournamespace"
  xmlns:Q1="http://www.admin-shell.io/aas/3/0">
  <import namespace="http://www.admin-shell.io/IEC61360/3/0" schemaLocation="IEC61360.xsd"/>
  <import namespace="http://yournamespace" schemaLocation="yourNS.xsd"/>
  ...
</schema>
```

7.4.5 Example for Top-Level Structures

One serialization describes one asset Administration Shell environment that is a collection of Administration Shells. The root element of the AssetAdministration Shell environment has 4 aggregations (see Figure 79). For each identifiable class, one aggregation is featured, as required by rule 3 (see Clause 7.4.3).
Mappings to Data Formats to Share I4.0-Compliant Information

Figure 79 Top level structure of an AssetAdministration Shell environment mapped to XML Schema

Note: XSD structuring was done with Eclipse tool chain

The resulting XML is the minimal XML:

Table 12 Minimal XML for top level structure

```xml
<?xml version="1.0" encoding="UTF-8"?>
<aas:aasenv xmlns:aas="http://www.admin-shell.io/aas/3/0"
xmlns:abac="http://www.admin-shell.io/aas/abac/3/0"
xmlns:aas_common="http://www.admin-shell.io/aas_common/3/0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <aas:assetAdministrationShells>
  </aas:assetAdministrationShells>
  <aas:assets>
  </aas:assets>
  <aas:conceptDescriptions>
  </aas:conceptDescriptions>
  <aas:submodels>
  </aas:submodels>
</aas:aasenv>
```

Note: \* designates line-wrap for purpose of layout

7.4.6 XSD Model Groups

There are a number of attribute groups in the UML model – i.e. identifiable or hasSemantics. These groups are modelled as XSD model groups so they could be reused as anonymous groups in different places.

Note: Identifier/id is not modelled as attribute but a typical identification looks like this:

```xml
<aas:identification idType="IRI">www.admin-shell.io/aas-sample/3/0</aas:identification>
```
This is realized in the according XSD as follows:

Table 13 Using XSD Model Groups

```xml
<complexType name="assetAdministrationShell_t">
  <sequence>
    <group ref="aas:identifiable"/>
    <group ref="aas:hasDataSpecification"/>
    <element maxOccurs="7" minOccurs="0" name="security" type="abac:security_t"/>
    <element maxOccurs="7" minOccurs="0" name="derivedFrom" type="aas:reference_t"/>
    <element maxOccurs="7" minOccurs="0" name="submodelRefs" type="aas:submodelRefs_t"/>
    <element maxOccurs="7" minOccurs="0" name="assetInformation" type="aas:assetInformation_t"/>
    <element maxOccurs="7" minOccurs="0" name="views" type="aas:views_t"/>
  </sequence>
</complexType>
```

**Note:** due to XSD group mechanism, hasDataSpecification maps to an element of embeddedDataSpecification_t and identifiable maps to multiple elements in Figure 81.

### 7.4.7 Keys and References

Keys and References (see Clause 4.7.11) are mapped on the same XML schema construct. Some of the attributes have enumerations defined – these are mapped on string constraints.
7.4.8 Asset Administration Shell Mapping

Asset Administration Shells are mapped using the following XML Schema construct – it consists of a set of meta data parameters and mostly links to other parts of the XML document or to external elements (based on keys and references).
7.4.9 ConceptDescriptions and EmbeddedDataSpecifications Mapping

As described above, the definition of a concept comprises of an according reference and a content, which is realized by a data specification.

The data specification can be e.g. along of an IEC 61360 property:

Full XSD and example XML can be found in Annex D.
7.4.10 Attribute Based Access Control Mapping

Security contains the access control policy points and certificate information.

![Figure 85 Attribute Based Access Control Model Mapping – XSD Security Model](image)

![Figure 86 Attribute Based Access Control Model Mapping – XSD Policy Points Model](image)

![Figure 87 Attribute Based Access Control Model Mapping – Policy Information Points](image)

7.5 JSON

7.5.1 General

In the following clauses an overview of the main concepts of the Asset Administration Shell JSON serialization is presented. For import and export scenarios the metamodel of an Asset Administration Shell needs to be serialized. A serialization format is JSON\(^\text{33}\) (JavaScript Object Notation). The information is divided in three parts. The first part discusses the rules, in the second part are examples for some specific rules and in the third part the schema and a complete example is shown in the annex.

7.5.2 JSON Mapping Rules

The main concepts of the JSON serialization are explained by the following rules.

1. **If present, names are taken from the information model.**
   For comprehensibility reasons the JSON key names should be the same as the representing Element in the metamodel.

2. **Each Referable, Qualifier and Formula have an additional attribute “modelType” with the name of the corresponding object class as value.**
   This rule is needed for deserialization reasons.

3. **All identifiables have an aggregation on root level.**
   The identifiables are AssetAdministrationShells, Assets, Submodels and ConceptDescriptions. To reduce redundancy instances, they are located exclusively in the top-level aggregation.

4. **Identifiables which are not in the top-level aggregations are only references to the corresponding instances in one of the top-level aggregations.**
   This rule completes the concept of rule 3. There should be no redundant identifiable in the serialized metamodel.

5. **Data Specification Templates are directly added to the Concept Description.**
   Additionally, a new element EmbeddedDataSpecification is introduced that has two attributes: one for the global reference to the data specification identifier and one for the content of the data specification.

7.5.3 Example for Top-Level Structures

One serialization describes one Asset Administration Shell environment, that is, a collection of Administration Shells. The root element of the Asset Administration Shell environment has 4 aggregations. For each identifiable class, one aggregation is provided, as required by rule 3.

![Figure 88 Top level structure of an AssetAdministration Shell environment mapped to JSON](source: Plattform Industrie 4.0)

The resulting JSON is the minimal valid JSON:

**Table 14 Minimal JSON for top level structure**

```json
{
    "assetAdministrationShells": [ ],
    "assets": [ ],
    "submodels": [ ],
    "conceptDescriptions": [ ]
}
```

7.5.4 Examples for References to Identifiables

As required by rule 4, Identifiables are only allowed to be located in the top-level aggregations. In deeper parts of the structure only References to the corresponding Identifiable must be taken.
In the Asset Administration Shell AAS1, the submodel S1 is only a Reference to the Submodel S1 instance in the top level Submodels aggregation.

**Table 15 Exemplary minimal JSON for References**

```json
{
  "submodels":{
    {
      "modelType":{
        "name":"Submodel"  
      },
      "idShort":"S1",
      "identification":{
        "id":"http://env.com/submodels/S1",
        "idType":"IRI"
      }
    },
    ...
    "submodelElements":[]
  }
},
"conceptDescriptions":[],
"assetAdministrationShells":{
  {
    "modelType":"AssetAdministrationShell",
    ...
    "submodels":
      {
        ...
      }
  }
}
```
A ReferenceElement has a Reference as value. This Reference has an aggregation of keys which represents a key chain. The resolved key chain points to an element. In this example the ReferenceElement’s value points to a property of another submodel in another Asset Administration Shell environment. The first key is a global key with “local”-attribute set to false, i.e. the reference is not part of the own environment. The second key is a model key which is used to define the corresponding property in the other environment by its IdShort. It is best practice to use the shortest key chain if there are multiple options.

Figure 90 Usage of ReferenceElement in JSON

This results in an exemplary JSON as such:

Table 16 Exemplary ReferenceElement in JSON

```json
{
  "modelType": {
    "name": "ReferenceElement"
  },
  "kind": "Instance",
  "semanticId": {
    "keys": [
      { "idType": "IRI", "local": false, "type": "Submodel", "value": "http://env.com/submodels/S1" }
      ...
    ]
  }
}
```

Source: Plattform Industrie 4.0
7.5.5 Examples for GlobalReference

Sometimes it is useful to refer to another standard or something that is not provided by the own Asset Administration Shell environment. In this example the semantics of a Property refers to ECLASS.

Figure 91 Usage of GlobalReference in JSON

This results in an exemplary JSON as such:
Table 17 Exemplary GlobalReference in JSON

```
{
  "modelType":{
    "name": "Property"
  },
  "kind": "Instance",
  "semanticId":{
    "keys": [ 
      {
        "type": "GlobalReference",
        "value": "0173-1#02-BAA120#007",
        "idType": "IRDI"
      }
    ],
    "idShort": "MaxRotationSpeed",
    "category": "PARAMETER",
    "value": "560",
    "valueType": "integer"
  }
}
```
**7.6 RDF**

### 7.6.1 General

The Resource Description Framework (RDF) [44] is recommended standard of the W3C to unambiguously model and present semantic data. RDF documents are structured in the form of triples, consisting of subjects, relations and objects. The resulting model is often interpreted as a graph, with the subject and object elements as the nodes and the relations as the graph edges.

RDF is closely related to Web standards, illustrated by the fact that all elements are encoded using (HTTP-)URIs. As a common practice, the provision of additional information at the referenced location of an RDF entity directly allows the interlinking of entities based on the Web. This process, the following of links in order to discover related information, is called dereferencing a resource and is supported by any browser or web client. Connecting distributed data sources through the Web in the described manner is referenced by the term Linked Data. Connecting the available resources and capabilities of Linked Data with the expressiveness of the Asset Shell is one motivation for the RDF serialization.

In addition, RDF is the basis of a wide range of logical inference and reasoning techniques. Vocabularies like RDF Schema (RDFS) and the Web Ontology Language (OWL) combine the graph-based syntax of RDF with formal definitions and axioms. This allows automated reasoners to understand the relation between entities to some extent and draw conclusions.

Combining both features, the RDF mapping of the Asset Administration Shell can provide the basis for complex queries and requests. SPARQL, the standard query language for the Semantic Web, can combine reasoning features with the integration of external data sources. In order to benefit of these abilities, the AAS requires a clear scheme of its RDF representation. In the following, the necessary transformation rules are presented, followed by an illustration of relevant parts of the scheme and an example. The complete data model together with the RDF scheme are listed in Annex H.

### 7.6.2 RDF Mapping Rules

1. **The default serialization format is Turtle.**
   Several, equivalent serializations exist for RDF. Among them, the Turtle syntax is regarded as the most appropriate compromise between readability and tool-support. Other formats (RDF/XML, JSON-LD, N3, etc.) can be used without any loss of information.

2. **Shape Graphs represent the validation rules.**
   The data model itself is an RDF ontology. As RDF itself is following the open-world-assumption, SHACL [38] constraints are necessary in order to enable schema validation. Similarly to XSD for XML, the SHACL format can be used to describe constraints (or shapes) of RDF graphs.

3. **Every entity is encoded as either an IRI or a Literal.**
   RDF uses IRIs for both entities and relations. If no IRI is predefined, a globally unique IRI is generated. Primitive values are encoded as Typed Literals.

4. **Entities are enhanced with well-known RDF attributes.**
   Interoperability of concepts and attributes is the main advantage of the RDF mapping. Applying common attributes (rdf:type, rdfs:label, and rdfs:comment) enables the usage of standard tools and interfaces.

5. **Repeating elements are described once and then linked using their IRI identifier.**
   If a distinct element appears more than one time in the original model but in a different context, for instance in more than one submodel, the RDF entity represents the combination of all attributes.

6. **Keys must have an index attribute.**
   Keys of a Reference have a defined order, however RDF is explicitly set-based. The index attribute encodes the position in the original sequence. Consequently, Keys belonging to one Reference must have unique numbers in the range [0..keyCount], ascending from 0. If only one Key is supplied, the index attribute can also be skipped, implying a default value of ‘0’.

---

34 Note: entity as a generic term and entity as a specific submodel element subtype need to be distinguished.
(7) **Multilanguage Strings are split into distinct language strings.**

Objects are expected to contain a singular information entity, and the currently available tools would not recognize the different pattern used.

### 7.6.3 Example Overview

RDF is often regarded as a graph model, as it provides the flexibility to interlink entities at any stage. In the following, the running example is originally provided in Turtle but accompanied with visualizations of the represented graph. Attributes referencing non-literal values are shown as directed links while Literal values are drawn together with the corresponding entity itself. In order to increase readability, the namespace declaring sections are omitted. The complete example with all namespaces can be found in Annex H iii. The instances of the core classes, the AssetAdministrationShell, the Asset, Submodels, and ConceptDescriptions are shown in Figure 92. A short snippet of the AssetAdministrationShell is also provided in Table 18. The RDF identifiers are visualized in a condensed format in the figure but represent complete URIs, as displayed in Table 18. One can see the additionally inserted triples for `rdf:type` (1), `rdfs:label` (2), and `rdfs:comment` (3) as determined by Rule 4. The first attribute states the instance’ class. The second provides its commonly used name, for instance based on the idShort attribute. `rdfs:comment` supplies a short description about the regarded entity, based on the description value. The generally available tools, for instance the open source tool Protégé, interpret these attributes and display the correct class hierarchy, render the elements with their labels or supply short explanations based on the comments.

**Figure 92 Simplified graph of the core classes in the example**

**Table 18 Turtle excerpt of an AssetAdministrationShell class**

```turtle
@prefix aas: <http://example.com/aas/9175_7013_7091_9168> .

a aas:AssetAdministrationShell; 
  aas:type aas:AssetAdministrationShell ;
  rdfs:label "ExampleMotor"^^xsd:string ;
  rdfs:comment "A very short description of the AAS instance."^^xsd:string ;

<https://admin-shell.io/aas/3/0/RC01/Referable/idShort> "ExampleMotor"^^xsd:string ;
<https://admin-shell.io/aas/3/0/RC01/Referable/description> "A very short description of the AAS instance."@en ;
<https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/assetInformation> .

<https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>[
  a as aas:value <http://example.com/assets/KHBVZJSQKIY> ; ...
].

<https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>[
  a as aas:value <http://i40.example.com/type/1/1/F13E5756F6488342> ; ...
].

<https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>[
  a as aas:value <http://i40.example.com/type/1/1/7A7104BDAB57E184> ; ...
].

<https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>[
  a as aas:value <http://i40.example.com/instance/1/1/AC69B1CB44F07935>; ...
].

<https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>[
  a as aas:value <http://i40.example.com/type/1/1/1A7B62529F19152> ; ...
].

```
7.6.4 Example Schema Shape

The Shapes Constraint Language (SHACL) [38] introduces a W3C recommendation for validation mechanisms on RDF graphs. The definition of required attributes, cardinality of relations or datatype restrictions in the form of shapes (see Table 19 for an example shape) is an important aspect to enable data quality assurance in any productive system. Some tools are already created to assist the creation of SHACL shapes, e.g., a Protégé plugin and as a part of TopBraid Composer. As SHACL shapes are also defined in RDF, they share the same format and thereby reduce the required technology stack and reduces the amount of necessary libraries.

Table 19: A SHACL Shape for the AssetAdministrationShell and its asset attribute

```xml
aas:AssetAdministrationShellShape a sh:NodeShape ;
  sh:targetClass aas:AssetAdministrationShell ;
  rdfs:subClassOf aas:HasDataSpecificationShape ;
  rdfs:subClassOf aas:IdentifiableShape ;
  sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/assetInformation> ;
    sh:class aas:AssetInformation ;
    sh:minCount 1 ;
    sh:maxCount 1 ;
    sh:message "Exactly one <i>assetInformation</i> attribute having an <i>AssetInformation</i> entity is required."^^xsd:string ;
    sh:name "assetInformation"^^xsd:string ;
  ] ; …
```

7.6.5 IRI Mapping

Every entity in RDF is either a Resource or a Literal. While Literals present data values, like strings, numbers or any sequence of characters, Resources represent the nodes and edges in the data graph. As Resources must be identified through IRIs (preferable even URIs), the creation of suitable IRIs is fundamental for the mapping. Whenever resources of an AAS are already identified through IRIs (see also Section 4.4.6), these IRIs/URIs are also utilized in the RDF model. However, in cases where no IRI is given, a defined procedure has to be followed. The following decision steps determine the necessary steps in order to create an unambiguous IRI for every element of the AAS.

These steps are only executed once per distinct element. If elements occur more than one time, always the same IRI identifier has to be used. This is especially relevant for the fallback solution (2b and 3) where the initial character sequence must be reused. Different elements must not get the same sequence under any circumstances.

1. If the element has IdentifierType = "IRI":
   Use the value of the identification attribute, else:
2. If the enclosing AAS has an IdentifierType = "IRI":
   a. **If the element inherits from Referable:**
      Apply the template:  <AAS identification URI>/<path/to/element>/<idShort>, where the path to the element is the concatenation of the respective idShorts separated by slashes, **else:**
      b. Apply the template:  <AAS identification URI>/<path/to/element>/<random characters>
3. Use randomized character sequence:
   <scheme>://<random characters>
Mappings to Data Formats to Share I4.0-Compliant Information

7.6.6 Example Mapping

Several mapping languages have been created in order to transform structured data into RDF graphs. Most prominently, R2RML (relational data only) and RML (relational data, XML, JSON, etc.) are used to specify the necessary mappings. A RML mapping can be used to transform a given Asset Administration Shell from its XML or JSON serialization to any potential RDF serialization. The snippet in Table 20 illustrates an RML TriplesMap used to convert the XML example from Annex E. The AssetAdministrationShell elements are iterated (rml:logicalSource) and, among others, all relations to referenced Submodels are extracted (rr:predicateObjectMap).

Table 20 RML TriplesMap snippet for parsing XML to RDF

```
_:AssetAdministrationShellMap rdf:type rr:TriplesMap ;
  rml:logicalSource [  
    rml:source "[...]/customer_com_aas_9175_7013_7091_9168.aas.xml" ;
    rml:referenceFormulation ql:XPath ;
    rml:iterator "*/[local-name()='assetAdministrationShell']"
  ] ;
  rr:subjectMap [  
    rr:reference "identification" ;
    rr:class aas:AssetAdministrationShell
  ] ;
  rr:predicateObjectMap [  
    rr:predicate aas:submodel ;
    rr:objectMap [  
      rml:reference "submodelRefs/submodelRef/keys/key" ;
      rr:termType rr:URI
    ]
  ] ; ...
```

7.6.7 Example Submodel with Property

Submodels contain the relevant information for a use case. Figure 93 shows the Identification Submodel with the Property containing the manufacturer of the asset. In the RDF terminology, every relation actually is called a property. In the data model of the Asset Administration Shell however, a Property is a defined sub class of the SubmodelElement. The distinction is made through the namespace: rdf:Property for every relation, aas:Property for certain SubmodelElements (see Table 20).
Table 21 Exemplary Submodel stating its semantic ID and containing one SubmodelElement

```xml
<http://i40.example.com/type/1/1/F13E8576F6488342> rdf:type aas:Submodel ;
  <https://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Identification"^^xsd:string ;
  <https://admin-shell.io/aas/3/0/RC01/HasSemantics/semanticId> [ a aas:Reference ;
    <https://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
      <https://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
      <https://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
      <https://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#01-ADN198#009"^^xsd:string ;
      <https://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;
    ] ; …
  ] ; …
  <https://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
    <http://i40.example.com/type/1/1/F13E8576F6488342> ;

  <https://admin-shell.io/aas/3/0/RC01/Submodel/submodelElement> [ rdf:type aas:Property ;
    rdf:subject <http://i40.example.com/type/1/1/F13E8576F6488342/Manufacturer> ;
    <https://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Manufacturer"^^xsd:string ; …
    <https://admin-shell.io/aas/3/0/RC01/HasSemantics/semanticId> [ a aas:Reference ;
      <https://admin-shell.io/aas/3/0/RC01/Reference/key> [ ...]] ; …
```
7.6.8 Example MultiLanguage String

The Identification Submodel in Table 22 has two descriptions, one in English and one in German. RDF proposes the usage of LangStrings, typed Literals with a language tag. Table 23 illustrates, how Rule 7 leads to different object values.

Table 22 Exemplary Multi-language description of a Submodel

```
<aas:submodel>
  <aas:idShort>Identification</aas:idShort>
  <aas:description>
    <aas:langString lang="EN">Identification from Manufacturer</aas:langString>
    <aas:langString lang="DE">Hersteller-Ide
tifikation</aas:langString>
  </aas:description>
</aas:submodel>
```

Table 23 RDF serialization of attribute values in different languages

```
<http://i40.example.com/type/1/1/F13E576F648342>
  <https://admin-shell.io/aas/3/0/RC01/Referable/description>  "Identification from Manufacturer"@en ;
```

7.6.9 Example Concept Description

A Concept Description defines the meaning of the entities used in the Asset Administration Shells, Assets, and Submodels. Table 24 illustrates a description for the organization name of a constant. The core building blocks of the example are the reference to the data specification key (1), the actual content conforming to IEC 61360 (2), and the reference to the actual identifier in the previously used elements (3).

Table 24 ConceptDescription Example in RDF

```
  rdf:type aas:ConceptDescription ;
  <https://admin-shell.io/aas/3/0/RC01/Referable/idShort>  "OrganizationName"^^xsd:string ;
  rdfs:label "OrganizationName"^^xsd:string ;
  <https://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
  <https://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
```
7.7 OPC UA

7.7.1 General

The works of the mapping to the OPC Unified Architecture are currently carried out in a joint working group\(^{35}\) between OPC Foundation, ZVEI and VDMA. In the following the main aspects for the mapping are described. In [39] the details of the companion specification can be found.

Note: Boxes in green (like "HasDictionaryEntry") are denoting elements (object types, reference types etc.) that are predefined in the OPC UA Specifications.

\(^{35}\) see: https://opcfoundation.org/collaboration/i4aas/
Mappings to Data Formats to Share I4.0-Compliant Information | 149

Figure 94 Overview OPC UA Information Model for AAS
HasOrderedComponent

HasInterface

AASCapabilityType

DictionaryEntryType::
<DictionaryEntry>

AASReference

PropertyType::
ValueType

PropertyType::
Max

PropertyType::
Min

Operation

AASOperationType

DictionaryEntryType::
<DictionaryEntry>

AASRangeType

AASQualifierType::
<Qualifier>

PropertyType::
Kind

IAASReferableType

semanticId

AASReferenceType::
ValueId

PropertyType::
ValueType

PropertyType::
Value

AASPropertyType

DictionaryEntryType::
<DictionaryEntry>

AASReference

AASReferenceType::
ValueId

PropertyType::
Value

AASMultiLanguagePropertyType

AASSubmodelElementType::
<SubmodelElement>

PropertyType::
AllowDuplicates

AASOrderedSubmodelElement
CollectionType

AASSubmodelElementType::
<SubmodelElement>

PropertyType::
AllowDuplicates

AASSubmodelElement
CollectionType

AASSubmodelElementType

PropertyType::
OutputArguments

PropertyType::
InputArguments

FileType::
File

AASBlobType

FileType::
File

PropertyType::
MimeType

PropertyType::
FileReference

AASFileType

BaseObjectType::
<Referable>

BaseObjectType::
<Referable>

AASReference

AASReferenceType::
Value

AASReferenceElementType

BaseObjectType::
<Referable>

AASReference

AASReference

AASReferenceType::
Second

AASReferenceType::
First

AASRelationshipElementType

BaseEventType

GeneratesEvent

AASEventType

AASAssetType::
<Asset>

AASReference

AASReferenceType::
Asset

PropertyType::
EntityType

AASSubmodelElementType::
<SubmodelElement>

AASEntityType

150 | Mappings to Data Formats to Share I4.0-Compliant Information

Figure 95 Submodel Element Subtypes in OPC UA


Mappings to Data Formats to Share I4.0-Compliant Information

7.7.2 OPC UA Mapping Rules

The rules for mapping of the AAS information model to OPC UA information model are given in the following. In subsequent clauses examples for the rules are given.

General Rules:

1. For all class elements in AAS an object type with the same name + suffix “Type” + prefix “AAS” is added. Example: AASAssetType for Asset, AASSubmodelElementType for SubmodelElement and AASQualifierType for Qualifier. These Types are derived from BaseObjectType. Exception: ConceptDescriptions und Referables see below.

2. For all types in AAS that cannot directly be mapped to OPC UA primitive types a data type is created with the same name + suffix “DataType” + prefix “AAS”. Example: AASAssetKindDataType for AssetKind. Exception: LangStringSet is mapped to the predefined OPC type “LocalizedText”.

3. Attributes of classes in AAS that have a simple data type are mapped to “HasProperty” references within the object type. The BrowzName corresponds to the name in the AAS UML model but is starting with Capital Letter. Example: AASAdministrativeInformationType has property Version with data type “String”.

4. The cardinality of an association or aggregation is specified via OPC Modelling rules. The OPC modelling rule “Optional” is used if the cardinality is Zero or 1. The OPC modelling rule “Mandatory” is used if the cardinality is One. The OPC Modelling rule “OptionalPlaceholder” is used if the cardinality is zero, one or more than one element. The OPC Modelling rule “MandatoryPlaceholder” is used if the cardinality is one or more than one element.

5. Aggregation and composition attributes of classes in AAS are mapped to “HasComponent” References within the object type. In case of cardinality 0 .. 1 or 1 the BrowzName corresponds to the name in the AAS UML model but is starting with Capital Letter. Example: Objects of type “AASAssetType” have a component with browse name “AssetIdenficationModel”.

6. Since OPC UA does not support multiple inheritance abstract classes (like e.g. “Qualifiable” or “Identifiable”) are not modelled via subtype reference in OPC UA. The corresponding attributes, aggregations and compositions are modelled as part of the inheriting class. For details see rules below.

Rules for SubmodelElements:

7. Specific for the Blob SubmodelElement type (AASBlobType) the predefined OPC type definition “FileType” is used for the value. References of type “FileType” are components of the object type. The browser name is not “value” but “File”. The mime type is part of the OPC File type and therefore not added. In contrast to the OPC File type mime type is mandatory to be filled.

8. Specific for the File SubmodelElement type (AASFileType) the value attribute is mapped to an OPC property with BrowzName “FileReference”. Additionally an object of type “FileType” with browse name “File” can be added similar as for the Blob. Since this is optional the mime type is modelled as OPC property. In case both are present, then the mime type needs to be the same.

9. SubmodelElementCollection can be either ordered or not ordered. In case of an ordered collection “SubmodelElementCollection” is realized as AASOrderedSubmodelElementCollectionType and the relationship between collection and submodel elements is realized via the predefined OPC UA “HasOrderedComponent” reference type. Otherwise a AASSubmodelElementCollectionType is used.

10. For Operations first an AASOperationType is defined but then the OPC “Method” is used for describing the operation. The name of the method is “Operation”. Hint: The OPC UA Specification Amendment 3: Method Metadata allows to add meta information to individual arguments (HasArgumentDescription). This is used to realize semanticId by using the OPC reference type “HasDictionaryEntry”. 


Mappings to Data Formats to Share I4.0-Compliant Information

11. For AAS references as used in ReferenceElement of RelationshipElement see rule for referencing.
12. For AAS submodel elements “Event” the object type “AASEventType” references an OPC UA event via the reference type “GenerateEvent”.

Rules for Referables and Identifiables:

13. For Referable and Identifiable separate OPC object types are defined that are referenced from the corresponding object types representing the concrete referables and identifiables via the OPC “HasInterface” Reference type. The naming convention for this is as follows “IAAS<AAS UML class name>”. Example: IAASIdentifiableType
14. In case of referenced referables with modelling rule “OptionalPlaceholder” or “MandatoryPlaceholder” the attribute idShort of AAS Referables is represented by the browse name of an element. Since there are cases like for AssetAdministrationShell/asset where the browse name is “Asset” but the asset has an idShort as well, idShort is modelled additionally. In cases with no predefined browse name the browse name and the idShort should be identical.
15. <<obsolete>>34 The parent attribute of Referables is not explicitly modelled because OPC UA supports native navigation.
16. In case of referenced referables with modelling rule “Optional” or “Mandatory” the browse name is identical to the AAS attribute name and the display name shall be identical to the idShort.

Rules for Qualifiables:

17. Qualifier of an element are modelled with OPC UA HasComponent reference type. Since qualifier are not referable they do not have a browse name that corresponds to an AAS attribute. Instead the name should be generated as follows: qualifier: <value of AAS:Qualifier/type>=<value of Qualifier/value>.

Rules for semanticId and Concept Descriptions:

18. A concept description is inheriting from the predefined OPC “IrdiDictionaryEntry” or “UriDictionaryEntry”. This is why there are both object types: “AASIdriConceptDescriptionType” or “AASIdriConceptDescriptionType” and not only one like for the other AAS classes. Additionally for idType = Custom a new Type “AASCustomConceptDescriptionType” is created inheriting directly from “DictionaryEntryType”.
19. Concept descriptions are added to a folder on the server side. The top-level folder shall be named “Dictionaries”. Below additional subfolders can be created.
20. semanticId is modelled by using the predefined OPC reference type “HasDictionaryEntry” and is either referencing an object of type “AASIdriConceptDescriptionType” or of type “AASIdriConceptDescriptionType” or of type “AASCustomConceptDescriptionType”.
21. Additionally a concept description has at least one Add-In to allow the usage of the IEC61360 data specification template (see rules for data specifications).

Rules for Data Specifications:

22. Concrete data specifications are inheriting from the AAS object type “AASDataSpecificationType”.
23. There is no need in OPC to distinguish between the data specification properties and the data specification content defining the properties that shall be added to the object type that uses the data specification. The AAS attributes of DataSpecification are modelled as OPC UA properties or components (rules as above) of the AASDataSpecificationType but are not instantiated. This is always the case in OPC UA if there are no modelling rules attached to a property or component.

34 Parent attribute was removed in V3.0RC01, no change in OPC UA needed
24. The concept of embedded data specifications is used. The element that is using the data specification uses the OPC reference type “HasAddIn”. This Add-In uses pairs of elements: one property being the global external reference to a data specification, the other one the data specification content.

Rules for Referencing:

25. For AAS references as used in ReferenceElement of RelationshipElement a new non-hierarchial Reference Type “AASReference” is introduced. The OPC Reference Type “HasComponent” is not directly used to reference an element because OPC references can only reference to elements within its own name space. For AAS, however, also global external references are possible – to elements in other AAS on other OPC Servers or to entities completely outside the scope of AAS. The object with type “AASReferenceType” is holding the unique key chain to the referenced elements and optionally can reference the “real” element via “AASReference” reference. There is no special rule for the browse name in this case. The display name should be the same as the idShort of the referenced element.

26. The Keys of a references are realized as an array. Every single Key is serialized as described in Clause 7.2.2

Rules for Semantics of Model Elements

27. The “HasDictionaryEntry” reference type of OPC UA is not only used to describe the semantics of objects but also of object types. For doing so the rules for creating identifiers as defined in Clause 7.2.2 are used.

7.7.3 Example Overview

Figure 96 shows an OPC UA Server with an AAS containing several submodels: Documentation, Identification, OperationalData and TechnicalData. For TechnicalData the attributes CoolingType, Identification, Kind, etc. are visible. The property maxRotationSpeed has the OPC properties Kind, Value, Category and so on. The mapping are explained in more detail in the following subclauses.
7.7.4 Identifiables and Referables

Identifiables and Referables are modelled as interfaces, see Figure 97. As explained in the rules, idShort is not only a property but in cases with no predefined browse name also the browse name of an object.

Figure 97 Identifiables and Referables in OPC UA

7.7.5 Example Submodel with Property etc.

In Figure 98 an example for a submodel with one property “MaxRotationSpeed” is shown. The example is not complete, some attributes like kind etc. are missing. In the next Clause the same example is shown adding semanticId.

In Figure 99 the definition of the submodel type is shown.

In Figure 100 the same example from Figure 98 is shown in UAExpert.
Figure 98 Example Submodel TechnicalData (Extract)

```
AASSubmodelType::
TechnicalData
DisplayName = Submodel:TechnicalData

AASIdentifierType::
Identification

PropertyType::
IdShort = TechnicalData

PropertyType::
Id = http://i40.customer.com/type/1/1/7A7104BDAB57E184

PropertyType::
IdType = IRI

AASPropertyType::
MaxRotationSpeed

PropertyType::
IdShort = MaxRotationSpeed

PropertyType::
Value = 5000
```

Figure 99 OPC UA Structure Submodel
**Mappings to Data Formats to Share I4.0-Compliant Information | 157**

**Figure 100 Example UAExpert Max. Rotation Speed Property**

<table>
<thead>
<tr>
<th>#</th>
<th>Display Name</th>
<th>Value</th>
<th>Datatype</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Category</td>
<td>PROPERTY</td>
<td>String</td>
</tr>
<tr>
<td>2</td>
<td>Id</td>
<td>0173-1#02-BAA120#008</td>
<td>String</td>
</tr>
<tr>
<td>3</td>
<td>IdShort</td>
<td>IRDI</td>
<td>String</td>
</tr>
<tr>
<td>4</td>
<td>KeyType</td>
<td>STRING</td>
<td>String</td>
</tr>
<tr>
<td>5</td>
<td>Key</td>
<td>Null</td>
<td>String</td>
</tr>
<tr>
<td>6</td>
<td>DataType</td>
<td>INTEGER, MEASURE</td>
<td>String</td>
</tr>
<tr>
<td>7</td>
<td>Definition</td>
<td>Double click to display value</td>
<td>String</td>
</tr>
<tr>
<td>8</td>
<td>PreferredName</td>
<td>Double click to display value</td>
<td>LocalizedText</td>
</tr>
<tr>
<td>9</td>
<td>ShortName</td>
<td>1/ min</td>
<td>String</td>
</tr>
<tr>
<td>10</td>
<td>Unit</td>
<td>1/ min</td>
<td>String</td>
</tr>
<tr>
<td>11</td>
<td>Revision</td>
<td>2</td>
<td>String</td>
</tr>
<tr>
<td>12</td>
<td>Version</td>
<td>(GlobalReference)</td>
<td>LocalizedText</td>
</tr>
<tr>
<td>13</td>
<td>Keys</td>
<td>{'GlobalReference': 'no-local', 'IRDI': '0173-1#02-BAA120#008'}</td>
<td>String</td>
</tr>
</tbody>
</table>

**7.7.6 Example Property of a Submodel with SemanticId**

In the following (Figure 101) the example from Clause 7.7.4 is extended and now also includes a semantic reference to a concept description of MaxRotationSpeed (modelled via “HasDictionaryEntry” reference type of OPC UA).

The property with idShort and thus browse name _MaxRotationSpeed_ has a reference to a dictionary entry with IRDI “0173-1#02-BAA120#008”. Since the semanticId is an IRDI the _AASIrdiConceptDescriptionType_ is instantiated. _AASIrdiConceptDescriptionType_ is inheriting from the OPC UA Object Type „IrdiDictionaryEntryType“ as defined in the Amendment for Dictionary Entries.

**Figure 101 Example MaxRotationSpeed Property as part of Submodel TechnicalData**

**7.7.7 Examples Submodel Element Collections**

SubmodelElementCollection is mapped to AASOrderedSubmodelElementCollectionType if ordered=True and AASSubmodelElementCollection if ordered=False (Figure 102).

An Example for a collection is shown in Figure 103.
Mappings to Data Formats to Share I4.0-Compliant Information

Figure 102 Structure CollectionType and OrderedCollectionType

![Diagram showing AASSubmodelElementType and its properties]

Figure 103 Example Submodel Documentation with Collection for OperatingManual

7.7.8 Example Asset

Asset as modelled as a normal component of the AAS object (see Figure 106). Figure 104 shows as an example an Asset with idShort “ServoDCMotor” with its reference to the assetIdentificationModel. Figure 105 shows the same example in UAExpert.
Mappings to Data Formats to Share I4.0-Compliant Information

Figure 104 Example ServoDCMotor as Asset

AASAssetAdministrationType:: ExampleMotor

AASAssetType:: Asset
DisplayName = ServoDCMotor

AASIdentifierType:: Identification
PropertyType:: IdShort = ExampleMotor
PropertyType:: Id = http://customer.com/aas/9175_7013_7091_9168

AASReferenceType:: AssetIdentificationModel
PropertyType:: AssetKind = Instance
PropertyType:: Id = http://customer.com/assets/KHVZJSQKYI
PropertyType:: IdType = IRI

AASSubmodelType:: Identification
PropertyType:: IdShort = ServoDCMotor

Figure 105 Example UAExpert Asset ServoMotor

Figure 106 Structure Asset Administration Shell with Asset and Submodels
7.7.9 Example File

In Figure 107 the OPC UA types for Blob and File submodel elements are shown (inheritance from AASSubmodelElementType is not shown, see Figure 95). In Figure 108 an example how to model a submodel element “File” is shown for a documentation submodel conformant to VDI 2770 containing an operation manual. The OPC type “FileType” is used for modelling the file itself. In Figure 109 the same example is shown in UAExpert.
Mappings to Data Formats to Share I4.0-Compliant Information | 161

Figure 107 OPC UA Types for Submodel Elements File and Blob

Figure 108 Example OperationManual as AASFileType

Figure 109 Example OperatingManual File in UAExpert
7.7.10 Example Operation and Capabilities

In Figure 110 an operation “Scan” is shown as defined in the OPC UA Companion Specification for AutoId.

It is visible that methods are not directly contained as part of the submodel but as part of an Instance of “OperationType” first. This is because on the one side to be consistent with the other submodel elements and on the other side otherwise no DictionaryEntry reference can be added; this is not foreseen so far in OPC UA Amendment for Dictionary Entries.

The predefined reference type for methods “HasArgumentDescription” is used to describe the semantics of the input and output variables. The references variable with the description has the “HasDictionaryEntry” representing the semanticId information.

In Figure 111 a different modelling is shown, not yet using the predefined reference type “HasArgumentDescription” but just explicitly modelling the input and output variables as components.
7.7.11 Example References

In Figure 112 an example is show how to use references. References are for example used in ReferenceElements and in RelationshipElements. For this there is a predefined `AASReference` reference type defined that is used for references to
Mappings to Data Formats to Share I4.0-Compliant Information

Local elements (Key/local=True). Local in this case means the referenced object is on the same OPC UA Server as the AAS. For global references (Key/local=False) no AASReference can be used. In this example the global reference is “http://i40.example.com/type/1/1/1A7B62B529F19152”.

Figure 112 Example References shown for the reference to a submodel

7.7.12 Example Qualifier

In Figure 113 the OPC UA Type for Qualifier is shown. In Figure 114 a Submodel “TechnicalData” with the qualifier of type “life cycle qual” and value “SPEC” for “as specified” is shown. Normally the name of an OPC UA element corresponds to the idShort within the AAS metamodel. However, qualifiers do not have an idShort because they are no referables. Therefore the name in OPC UA needs to be created, it is “LifeCycle=SPEC”.

In Figure 115 the example is shown in UA Expert.

37 In the example the name of the submodel is „TechnicalData_SPEC“.
Mappings to Data Formats to Share I4.0-Compliant Information | 165

Figure 113 Qualifier Type in OPC UA

Figure 114 Example Qualifiers for Submodel

Figure 115 Example Lifecycle Qualifier for Submodel Technical Data
7.7.13 Example Concept Description

In Figure 116 it is shown how to add the semanticId to a property. In this example the reference “HasDictionaryEntry” references the concept description. The difference between an external reference and a local reference to a concept dictionary is only visible looking at the addIns used to describe the attributes of a dictionary entry. The corresponding extract that can be referenced by any element that can have a dictionaryEntry reference is shown in Figure 116. A concrete example how it is realized in an OPC UA Server is shown in Figure 117.
**Mappings to Data Formats to Share I4.0-Compliant Information**

Figure 116 Example ConceptDescription Max. Rotation Speed (Extract)

Figure 117 ConceptDescription MaxRotationSpeed in OPC UA Server
Mappings to Data Formats to Share I4.0-Compliant Information
7.7.14 Example Data Specification

In Figure 118 the data specification template for IEC61360 is defined. In this case the id and idShort are fixed. It also has a version. Additionally the Browse Name is fixed since it is used as addIn (using the reference type “HasAddIn” from OPC UA).

The usage of the template was discussed in Clause 7.7.13.

Figure 118 Example Data Specification Template IEC61360

7.7.15 Example Event

In Figure 119 Event Type in OPC UA the event type in OPC UA is shown. It uses the Event Mechanism of OPC UA.
7.7.16 Example HasDictionaryEntry for Model

In Clause 7.7.6 it was shown how to describe the semantics of an instance of an OPC UA type. Using the same reference type “HasDictionaryEntry” also the semantic of the types, variables etc. themselves can be described. This is shown for the submodel in Figure 120.

**Figure 120 HasDictionaryEntry for Submodel**

7.8 AutomationML

7.8.1 General

For import and export scenarios the metamodel of an Asset Administration Shell needs to be serialized. In the following clauses an overview of the main concepts of the Asset Administration Shell serialization using AutomationML (IEC 62714) are presented. As a serialization format, AutomationML is especially suitable for the engineering phase.

In general the serialization approach is to map each object of the Asset Administration Shell metamodel to an AutomationML Role Class or to an AutomationML Role Class accompanied by an AutomationML Interface Class. This Role Class and (if applied) Interface Class then also define the required attributes in AutomationML.

Asset Administration Shells itself shall be modelled as AutomationML System Unit Classes or as Internal Elements within an Instance Hierarchy depending of the kind information of type and instance.

For the Role Classes and Interface Classes that are required for the serialization an AutomationML Role Class Library resp. an Interface Class Library are defined and provided to the public.
Mappings to Data Formats to Share I4.0-Compliant Information | 171

One of the goals is to ensure that the AutomationML model of the Asset Administration Shell can be used as a standalone AutomationML model as well as in combination with existing AutomationML models such as the upcoming AutomationML Component Description. Therefore, the definition of the serialization approach defined in this clause is interleaved with the AutomationML definitions and applies the AutomationML technology definitions widely on https://www.automationml.org/o.red.c/dateien.html

The example is shown in tool “AutomationML Editor” of AutomationML e.V. 2015.

7.8.2 Rules

The rules for mapping of the AAS information model to AutomationML information model are given in the following. In subsequent clauses examples for the rules are given. For reasons of simplicity the term AML element is used for either InternalElements or for SystemUnitClasses or interfaces (or all of them) depending on the context.

Generic Rules for mapping:

(1) If present, AML role class and attribute name are taken from the AAS metamodel.

(2) If present, AML element names are the same as the value of id\textunderscore Short information from the AAS. If not present, a sufficiently unique element name is to be generated.

(3) Attributes of AAS Classes are modelled as attributes of AML elements.

(4) Semantics of AML attributes is given by the AML \textit{RefSemantic} attribute. Semantics of AML elements are defined via AML role and interface classes.

The values of RefSemantic follow the rules as described in Clause 7.2.2.

Example for RefSemantic values: \textit{AAS:Qualifier, AAS:Qualifier/type, AAS:Qualifier/value}

For a complete list of all RefSemantic values see Annex L.iii.

\textbf{Note: RefSemantic is not identical to semanticId in AAS. The difference is explained in Clause 7.8.8.}

(5) Attributes on AML Elements are created only if required.

Attributes, such as category, are only created for AML elements, if values are present in the AAS and vice versa.

(6) Values of Attributes in AAS which are of type “Reference” are serialized as string.

- The rules for serialization can be found in Clause 7.2.2
- Example: \textit{(Submodel)[IRI]} \textit{http://www.myuri.de}
- Every internal element that represents information of the AAS metamodel. A Tool with AASX-Import would search only for the AAS roles in the AML file. However, an AutomationML tool could also export/write a file containing AAS roles and other roles/models.

Rules for elements other than SubmodelElements of the AAS:

(7) Qualifiers are mapped on instance level to a complex attribute in AML.

- Name of top-most hierarchy attribute: qualifier:<<value of AAS:Qualifier/type>>:<<value of Qualifier/value>>. Example: “\textit{Qualifier:PredicateRelation=}\textit{GREATER\_THAN\_0}”
- Subordinate attributes of the qualifier are mapped to subordinate attributes of the attribute in AML, e.g. for qualifier type, qualifier value with according AML \textit{RefSemantic}.

(8) \textbf{View as InternalElement with RoleClass View groups mirror elements}

The internal elements with the assigned role class “View” group one to many mirror elements as a child. The target of the mirror element is the AAS entity identified by the AAS View as a contained element. A mirror element points with it’s \textit{RefBaseSystemUnitPath} attribute to the UUID of the corresponding AML element.

Rules for subtypes of AAS SubmodelElement:

(9) All AAS SubmodelElements are mapped to AML InternalElements with an associated role class equal to the respective \textit{SubmodelElement} subtype (e.g. AAS Property to AML Role Class Property).
172 | Mappings to Data Formats to Share I4.0-Compliant Information

(10) For submodel element File an interface FileDataReference with its predefined attributes refURI and MIMEType is used for referencing the file. Attribute value of submodel element File is not needed.

(11) For submodel elements ReferenceElement and RelationshipElement the interface “ReferableReference” is used to reference to the corresponding objects. In case of a local reference (AAS:Key/local = True) the interface “ReferableReference” needs to be set and is pointing to the corresponding element within AutomationML via an InternalLink. In this case, the value is empty. In case of an external reference (AAS:Key/local = False) no InternalLink is set for the interface. Instead, the value attribute carries a serialization of the AAS Reference.

(12) For Operation, the Operation is mapped to an InternalElement in AML with Role Class Operation.

- Input~output~inoutputVariable attributes of an AAS Operation are mapped to InternalElements in AML with RoleClass OperationInputVariables, OperationOutputVariables resp. OperationInoutputVariables. These InternalElements contain subordinated InternalElements for the submodel elements.

(13) SubmodelElementCollection is mapped to an InternalElement in AML with RoleClass SubmodelElementCollection. It contains subordinated InternalElements for contained elements.

Rules for the instance hierarchy of AML:

(14) For an AASX Tool with AML Export typically an instance hierarchy needs to be created. This instance hierarchy needs a name. If there is no other naming convention or no existing instance hierarchy that shall be used a possible name for the InstanceHierarchy is “AssetAdministrationShellInstanceHierarchy”. It contains the asset administration shells containing elements of kind=Instance. Elements within this hierarchy have the role “AssetAdministrationShell”.

Note: The AML import to an AASX Tool just needs to look for the role “AssetAdministrationShell”, not for the names of the instance hierarchies.

(15) For an AAS with concept descriptions an AASX Tool with AML Export needs to create an instance for the concept descriptions. If there is no other naming convention or no existing concept description instance hierarchy then a possible name for the InstanceHierarchy is “AssetAdministrationShellConceptDescriptions”. It contains the concept descriptions used or that can be used within the asset administration shells. The role of the elements contained in this instance hierarchy is “ConceptDescription”.

Note: The AML import to an AASX Tool just needs to look for the role “ConceptDescription”, not for the names of the instance hierarchies.

(16) For each AAS related element within an instance with role “AssetAdministrationShell” the corresponding role within AssetAdministrationShellRoleClassLib is assigned.

(17) In case of an AAS element having a data specification additionally an instance of the corresponding template with Role DataSpecificationContent within the corresponding SystemUnitClassLib is assigned. Thus, all attributes defined within the template are additionally predefined for the element.

(18) The name of the element within a concept description being instantiated by a data specification template, i.e. an element with role “DataSpecificationContent”, is “EmbeddedDataSpecification”. If more than one data specification template is used then the element containing the different elements has the name “EmbeddedDataSpecifications” (no role) and its sub-elements are names “EmbeddedDataSpecification_<Number>” because the names need to be unique.

(19) In case of a concept description AAS has a predefined data specification template (Role DataSpecification) called “DataSpecificationIEC61360Template”. This template is used for a concept description by instantiating its content, i.e. element with role “DataSpecificationContent”.

(20) The name of the elements within a library needs to be unique. This is why for concept descriptions within the library for concept descriptions the name is choosen as follows:

\[
<\text{value of AAS:ConceptDescription/idShort}>_\text{<value of AAS:ConceptDescription/identification/idType}>_\text{<value of AAS:ConceptDescription/identification/id>}
\]

Rules for the Role Class Library of AML:
Mappings to Data Formats to Share I4.0-Compliant Information

(21) There is a predefined RoleClassLibrary with name “AssetAdministrationShellRoleClassLib”. It contains all roles specific for asset administration shells.

(22) All AAS referables (and thus identifiability) are mapped to specific Role Classes in AML. The name is identical to the name in AAS.

(23) A small number of role classes are required for entities that have cardinality > 1 and different names like “OperationInputVariables”, “OperationOutputVariables”, and “OperationInOutVariables” of Operation Rules for System Unit Class Libraries:

(24) For an AASX Tool with AML Export a system unit class library needs to be created if the AASX contains submodels or submodel elements of kind=Template. This system unit class library needs a name. If there is no other naming convention or no other system unit class lib that can be used a possible name for the library is “AssetAdministrationShellSystemUnitClasses”. It contains the asset administration shells containing elements of kind=Type. Elements within this library have the role “AssetAdministrationShell”.

Note: The AML import to an AASX Tool just needs to look for the role “AssetAdministrationShell”, not for the names of the system unit class libraries.

(25) If an AAS contains a submodel of kind=Template, then a corresponding SystemUnitClass is created for:
- the AAS itself, and
- the submodels within the AAS with kind=Template

(26) The same roles as for AAS with submodels of kind=Instance are assigned.

(27) There is a predefined SystemUnitClassLibrary with name “AssetAdministrationShellDataSpecification-Templates”. It contains the predefined data specification templates as defined in Asset Administration Shell in Detail. These data specifications have the role “DataSpecification”.

(28) A Data Specification has an internal element with role “DataSpecificationContent” defining all the attributes available when using the data specification.

(29) In case there is the need to assign more than one data specification template to an element a system unit class containing the needed data specification content elements needs to be defined.

Rules for Interface Libraries:

(1) There is a predefined InterfaceClassLibrary with name “AssetAdministrationShellInterfaceClassLib”. It contains the predefined interfaces used within the asset administration shell.

(2) FileDataReference is an interface derived from the AutomationML interface “ExternalDataReference”. It is used as interface for submodel element “File”.

(3) ReferableReference is an interface for realizing references as used within submodel elements “ReferenceElement” and “RelationshipElement” (and its subclasses) within asset administration shells

7.8.3 Example Overview

In Figure 121 the example is shown in the AutomationML Editor. Details are explained in the following subclauses.
7.8.4 Example Property and Concept Description
Mappings to Data Formats to Share I4.0-Compliant Information | 175

Figure 122 shows the property “MaxRotationSpeed”.

Please note: the Unit “1/min” could have been added to the AML field “Unit” of attribute value. However, it is available only indirectly via its semanticId (see Figure 123).

The value of attribute “semanticId” used the reference serialization as defined in Clause 7.2.2.

Figure 122 Example Property MaxRotationSpeed

---

Figure 123 Example DataSpecificationContent of Concept Description MaxRotationSpeed conformant to template DataSpecificationIEC61360Template
7.8.5 Example Attributes of Attributes

Complex Types are realized as attributes with sub-attributes (see Figure 124).

Figure 124 Example Identification with two subattributes

![Diagram of Identification with two subattributes]

7.8.6 Example Language Tagged Strings

For attributes of type langString or LangStringSet the predefined AML attribute “aml-lang” is used (see Figure 125).

Figure 125 Example for attribute value in multiple languages

![Diagram of Language Tagged Strings]

7.8.7 Example Asset

In Figure 126 the asset represented by an asset administration shell is shown: it has the role “Asset” assigned to it.
7.8.8 Example RefSemantic

*Note: RefSemantic is an attribute of AutomationML whereas semanticId is an attribute of Asset Administration Shell.*

RefSemantic\(^{38}\) describes the semantics of the metamodel. Thus the values reference to a description within the Asset Administration Shell Specification.

SemanticId describes the semantics of an instance.

RefSemantic for the AML attribute “semanticId” of an AML element “MaxRotationSpeed” for example says that it has the semantics as defined for the attribute “semanticId” within the AAS specification. The semanticId of the property says that it is the maximum rotation speed (see Figure 127).

For a complete list of all RefSemantic see Annex I.iii.

---

\(^{38}\) In the tooling it is sometimes just denoted as „Semantic“. 
7.8.9 Example References

References are serialized into a single string. See example in Figure 128 The value of the semanticId is typed as “Reference” and is serialized as string.

Exceptions: ReferenceElement and RelationshipElement including its subtypes as well as Views.
7.8.10 Example ReferenceElement

In Figure 129 an example for a reference element is given: it references another element within the AAS by using the interface “ReferableReference”. The blue dotted line represents a InternalLink to the target referenced element (not visible here).

Figure 129 Example for ReferenceElement with Interface

7.8.11 Example File

In Figure 130 an AAS File submodel element is shown. It is realized with the predefined AML interface FileDataReference from Interface Class Library “AssetAdministrationShellInterfaceClassLib”. It is derived from the AML interface “ExternalDataReference” from Interface Class Library “AutomationMLBPRInterfaceClassLib” that again is derived from the AML interface “ExternalDataConnector” as defined in the Interface Class Library “AutomationMLInterfaceClassLib”. The interface FileDataReference already has a MIMETYPE inherited that is conformant to AAS:/File/mimeType.

Figure 130 Example File

7.8.12 Example Operation

Operation is mapped to InternalElement in AML with Role Class Operation. InputVariables/OutputVariables/InoutputVariables are mapped to InternalElements in AML with RoleClass Operation-InputVariables resp. ~Output~. These InternalElements contain subordinated InternalElements for the submodel elements.

The in or out element can be empty, i.e. does not need to have child elements.
7.8.13 Example Qualifier

The example in Figure 132 shows a property with two qualifiers. One of the qualifiers is of type “ExpressionSemantic”, the other of type “PredicateRelation”. The qualifier value of the “PredicateRelation” qualifier is “GREATER_THAN_0”. Qualifiers are not referable, i.e. they do not have an idShort attribute. This is why a name of the AML attribute was generated as follows:

```
qualifier:<value of AAS:Qualifier/type>=<value of Qualifier/value>.
```

7.8.14 Example Concept Descriptions

Concept Descriptions are stored in an Instance Hierarchy. The default name is “AssetAdministrationShellConceptDescriptions”.

The name of the elements within an instance hierarchy needs to be unique. This is why the name is choosen as follows:

```
<value of AAS:ConceptDescription/idShort>_<value of AAS:ConceptDescription/identification/idType>_<value of AAS:ConceptDescription/identification/id>
```

An example concept description for max. rotation speed using the predefined data specification template “DataSpecificationIEC61360” is shown in Figure 133 and Figure 134.
Mappings to Data Formats to Share I4.0-Compliant Information | 181

Figure 133 Example Concept Description using predefined data specification template IEC61360

Figure 134 Example Embedded Data Specification IEC61360 of Concept Description for Property “MaxRotationSpeed”

7.8.15 Example View

In Figure 135 an example view with name “SafetyView” is shown that contains a reference to the property RotationSpeed.
7.8.16 Example Submodels of kind=Template

Submodel templates (i.e. submodels and elements with kind = Template) are modelled as System Unit Classes. They are part of a System Unit Class Library with default name “AssetAdministrationShell\SystemUnitClasses”.

Figure 136 Example for System Unit Class with a Submodel template for Technical Data
When exchanging information from partner A to partner B there are two use cases:

- The producer of information does not want to submit the complete information but only parts of it. The information submitted might vary depending on the specific consumer the information is submitted to. I.e. a filtering mechanism is needed that allows to individually shape the information for the specific consumer.
- The consumer of information does not want to include all information provided by the producer of information in his own process, i.e. he wants to filter only the relevant information.

As an example, assume that the producer is submitting the complete order data. However, the consumer (in this case the machine builders) is filtering the information (1) and is only importing the information relevant to him. For the functionality both are filtering: the producer is filtering what he submits to the consumer (2) and the consumer again is not using all functionality but is filtering again which functionality shall be used in his environment. The same is possible between machine builders and operator.

Table 25 shows an example when using the defined xml format as defined in this document. In the example the German translation shall not be submitted, only English language is provided for partner B.
### Filtering of Information in Export and Import

**Table 25 Example Filtering of Information in XML**

```
[...]
<property>
  <#short>NMax</#short>
  <category>PARAMETER</category>
  <description lang="EN">maximum rotation speed</description>
  <description lang="DE">maximale Drehzahl</description>
  <ref hasSemantics>
    <keys>
      <key type="GlobalReference" keytype="#ID">0173-1#02-baa120#007</key>
    </keys>
  </ref>
</property>
[...]
```

```
[...]
<property>
  <#short>NMax</#short>
  <category>PARAMETER</category>
  <description lang="EN">maximum rotation speed</description>
  <description lang="DE">maximale Drehzahl</description>
  <ref hasSemantics>
    <keys>
      <key type="GlobalReference" keytype="#ID">0173-1#02-baa120#007</key>
    </keys>
  </ref>
</property>
[...]
```

**Only Lang = “EN”**
9  Tools for the Asset Administration Shell
9.1 Open Source Tools

This clause gives some hints with respect to available open source tools supporting the creation and operating of an asset administration shell. It is not necessarily complete. There might be other implementations as well.

The aasx package explorer is an open source browser and editor for creating asset administration shells as .aasx packages [40]. The aasx package explorer supports the xml and JSON serialization of the asset administration shell. Additionally, export formats for AutomationML or server generation for OPC UA are provided. But also, additional export formats like BMEcat etc. are supported. Since it is an open source implementation new features are added continuously. On [41] also additional information and code in the context of the asset administration shell can be found.

BaSyx, a software platform, is another open source implementation for the asset administration shell and provides software development kits for C++, C# and Java [42].
10 Summary and Outlook
In this document a metamodel for the structural viewpoint of the Asset Administration Shell is defined using UML. It covers security aspects as well as features for handling composite I4.0 Components. Data specification templates for defining concept descriptions for properties and physical units are provided.

Several serializations and mappings are offered:

- XML and JSON for Exchange between partners via exchange format .aasx
- RDF for reasoning
- AutomationML for the engineering phase
- OPC UA for the operation phase

Additional parts of the document series cover (see [49]):

- Interfaces and APIs for accessing the information of Asset Administration Shells (access, modify, query and execute information and active functionality). The payload of these APIs is based on the definitions of the information model in this document, part 1.
- The infrastructure, which hosts and interconnects multiple Asset Administration Shells together. It implements registry, discovery services, endpoint handling and more.
Annex
ANNEX A. CONCEPTS OF THE ADMINISTRATION SHELL

i. GENERAL

In this clause, a general information is given about sources of information and relevant concepts for the Asset Administration Shell. Some of these concepts are explained in a general manner. Some concepts are updated in order to reflect actual design decisions. No new concepts are introduced. Thus, the clause can be taken as a fully informative (annex) to the specification of the Administration Shell.

ii. RELEVANT SOURCES AND DOCUMENTS

The following documents were used to identify requirements and concepts for the Administration Shell:

- Implementation strategy of Plattform Industrie 4.0 [1][2]
- Aspects of the research roadmap in application scenarios [7]
- Continuation of the application scenarios [8]
- Structure of the Administration Shell [4][18]
- Examples for the Administration Shell of the Industrie 4.0 Components [6]
- Technical Overview “Secure identities” [9]
- Security of the Administration Shell [14]
- Relationships between I4.0 components – Composite components and smart production [12]

Note 1: The global Plattform Industrie 4.0 glossary can be found at: https://www.plattform-i40.de/PI40/Navigation/EN/Industrie40/Glossary/glossary.html
Note 2: The online library of the Plattform Industrie 4.0 can be found at: https://www.plattform-i40.de/PI40/Navigation/EN/Downloads-News/downloads-news.html

iii. BASIC CONCEPTS FOR INDUSTRIE 4.0

Industrie 4.0 describes concepts and definitions for the domain of smart manufacturing. For Industrie 4.0, the term asset, being any "object which has a value for an organization", is of central importance [2][23]. Thus, assets in Industrie 4.0 can take almost any form, for example be a production system, a product, a software installation, intellectual properties or even human resources.

According [23], the "reference architecture model Industry 4.0 (RAMI4.0) provides a structured view of the main elements of an asset using a level model consisting of three axes [...]. Complex interrelationships can thus be broken down into smaller, more manageable sections by combining all three axes at each point in the asset’s life to represent each relevant aspect.”

Assets shall have a logical representation in the "information world", for example shall be managed by IT-systems. Thus, an asset has to be precisely identified as an entity, shall have a "specific state within its life (at least a type or instance)", shall have communication capabilities, shall be represented by means of information and shall be able to provide technical functionality [23]. This logical representation of an asset is called Administration Shell [4]. The combination of asset and Administration Shell forms the so-called I4.0 Component. In international papers [18], the term smart manufacturing replaces the term Industrie 4.0.

For the large variety of assets in Industrie 4.0, the Administration Shell allows handling of these assets in the information world in always the same manner. This reduces complexity and allows for scalability. Additional motivation can be found in [2][4][7][8].
iv. **THE CONCEPT OF PROPERTIES**

According [20], the "IEC 61360 series provides a framework and an information model for product dictionaries. The concept of product type is represented by 'classes' and the product characteristics are represented by 'properties'".

Such properties are standardized data elements. The definitions of such properties can be found in a range of repositories, such as IEC CDD (common data dictionary) or ECLASS. The definition of a property (aka standardized data element type, property type) associates a worldwide unique identifier with a definition, which is a set of well-defined attributes. Relevant attributes for the Administration Shell are, amongst other, the preferred name, the symbol, the unit of measure and a human-readable textual definition of the property.
The instantiation of such definition (just 'property', property instance) typically associates a value to the property. By this mechanism, semantically well-defined information can be conveyed by the Administration Shell.

Note: Industrie 4.0 and smart manufacturing in general will require many properties which are beyond the current scope of IEC CDD, ECLASS or other repositories. It is expected that these sets of properties will be introduced, as more and more domains are modelled and standardized (next clause).

v. THE CONCEPT OF SUBMODELS

"The Administration Shell is the standardized digital representation of the asset, corner stone of the interoperability between the applications managing the manufacturing systems” [18]. Thus, it needs to provide a minimal but sufficient description according to the different application scenarios in Industrie 4.0 [7] [8]. Many different (international) standards, consortium specifications and manufacturer specifications can already contribute to this description [18]. As the figure shows, information from different many different technical domains could be associated with a respective asset and thus, many different properties are required to be represented in Administration Shells of future I4.0 Components. In order to manage these complex set of information, submodels provide a separation of concern.
The Administration Shell is thus made up of a series of submodels [4]. These represent different aspects of the asset concerned; for example, they may contain a description relating to safety or security [14] but could also outline various process capabilities such as drilling or installation [6].

From the perspective of interoperability, the aim is to standardise only a single submodel for each aspect / technical domain. For example, it will thus be possible to find a drilling machine by searching for an Administration Shell containing a submodel “Drilling” with appropriate properties. For communication between different IIoT components, certain properties can then be assumed to exist. In an example like this, a second submodel, “energy efficiency”, could then ensure that the drilling machine is able to cut its electricity consumption when it is not in operation.

Note: side benefit of the Administration Shell will be to simplify the update of properties from product design (and in particular system design) tools, update of properties from real data collected in the instances of assets, improve traceability of assets along life cycle and help certify assets from data.

vi. BASIC STRUCTURE OF THE ASSET ADMINISTRATION SHELL

The document on the Structure of the Asset Administration Shell [4] [18] presented a rough, logical view of the Asset Administration Shell’s structure. The Asset Administration Shell – shown in blue in the following figure – comprises different sets of information. Both, the asset and the Administration Shell are identified by a globally unique identifier. It comprises a number of submodels for a characterisation of the Asset Administration Shell.
Properties, data and functions will also contain information which not every partner within a value-added network or even within an organisational unit should be able to access or whose integrity and availability should be guaranteed. Therefore, the structure of the Administration Shell shall be able to handle aspects such as access protection, visibility, identity and rights management, confidentiality and integrity. Information security needs to be respected and has to be aligned with an overall security concept. Implementation of security must go together with the implementation of other components of an overall system.

Each submodel contains a structured quantity of properties that can refer to data and functions. A standardized format based on IEC 61360-1/ISO 13584-42 is envisaged for the properties. Thus, property value definition shall follow the same principles as also ISO 29002-10 and IEC 62832-2. Data and functions may be available in various, complementary formats.

The properties of all the submodels therefore result in a constantly readable directory of the key information of the Administration Shell and thus of the I4.0 component. To enable binding semantics, Administration Shells, assets, submodels and properties must all be clearly identified. Permitted global identifiers are IRDI (e.g. in ISO TS 29002-5, ECLASS and IEC Common Data Dictionaries) and URIs (Unique Resource Identifiers, e.g. for ontologies).

It should be possible to filter elements of the Administration Shell or submodels according to different given views (→ Example C.4 in [18]). This facilitates different perspectives or use-cases for the application of Administration Shell's information.
vii. REQUIREMENTS

This section collects the requirements from various documents that have impact on the specific structure of the Administration Shell. These requirements serve as input for the specific description of the structures of the Administration Shell.

The following requirements are taken from the document “Implementation strategy of Plattform Industrie 4.0” [2]. They are marked “STRAT”. The “Tracking” column validates the requirements by linking to features of the UML metamodel or this document in general.

<table>
<thead>
<tr>
<th>ID</th>
<th>Requirement</th>
<th>Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRAT#1</td>
<td>A network of Industrie 4.0 components must be structured in such a way that connections between any end point (Industrie 4.0 components) are possible. The Industrie 4.0 components and their contents are to follow a common semantic model.</td>
<td>Network possible but not scope of this part of the document series. Common semantic model realized by domain specific submodels (HasSemantics/ConceptDescription and by Relations)</td>
</tr>
<tr>
<td>STRAT#2</td>
<td>It must be possible to define the concept of an Industrie 4.0 component in such a way that it can meet requirements with different focal areas, i.e. “office floor” or “shop floor”.</td>
<td>Content-wise, many different submodels possible.</td>
</tr>
<tr>
<td>STRAT#3</td>
<td>Industrie 4.0 compliant communication must be performed in such a way that the data of a virtual representation of an Industrie 4.0 component can be kept either in the object itself or in a (higher level) IT system.</td>
<td>Metamodel and information representation independent of any deployment scenario.</td>
</tr>
<tr>
<td>STRAT#4</td>
<td>In the case of a virtual representation of an I4.0 component in a higher-level system, an integrity association must be ensured between the asset and its representation.</td>
<td>Integrity part of security approach.</td>
</tr>
<tr>
<td>STRAT#5</td>
<td>A suitable reference model must be established to describe how a higher-level IT system can make the Administration Shell available in an Industrie 4.0 compliant manner (SOA approach, delegation principle).</td>
<td>Scope of upcoming part of the document series; not scope of this part.</td>
</tr>
<tr>
<td>STRAT#6</td>
<td>A description is required of how the Administration Shell can be “transported” from the originator (e.g. component manufacturer or electrical designer) to the higher-level IT system (e.g. as an attachment to an email).</td>
<td>Hierarchical representation by XML/JSON and package file format allow for different transport scenarios.</td>
</tr>
<tr>
<td>STRAT#7</td>
<td>Depending on the nature of the higher-level systems, it may be necessary for the administration objects to allow for deployment in more than one higher level IT system.</td>
<td>Metamodel and information representation independent of any deployment scenario.</td>
</tr>
<tr>
<td>STRAT#8</td>
<td>The Industrie 4.0 component, and in particular the Administration Shell, its inherent functionality and the protocols concerned are to be “encapsulation-capable” or “separable” from any field busses in use.</td>
<td>Metamodel and information representation independent of any communication scenario.</td>
</tr>
<tr>
<td>STRAT#9</td>
<td>The aim of the Industrie 4.0 component is to detect non-Industrie 4.0 compliant communication relationships leading to or from the object’s Administration Shell and to make them accessible to end-to-end engineering.</td>
<td>Non-Industrie 4.0 compliant communication relationships could be modelled by submodels and therefore made available.</td>
</tr>
<tr>
<td>STRAT#10</td>
<td>It should be possible to logically assign other Industrie 4.0 components to one Industrie 4.0 component (e.g. an entire machine) in such a way that there is (temporary) nesting.</td>
<td>References and preparations for Composite components [12]</td>
</tr>
<tr>
<td>STRAT#11</td>
<td>Higher level systems should be able to access all Industrie 4.0 components in a purpose-driven and restrictable manner, even when these are (temporarily) logically assigned.</td>
<td>Scope of upcoming part of the document series; not scope of this part.</td>
</tr>
<tr>
<td>Strategy ID</td>
<td>Characteristics</td>
<td>Tracking</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td>----------</td>
</tr>
<tr>
<td>STRAT#12</td>
<td>(1) Identifiability</td>
<td>Given by <code>Identifiable</code></td>
</tr>
<tr>
<td>STRAT#13</td>
<td>(2) I4.0-compliant communication</td>
<td>Not scope of part 1</td>
</tr>
<tr>
<td>STRAT#14</td>
<td>(3) I4.0-compliant services and multiple status</td>
<td>Standardisation of submodels</td>
</tr>
<tr>
<td>STRAT#15</td>
<td>(4) Virtual description</td>
<td>Available by digital representation (<code>Submodel</code> and <code>SubmodelElements</code>)</td>
</tr>
<tr>
<td>STRAT#16</td>
<td>(5) I4.0-compliant semantics</td>
<td>HasSemantics</td>
</tr>
<tr>
<td>STRAT#17</td>
<td>(6) Security and safety</td>
<td>Security by Attribute Based &amp; Role Based Access. Safety not scope of part 1</td>
</tr>
<tr>
<td>STRAT#18</td>
<td>(7) Quality of services</td>
<td>Metamodel and information representation independent of any communication scenario.</td>
</tr>
<tr>
<td>STRAT#19</td>
<td>(8) Status</td>
<td>Standardisation of submodels</td>
</tr>
<tr>
<td>STRAT#20</td>
<td>(9) Nestability</td>
<td>Supported by <code>billOfMaterial</code> of an Asset and RelationshipElements</td>
</tr>
<tr>
<td>STRAT#21</td>
<td>The minimum infrastructure must satisfy the principles of Security by Design (SbD).</td>
<td>Security by Attribute Based &amp; Role Based Access.</td>
</tr>
</tbody>
</table>

The following requirements are taken from the document “The Structure of the Administration Shell: Trilateral perspectives from France, Italy and Germany” [18]. They are marked “tAAS”.

**Note:** The term "property" was used in a very broad sense in previous publications of the Plattform Industrie 4.0. The metamodel in this document distinguishes between properties in a more classical sense as data elements like “maximum temperature” and other submodel elements like operations, events etc.
The only thing required is that the domain a property is derived from has a unique id (semanticId).

<table>
<thead>
<tr>
<th>tAAS-#3</th>
<th>For finding definitions within each relevant technical domain, different procedural models should be allowed that respectively meet the requirements of standards, consortium specifications and manufacturer specifications sets.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HasSemantics/semanticId (see tAAS-#2)</td>
<td></td>
</tr>
<tr>
<td>ConceptDescription</td>
<td></td>
</tr>
<tr>
<td>Proprietary manufacturer specific property – or more general – concept descriptions or copies from external dictionaries are supported by defining ConceptDescriptions. They are referenced in semanticId via their global id.</td>
<td></td>
</tr>
<tr>
<td>Up to now there is only a predefined data specification template for Property elements (DataSpecification_IEC61360).</td>
<td></td>
</tr>
<tr>
<td>Usage of proprietary concept descriptions is not recommended because then interoperability cannot be ensured.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tAAS-#4</th>
<th>Different Administration Shells in respect of an asset must be capable of referencing each other.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AssetAdministrationShell/derivedFrom</td>
<td></td>
</tr>
<tr>
<td>The derivedFrom relationship is especially designed for supporting the relationship between an Asset Administration Shell representing an asset type and the Asset Administration Shells representing the asset instances of this asset type.</td>
<td></td>
</tr>
<tr>
<td>See also tAAS-#16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tAAS-#5</th>
<th>Individual Administration Shells should, while retaining their structure, be combined into an overall Administration Shell.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AssetAdministrationShell/assetInformation</td>
<td></td>
</tr>
<tr>
<td>AssetInformation/billOfMaterial</td>
<td></td>
</tr>
<tr>
<td>RelationshipElement</td>
<td></td>
</tr>
<tr>
<td>The billOfMaterial for an asset defines co-managed and self-managed entities the asset is composed of.</td>
<td></td>
</tr>
<tr>
<td>Via the submodel element “RelationshipElement” relations between entities can be defined.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tAAS-#6</th>
<th>Identification of assets, Administration Shells, properties and relationships shall be achieved using a limited set of identifiers (IRDI, URI and GUID), providing as far as possible offer global uniqueness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifiable</td>
<td></td>
</tr>
<tr>
<td>Identification/idType</td>
<td></td>
</tr>
<tr>
<td>Requirement tAAS-#6 is fulfilled for all elements inheriting from Identifiable. For example, this is the case for Asset, AssetAdministrationShell and for concept descriptions. However, properties (like any other submodel element) are only referable. However, unique referencing is possible via the unique submodel id and the Reference via Keys concept.</td>
<td></td>
</tr>
<tr>
<td>The supported id types include IRDI, URI (=IRI), IRI and GUID (=Custom) as requested.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tAAS-#7</th>
<th>The Administration Shell should allow retrieval of alternative identifiers such as a GS1 and GTIN identifier in return to asset ID (referencing).</th>
</tr>
</thead>
<tbody>
<tr>
<td>AssetInformation/specificAssetIds</td>
<td></td>
</tr>
<tr>
<td>AssetInformation/globalAssetId</td>
<td></td>
</tr>
<tr>
<td>Every asset has a globally unique identifier (globalAssetId). Besides this global identifier additional external identifiers can be specified (specificAssetIds)</td>
<td></td>
</tr>
<tr>
<td>tAAS-#{num}</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>tAAS-8</td>
<td>The Administration Shell consists of header and body.</td>
</tr>
<tr>
<td></td>
<td>AssetAdministrationShell</td>
</tr>
<tr>
<td></td>
<td>AssetAdministrationShell/identification</td>
</tr>
<tr>
<td></td>
<td>AssetAdministrationShell/administration</td>
</tr>
<tr>
<td></td>
<td>AssetAdministrationShell/assetInformation</td>
</tr>
<tr>
<td></td>
<td>The Asset Administration Shell does not explicitly distinguish between Header and Body. However, the Asset Administration Shell has attributes defined that belong to itself like the global unique id (identification), version information (administration), a mandatory reference to the asset identifier information (assetInformation) it represents etc.</td>
</tr>
<tr>
<td>tAAS-9</td>
<td>The header contains information about the identification.</td>
</tr>
<tr>
<td></td>
<td>The Asset Administrative Shell is representing an asset with a unique id.</td>
</tr>
<tr>
<td></td>
<td>See also tAAS-7</td>
</tr>
<tr>
<td></td>
<td>See also tAAS-13</td>
</tr>
<tr>
<td>tAAS-10</td>
<td>The body contains information about the respective asset(s).</td>
</tr>
<tr>
<td></td>
<td>All submodels give information with respect to or related to the asset presented by the AAS.</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> An Asset Administration Shell is representing exactly one asset. In case of a Composite Asset Administration Shell it is implicitly representing several assets (see also tAAS-#5).</td>
</tr>
<tr>
<td>tAAS-11</td>
<td>The information and functionality in the Administration Shell is accessible by means of a standardized application programming interface (API).</td>
</tr>
<tr>
<td>tAAS-12</td>
<td>The Administration Shell has a unique ID.</td>
</tr>
<tr>
<td></td>
<td>Since AssetAdministrationShell inherits from Identifiable Requirement tAAS-#12 is fulfilled.</td>
</tr>
<tr>
<td>tAAS-13</td>
<td>The asset has a unique ID.</td>
</tr>
<tr>
<td></td>
<td>AssetInformation/globalAssetId</td>
</tr>
<tr>
<td></td>
<td>Since Asset inherits from Identifiable Requirement tAAS-#13 is fulfilled. It is references via the globalAssetId as described in the Asset Administration Shell.</td>
</tr>
<tr>
<td></td>
<td>See also Requirement tAAS-#7.</td>
</tr>
<tr>
<td>tAAS-14</td>
<td>An industrial facility is also an asset, it has an Administration Shell and is accessible by means of ID.</td>
</tr>
<tr>
<td></td>
<td>Asset/identification/id</td>
</tr>
</tbody>
</table>
Since `Asset` does not contain any specific attributes mandatory and only suitable for sensors etc. also more complex assets like industrial facilities can be modelled. The only assumption is that the industrial facility also has a globally unique id.

**Note:** See also Composite Asset Administration Shell (see tAAS-#5) that allows the modelling of complex assets consisting of other assets that are represented by an AAS each by themselves.

| tAAS-#15 | Types and instances must be identified as such. | Attribute `kind=Type` or `kind=Instance` for Asset `AssetAdministrationShell/derivedFrom`  
With attribute kind of Asset Requirement tAAS-#15 is fulfilled and asset types can be distinguished from asset instances.  
Additionally, a `derivedFrom` relationship can be established between the AAS for an asset instance and the AAS for the asset type. |
|---|---|---|
| tAAS-#16 | The Administration Shell can include references to other Administration Shells or Smart Manufacturing information. | `ReferenceElement`  
`File`  
`Blob`  
`AssetAdministrationShell/derivedFrom`  
The `derivedFrom` relationship between two AAS is special and is for example used to establish a relationship between asset instances and the asset type.  
For composite AAS (see tAAS-#5) there also is the relationship to AAS the composite AAS is composed of.  
The `ReferenceElement` is very generic and can reference another AAS as well as information within another AAS or even some information that is completely outside any AAS (as long as it has a global unique id).  
Files and BLOB can be used as submodel elements to include very generic manufacturing information that is not or cannot be modelled via properties or the other submodel elements defined for the Asset Administration Shell. |
| tAAS-#17 | Additional properties, e. g. manufacturer specific, must be possible. | `HasDataSpecification`  
`ConceptDescription`  
Via Data Specification Templates additional attributes for assets, properties and other submodel elements, submodels, views and even the Asset Administration Shell itself can be defined and checked by tools.  
New proprietary property descriptions (`ConceptDescription`) can be added and used for semantic definition in properties or other submodel elements. |
### DETAILS OF THE ADMINISTRATION SHELL - PART 1

An extension of the metamodel by defining proprietary classes inheriting from the defined classes of this metamodel is also possible.

Via API (see tAAS-#11) new properties, other submodel elements and submodels can be added – assumed the corresponding access permissions are given.

**tAAS-#18**  
A reliable minimum number of properties must be defined for each Administration Shell.  

*hasKind for Submodel and SubmodelElements*  

A reliable minimum number of properties is defined by the metamodel itself. They are called (class) attributes.

*HasKind (with kind=Template) for Submodel and submodel elements* enables the definition of submodel (element) templates. These templates are referenced via semanticId.

**Note:** the term property within the metamodel has a special semantics and shall not be mixed with the implicitly available attributes of the different classes. Although these attributes as well might be based on existing standards they are no properties in the sense that a semantic reference can be added that defines the semantics externally: The semantics is defined for the metamodel itself in the class tables within this document.

**tAAS-#19**  
The properties and other elements of information in the Administration Shell must be suitable for types and instances.  

*HasKind (with kind=Template or kind=Instance) for Submodel and SubmodelElement*  

All elements inheriting from HasKind can distinguish between types and instances. This is especially true for SubmodelElement and Submodel.

**Note:** Submodels or properties of kind=Template do not describe an asset of kind=Type. This is done via properties of kind=Instance.

**tAAS-#20**  
There must be a capability of hierarchical and countable structuring of the properties.  

*SubmodelElementCollection*  

Requirement tAAS-#20 is fulfilled by collections of data elements. The collection can be further characterized whether it is ordered and whether it may contain duplicates. Collections are built recursively and thus contain other submodel elements of the same AAS. For referencing properties or other submodel elements of other AAS a reference (ReferenceElement) or relationship element (RelationshipElement) needs to be included as part of the complex property.

**tAAS-#21**  
Properties shall be able to reference other properties, even in other Administration Shells.  

*SubmodelElementCollection, ReferenceElement, RelationshipElement, OperationVariable in Operation*  

A reference element can either reference any other element that is referable (i.e. inheriting from Referable) within the same or
another AAS. Or it can reference entities completely outside any AAS via its global id.

**Note:** For referencing elements within the same AAS it is not always necessary to use a reference property. Depending on the context also submodel element collections, relations etc. might be more suitable.

Within *operations* also other elements are referenced or used as input or output argument via *OperationVariable*.

**tAAS-#22**

| Properties must be able to reference information and functions of the Administration Shell. |

**Operation**

See also tAAS-#21

Functions in the sense of executable entities are represented as *operations*.

The following requirements have been derived from the document "Security of the Administrative Shell" [14]. They are marked as "SecAAS"

<table>
<thead>
<tr>
<th>ID</th>
<th>Requirement</th>
<th>Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>SecAAS-#1</td>
<td>Identification and authentication: It must be ensured that the correct entities (Administration Shell and users) interact with each other. This applies both in a local communication context (within a machine or plant) and in a global context (across companies). The clear identification (by authentication) of the communication partners is a basic requirement for the interaction with a management shell. Without them, further security features (confidentiality, integrity, etc.) cannot be guaranteed.</td>
<td>Security/certificate</td>
</tr>
<tr>
<td></td>
<td>Certificates are supported.</td>
<td></td>
</tr>
<tr>
<td>SecAAS-#2</td>
<td>User and rights management: An Asset Administration Shell can have different interaction partners. To control the possibilities of interaction with the Administration Shell, a user and rights management is necessary.</td>
<td>Security/accessControlPolicyPoints/policyAdministrationPoint AccessControl AccessControl/accessPermissionRules</td>
</tr>
<tr>
<td></td>
<td>There is no explicit subject management in the AAS: It is assumed that the identity of the subject requesting access with a given role (via the API - see tAAS-#11) is authenticated outside the AAS. The AAS can check the authorization via the endpoint to the subject attributes' provider.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For every object in the Asset Administration Shell access permission rules can be defined.</td>
<td></td>
</tr>
</tbody>
</table>
### Secure Communication

**Communication**

Communication with the Administrative Shell may include sensitive information. Likewise, a change in the communication between the Administration Shell and its communication partners can cause serious and dangerous disruptions in a machine or plant. It is therefore mandatory that adequate measures be taken to ensure communication security. This must be done by using appropriate security protocols.

**SecAAS-#3**

| Secure Communication: Communication with the Administrative Shell may include sensitive information. Likewise, a change in the communication between the Administration Shell and its communication partners can cause serious and dangerous disruptions in a machine or plant. It is therefore mandatory that adequate measures be taken to ensure communication security. This must be done by using appropriate security protocols. | Not applicable |

### Event Logging

**Event logging**

The traceability of interaction with the Administration Shell plays a crucial role in the detection of security incidents. This traceability is achieved through logging / event logging and auditing. The management shell must therefore provide methods that log accesses and changes in state of the management shell without modification. It is also important to be able to centrally collect and evaluate this event information.

**SecAAS-#4**

| Event logging: The traceability of interaction with the Administration Shell plays a crucial role in the detection of security incidents. This traceability is achieved through logging / event logging and auditing. The management shell must therefore provide methods that log accesses and changes in state of the management shell without modification. It is also important to be able to centrally collect and evaluate this event information. | History handling will be detailed in future parts or versions of the document (series). |
ANNEX B. AASX PACKAGE FILE FORMAT – BACKGROUND INFORMATION

i. SELECTION OF THE REFERENCE FORMAT FOR THE ASSET ADMINISTRATION SHELL PACKAGE FORMAT

The Führungskreis Industrie 4.0 – UAG Verwaltungsschale has decided to use the Open Packaging Conventions (OPC)\(^39\) format as the reference for the Asset Administration Shell package format definition, due to the following reasons:

- Open Packaging Conventions is based on ZIP (as a package container) and XML (for the description of some internal files and definitions). Those two technologies are the most widely used in their respective domains and are also addressed for long-term archiving.
- Open Packaging Conventions can be used as package for non-office applications too (there are many examples available, such as NuGet, FDI packages, etc.). It provides a logical model that is independent from how the files are stored in the package. This logical model can be expanded to any sort of application.
- Open Packaging Conventions is also used in the scope of Industry (e.g. FDI packages) and currently in discussion as possible container format for some FDT® and ODVA Project xDS™ use cases.
- Open Packaging Conventions (and Open Document Format packages too) supports digital signing. It can be done for individual files inside the package. Encryption isn’t specified in Open Packaging Conventions (it only mentions what shall not be done). Anyway, encryption is still possible (see later)
- There are some APIs to handle Open Packaging Conventions packages (Windows API, .NET, Java, …) without the need of much knowledge on the technical specification
- Chunking in Open Packaging Conventions is encouraged, i.e. split files into small chunks. This is better for reducing the effect of file corruption and better for data access.
- There are some international organizations that recommend using Open Document Format (ISO/IEC 26300-3) instead (e.g. EU, NATO, …), but this recommendation is related to the formats used specifically in office applications.
- The Office Open XML and Open Packaging Conventions specifications originated from Microsoft Corporation and later standardized as ISO/IEC 29500 and ECMA-376. Current and future versions of ISO/IEC 29500 and ECMA-376 are covered by Microsoft's Open Specification Promise, whereby Microsoft "irrevocably promises" not to assert any claims against those making, using, and selling conforming implementations of any specification covered by the promise (so long as those accepting the promise refrain from suing Microsoft for patent infringement in relation to Microsoft's implementation of the covered specification). [24]
- Office Open XML (including the Open Packaging Conventions format) and Open Document Format are politically conflicting formats (see details in [25]and [26]). Choosing Open Packaging Conventions as the option for storing the Asset Administration Shell information was solely a technical decision based on the arguments mentioned here.
- Open Packaging Conventions was chosen in favour of iiRDS (v1.0). The scope of iiRDS might not be aligned with the requirements of the Asset Administration Shell, i.e. iiRDS is mostly a format for storing technical documentation of industry devices based on concepts of ontology.

\(^{39}\) Not to be confused with OPC (Open Platform Communication) of the OPC Foundation. Therefore, we will use the full term of “Open Packaging Conventions” instead of the abbreviation “OPC”.
ANNEX C. TEMPLATES FOR UML TABLES

In this annex, the templates used for element specification are explained. For details for the semantics see Annex Legend for UML Modelling.

Template for document classes (elements):

<table>
<thead>
<tr>
<th>Class:</th>
<th>Explanation</th>
<th>Inherit from:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Attribute (*=mandatory)</th>
<th>Explanation</th>
<th>Type</th>
<th>Kind</th>
<th>Card.</th>
</tr>
</thead>
</table>

*Kind* is defined with semantics of UML (for details see Annex Legend for UML Modelling):

- *attr*: attribute (Type is no object type but a data type, it is just a value)
- *aggr*: composite aggregation (composition) (does not exist independent of its parent)
- *ref*: shared aggregation (does exist independent of its parent)

*ref* has the semantics as explained in Annex Legend for UML Modelling, Figure 160:

- reference via “Reference” class (as composite aggregation) with Key/type=<Type> for the last Key in the Reference.

For more information on referencing see Clause 4.7.11.

*Card.* is the cardinality (or multiplicity) defining the lower and upper bound of the number of instances of the member element. “*” denotes an arbitrary infinite number of elements of the corresponding Type. “0..1” means optional.

Constraints are prefixed with AASd- followed by a three-digit number. The “d” in AAS was motivated by “in Detail”. The numbering of constraints is unique, a number of a constraint that was removed will not be used again.

Template for enumerations:

<table>
<thead>
<tr>
<th>Enumeration:</th>
<th>Explanation</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Literal</th>
<th>Explanation</th>
</tr>
</thead>
</table>

ANNEX D. LEGEND FOR UML MODELLING

i. OMG UML GENERAL

In the following the used UML elements used in this specification are explained. For more information please refer to the comprehensive literature available for UML. The formal specification can be found in [47].

Figure 142 shows a class with name “Class1” and an attribute with name “attr” of type Class2. Attributes are owned by the class. Some of these attributes may represent the end of binary associations, see also Figure 149. In this case the instance of Class2 is navigable via the instance of the owning class Class1.40

Figure 142 Class

```
+ attr: Class2
```

Figure 143 shows that Class4 is inheriting all member elements from Class3. Or in other word, Class3 is a generalization of Class4. Class4 is a specialization of Class3. This means that each instance of Class4 is also an instance of Class3. An instance of the Class4 has the attributes attr1 and attr2 whereas instances of Class3 only have the attribute attr1.

Figure 143 Inheritance/Generalization

```
+ attr1: Class1

Class3
```

```
+ attr2: Class2

Class4
```

Figure 144 defines the required and allowed multiplicity/cardinality within an association between instances of Class1 and Class2. In this example an instance of Class2 is always related to exactly one instance of Class1. An instance of Class1 is either related to none, one or more (unlimited, i.e. no constraint on the upper bound) instances of Class2. The relationship can change over time.

Multiplicity constraints can also be added to attributes and aggregations.

The notation of multiplicity is as follows:

<lower-bound>..<upper-bound>

40 “Navigability notation was often used in the past according to an informal convention, whereby non-navigable ends were assumed to be owned by the Association whereas navigable ends were assumed to be owned by the Classifier at the opposite end. This convention is now deprecated. Aggregation type, navigability, and end ownership are separate concepts, each with their own explicit notation. Association ends owned by classes are always navigable, while those owned by associations may be navigable or not. [47]”
206 | DETAILS OF THE ADMINISTRATION SHELL - PART 1

Where <lower-bound> is a value specification of type Integer - i.e. 0, 1, 2, … - and <upper-bound> is a value specification of type UnlimitedNatural. The star character (*) is used to denote an unlimited upper bound.

The default is 1 for lower-bound and upper-bound.

**Figure 144 Multiplicity**

A multiplicity element represents a collection of values. The default is a set, i.e. it is not ordered and the elements within the collection are unique, i.e. contain no duplicates. In Figure 145 an ordered collection is shown: the instances of Class2 related to an instance of Class1 are ordered. The stereotype <<ordered>> is used to denote that the relationship is ordered.

**Figure 145 Ordered Multiplicity**

Figure 146 shows that the member ends of an association can be named as well. I.e. an instance of Class1 can be in relationship “relation” to an instance of Class2. Vice versa the instance of Class2 is in relationship “reverseRelation” to the instance of Class1.

**Figure 146 Association**

Figure 147 shows a composition, also called a composite aggregation. A composition is a binary association. It groups a set of instances. The individuals in the set are typed as specified by Class2. The multiplicity of instances of Class2 to Class1 is always 1 (i.e. upper-bound and lower-bound have value “1”). One instance of Class2 belongs to exactly one instance of Class1. There is no instance of Class2 without a relationship to an instance of Class1. In Figure 148 the composition is shown using an association relationship with a filled diamond as composition adornment.

**Figure 147 Composition (composite aggregation)**

Figure 148 show an aggregation. An aggregation is a binary association. In contrast to a composition an instance of Class2 can be shared by several instances of Class1. In Figure 148 the shared aggregation is shown using an association relationship with a hallow diamond as aggregation adornment.
Figure 148 Aggregation

![Class1](#) \[arrow\] \![Class2](#)

Figure 149 shows that the attribute notation can be used for an association end owned by a class. In this example the attribute name is “attr” and the elements of this attribute are typed with `Class2`. The multiplicity, here “0..*”, is added in square brackets. If the aggregation is ordered then this is added in curly brackets like in this example.

**Figure 149 Navigable Attribute Notation for Associations**

<table>
<thead>
<tr>
<th>Class1</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ attr: Class2 [0..*] (ordered)</td>
</tr>
</tbody>
</table>

Figure 150 shows that there is a dependency relationship between `Class1` and `Class2`. In this case the dependency means that `Class1` depends on `Class2`. Why is this: because the type of attribute `attr` depends on the specification of class `Class2`. A dependency is shown as dashed arrow between two model elements.

**Figure 150 Dependency**

![Class1](#) \[dashed arrow\] \![Class2](#)

Figure 151 shows an abstract class. It uses the stereotype `<abstract>`. There are no instances of abstract classes. They are typically used to specific member elements that are then inherited by non-abstract classes.

**Figure 151 Abstract Class**

![<<abstract>>](#)

Figure 152 shows a package with name “Package2”. A package is a namespace for its members. In this example the member belonging to `Package2` is class `Class2`.

**Figure 152 Package**

![Package2](#)

+ Class2

Figure 153 shows that all elements in `Package2` are imported into the namespace defined by `Package1`. This is a special dependency relationship between the two packages with stereotype `<import>`.
An enumeration is a data type whose values are enumerated as literals. Figure 154 shows an enumeration with name “Enumeration1”. It contains two literal values, “a” and “b”. It is a class with stereotype <<enumeration>>. The literals owned by the enumeration are ordered.

Figure 154 Enumeration

Figure 155 shows the definition of the data type with name “DataType1”. A data type is a type whose instances are identified only by their value. It is a class with stereotype <<dataType>>.

Figure 155 Data Type

Figure 156 shows a primitive data type with name “int”. Primitive data types are predefined data types, without any substructure. The primitive data types are defined outside UML.

Figure 156 Primitive Data Type

Figure 157 shows how a note can be attached to an element, in this example to class “Class1”.

Figure 157 Note

Figure 158 shows how a constraint is attached to an element, in this example to class “Class1”.

This is the note.
Figure 158 Constraint

ii. NOTES TO GRAPHICAL REPRESENTATION

In the following specific graphical modelling rules used in this specification are explained that are not included in this form in [47].

Figure 159 shows two different graphical representations of a composition (composite aggregation). In Variant A) a relationship with a filled aggregation diamond is used. In Variant B) an attribute with the same semantics is defined. And in Variant C) the implicitly assumed default name of the attribute in Variant A) is explicitly stated as such.

As a default it is assumed that only the end member of the association is navigable, i.e. it is possible to navigate from an instance of Class1 to the owned instance of Class2 but not vice versa. If there is no name for the end member of the association given then it is assumed that the name is identical to the class name but starting with a small letter – compare to Variant C).

Class2 instance does only exist if parent object of type Class1 exists.

Figure 159 Graphical Representations of Composite Aggregation/Composition

In Figure 160 different representations of a shared aggregation are shown. In a shared aggregation a Class2 instance can exist independent of the existence of an an Class1 instance. It is just referencing the instances of Class2. In Variant B) an attribute with the same semantics is defined. The reference is denoted by a star added after the type of the attribute.

As a default it is assumed that only the end member of the aggregation association is navigable, i.e. it is possible to navigate from an instance of Class1 to the owned instance of Class2 but not vice versa. Otherwise Variant B) would not be identical to Variant A).

A speciality in Figure 160 is that the aggregated instances are referables in the sense of the Asset Administration Shell metamodel (i.e. they inherit from the predefined abstract class “Referable”). This is why Variant C) is also identical to Variant A) and B). This would not be the case for non-referable elements in the metamodel. The structure of a reference to a model element of the Asset Administration Shell is explicitly defined. A reference consists of an ordered list of keys. The last key in the key chain shall reference an instance of type Class2 (i.e. Reference/type equal to “Class2”).
Figure 160 Graphical Representation of Shared Aggregation

Figure 161 show different graphical representations of generalization. Variant A) is the classical graphical representation as defined in [47]. Variant B) is a short form if Class1 is not on the same diagram. To see from which class Class3 is inheriting the name of the class is depicted in the upper right corner.

Variant C) is not only showing from which class Class3 instances are inheriting but also what they are inheriting. This is depicted by the class name it is inheriting from followed by "::" and then the list of all inherited elements – here attribute class2. Typically, the inherited elements are not shown.

Figure 161 Graphical Representation of Generalization/Inheritance

In Figure 162 different graphical notations for enumerations in combination with inheritance are shown. In Variant A) enumeration “Enumeration1” additionally contains the literals as defined by “Enumeration2”. Note: the direction of inheritance is opposite to the one for class inheritance. This can be seen in Variant C) that defined the same enumerations but without inheritance. In Variant B) another graphical notation is shown that makes it visible which literals are inherited by which enumeration. The literals within an enumeration are ordered so the order of classes it is inheriting from is important.
Figure 162 Graphical Representation for Enumeration with Inheritance

A)  
```
+-----------+           +-----------+           +-----------+
| Enumeration1 | Enumeration1 | Enumeration1 |
| a            | a            | a            |
| Enumeration2 | Attributes   | Enumeration2 |
| b            | + b          | b            |
```

B)  
```
+-----------+           +-----------+           +-----------+
| Enumeration1 | Enumeration1 | Enumeration1 |
| a            | a            | a            |
| Attributes   | Enumeration2 |
| + b          | b            |
```

C)  
```
+-----------+           +-----------+           +-----------+
| Enumeration1 | Enumeration1 | Enumeration1 |
| a            | a            | a            |
| Enumeration2 | b            | b            |
```
ANNEX E. METAMODEL UML WITH INHERITED ATTRIBUTES

In this annex some UML diagrams are shown together with all attributes inherited for better overview.

Note: The abstract classes are numbered h0_, h1_ etc. but Aliases are defined for them without this prefix. The reason for this naming is that in the tooling used for UML modelling (Enterprise Architect) no order for inherited classes can be defined, they are ordered in an alphabetical way.
Figure 163 Core Model with inherited Attributes
Figure 164 Operation with inherited Attributes

```
<table>
<thead>
<tr>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ inputVariable: OperationVariable [0..*]</td>
</tr>
<tr>
<td>+ outputVariable: OperationVariable [0..*]</td>
</tr>
<tr>
<td>+ inoutputVariable: OperationVariable [0..*]</td>
</tr>
</tbody>
</table>

| :h6_HasDataSpecification |
| + dataSpecification: Reference [0..*] |

| :h5_Qualifiable |
| + qualifier: Constraint [0..*] |

| :h4_HasSemantics |
| + semanticId: Reference [0..1] |

| :h3_HasKind |
| + kind: ModelingKind [0..1] = Instance |

| :h1_Referable |
| + idShort: string |
| + displayName: LangStringSet [0..1] |
| + category: string [0..1] |
| + description: LangStringSet [0..1] |

| :h0_HasExtensions |
| + extension: Extension [0..*] |
```
Figure 165 Access Control with inherited attributes
Figure 166 Submodel Element Collection with inheritance
i. GENERAL

The schema is split into three parts:

- The main concepts of the Asset Administration Shell (AAS.xsd)
- The Data Specification Template IEC61360 (IEC61360.xsd)
- The Attribute Based Access Control Model (AAS_ABAC.xsd)

Subsequently, an example in XML is discussed.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<schema elementFormDefault="qualified" targetNamespace="http://www.admin-shell.io/aas/3/0"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:aas="http://www.admin-shell.io/aas/3/0"
xmlns:abac="http://www.admin-shell.io/aas/abac/3/0"
xmlns:IEC61360="http://www.admin-shell.io/IEC61360/3/0"
xmlns:Q1="http://www.admin-shell.io/aas/3/0">

<import namespace="http://www.admin-shell.io/aas/abac/3/0" schemaLocation="AAS_ABAC.xsd"/>
<import namespace="http://www.admin-shell.io/IEC61360/3/0" schemaLocation="IEC61360.xsd"/>

<attributeGroup name="keyTypes">
<attribute name="identifierType" use="optional">
    <simpleType>
        <restriction base="string">
            <enumeration value="Custom"/>
            <enumeration value="IRDI"/>
            <enumeration value="IRI"/>
        </restriction>
    </simpleType>
</attribute>
<attribute name="localKeyType" use="optional">
    <simpleType>
        <restriction base="string">
            <enumeration value="idShort"/>
        </restriction>
    </simpleType>
</attribute>
</attributeGroup>
<complexType name="aasenv_t">
    <sequence>
        <element maxOccurs="1" minOccurs="0" name="assetAdministrationShells" type="aas:assetAdministrationShells_t"/>
        <element maxOccurs="0" minOccurs="0" name="assets" type="aas:assets_t"/>
        <element maxOccurs="0" minOccurs="0" name="conceptDescriptions" type="aas:conceptDescriptions_t"/>
    </sequence>
</complexType>
</schema>
```
<element maxOccurs="1" minOccurs="0" name="submodels" type="aas:submodels_t"/>
</sequence>
</complexType>
<complexType name="administration_t">
<sequence>
  <element maxOccurs="1" minOccurs="0" name="revision" type="string"/>
  <element maxOccurs="1" minOccurs="0" name="version" type="string"/>
</sequence>
</complexType>
<complexType name="annotatedRelationshipElement_t">
<complexContent>
  <extension base="aas:relationshipElement_t">
    <sequence>
      <element name="annotations" type="aas:dataElements_t"/>
    </sequence>
  </extension>
</complexContent>
</complexType>
<complexType name="asset_t">
<sequence>
  <group ref="aas:identifiable"/>
  <group ref="aas:hasDataSpecification"/>
</sequence>
</complexType>
<complexType name="assetAdministrationShell_t">
<sequence>
  <group ref="aas:identifiable"/>
  <group ref="aas:hasDataSpecification"/>
  <element maxOccurs="1" minOccurs="0" name="security" type="abac:security_t"/>
  <element maxOccurs="1" minOccurs="0" name="derivedFrom" type="aas:reference_t"/>
  <element maxOccurs="1" minOccurs="0" name="submodelRefs" type="aas:submodelRefs_t"/>
  <element maxOccurs="1" minOccurs="0" name="assetInformation" type="aas:assetInformation_t"/>
  <element maxOccurs="1" minOccurs="0" name="views" type="aas:views_t"/>
</sequence>
</complexType>
<complexType name="assetAdministrationShells_t">
<sequence>
  <element maxOccurs="unbounded" minOccurs="0" name="assetAdministrationShell" type="aas:assetAdministrationShell_t"/>
</sequence>
</complexType>
<complexType name="assetInformation_t">
<sequence>
<element maxOccurs="1" minOccurs="0" name="defaultThumbNail" type="aas:file_t"/>
<element maxOccurs="1" minOccurs="0" name="globalAssetId" type="aas:reference_t"/>
<element maxOccurs="1" minOccurs="0" name="assetKind" type="aas:assetKind_t"/>
<element maxOccurs="1" minOccurs="0" name="billOfMaterials" type="aas:submodelRefs_t"/>
<element maxOccurs="1" minOccurs="0" name="specificAssetIds" type="aas:specificAssetIds_t"/>

</sequence>
</complexType>
<complexType name="specificAssetIds_t">
<sequence>
<element maxOccurs="unbounded" minOccurs="0" name="specificAssetId" type="aas:identifierKeyValuePair_t"/>
</sequence>
</complexType>
<complexType name="assets_t">
<sequence>
<element maxOccurs="unbounded" minOccurs="0" name="asset" type="aas:asset_t"/>
</sequence>
</complexType>
<complexType name="basicEvent_t">
<complexContent>
<extension base="aas:eventAbstract_t">
<sequence>
<element maxOccurs="1" minOccurs="1" name="observed" type="aas:reference_t"/>
</sequence>
</extension>
</complexContent>
</complexType>
<complexType name="blob_t">
<complexContent>
<extension base="aas:submodelElementAbstract_t">
<sequence>
<element maxOccurs="1" minOccurs="0" name="value" type="aas:blobType_t"/>
<element maxOccurs="1" minOccurs="1" name="mimeType" type="string"/>
</sequence>
</extension>
</complexContent>
</complexType>
<complexType name="blobType_t">
<simpleContent>
<extension base="base64Binary"/>
</simpleContent>
</complexType>
<complexType name="conceptDescription_t">
<sequence>
<complexType name="embeddedDataSpecification_t">
  <sequence>
    <element maxOccurs="1" minOccurs="0" name="dataSpecificationContent" type="aas:DataSpecificationContent_t"/>
    <element maxOccurs="1" minOccurs="0" name="dataSpecification" type="aas:DataSpecification_t"/>
  </sequence>
</complexType>

<complexType name="entity_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t">
      <sequence>
        <element maxOccurs="1" minOccurs="0" name="globalAssetId" type="aas:reference_t"/>
        <element maxOccurs="1" minOccurs="0" name="specificAssetId" type="aas:IdentifierKeyValuePair_t"/>
        <element name="entityType">
          <simpleType>
            <restriction base="aas:entityType_t">
              <enumeration value="CoManagedEntity"/>
              <enumeration value="SelfManagedEntity"/>
            </restriction>
          </simpleType>
        </element>
        <element name="statements" type="aas:SubmodelElements_t"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<complexType name="eventAbstract_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t"/>
  </complexContent>
</complexType>

<complexType name="extension_t">
  <sequence>
    <group ref="aas:hasSemantics"/>
    <element maxOccurs="1" minOccurs="0" name="name" type="string"/>
    <element maxOccurs="1" minOccurs="0" name="valueType" type="aas:DataTypeDefinition_t"/>
    <element maxOccurs="1" minOccurs="0" name="value" type="aas:ValueDataType_t"/>
    <element maxOccurs="1" minOccurs="0" name="refersTo" type="aas:References_t"/>
  </sequence>
</complexType>

<complexType name="extensions_t">
  <sequence>
    <element maxOccurs="unbounded" minOccurs="0" name="extension" type="aas:Extension_t"/>
  </sequence>
</complexType>
<complexType name="file_t">
    <complexContent>
        <extension base="aas:submodelElementAbstract_t">
            <sequence>
                <element maxOccurs="1" minOccurs="0" name="value" type="aas:pathType_t"/>
                <element name="mimeType" type="string"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="formula_t">
    <sequence>
        <element maxOccurs="1" minOccurs="0" name="dependsOnRefs" type="aas:references_t"/>
    </sequence>
</complexType>

<complexType name="identification_t">
    <simpleContent>
        <extension base="string">
            <attribute name="idType" use="optional">
                <simpleType>
                    <restriction base="string">
                        <enumeration value="Custom"/>
                        <enumeration value="IRDI"/>
                        <enumeration value="IRI"/>
                    </restriction>
                </simpleType>
            </attribute>
        </extension>
    </simpleContent>
</complexType>

<complexType name="identifier_t">
    <sequence>
        <element maxOccurs="1" minOccurs="1" name="id" type="string"/>
        <element maxOccurs="1" minOccurs="1" name="idType" type="aas:identifierType_t"/>
    </sequence>
</complexType>

<complexType name="identifierKeyValuePair_t">
    <sequence>
        <group ref="aas:hasSemantics"/>
        <element maxOccurs="1" minOccurs="1" name="externalSubjectId" type="aas:reference_t"/>
        <element maxOccurs="1" minOccurs="1" name="key" type="string"/>
    </sequence>
</complexType>
<element maxOccurs="1" minOccurs="1" name="value" type="string"/>
</sequence>
</complexType>
<complexType name="idPropertyDefinition_t">
  <simpleContent>
    <extension base="string">
      <attribute name="idType" type="string"/>
    </extension>
  </simpleContent>
</complexType>
<complexType name="idShort_t">
  <simpleContent>
    <extension base="string"/>
  </simpleContent>
</complexType>
<complexType name="key_t">
  <simpleContent>
    <extension base="string">
      <attribute name="idType">
        <simpleType>
          <restriction base="string">
            <enumeration value="Custom"/>
            <enumeration value="FragmentId"/>
            <enumeration value="IdShort"/>
            <enumeration value="IRDI"/>
            <enumeration value="IRI"/>
          </restriction>
        </simpleType>
      </attribute>
      <attribute name="type">
        <simpleType>
          <restriction base="string">
            <enumeration value="AccessPermissionRule"/>
            <enumeration value="AnnotatedRelationshipElement"/>
            <enumeration value="Asset"/>
            <enumeration value="AssetAdministrationShell"/>
            <enumeration value="BasicEvent"/>
            <enumeration value="Blob"/>
            <enumeration value="Capability"/>
            <enumeration value="ConceptDescription"/>
            <enumeration value="ConceptDictionary"/>
            <enumeration value="DataElement"/>
            <enumeration value="Entity"/>
          </restriction>
        </simpleType>
      </attribute>
    </extension>
  </simpleContent>
</complexType>
<enumeration value="Event"/>
<enumeration value="File"/>
<enumeration value="FragmentReference"/>
<enumeration value="GlobalReference"/>
<enumeration value="MultiLanguageProperty"/>
<enumeration value="Operation"/>
<enumeration value="Property"/>
<enumeration value="Range"/>
<enumeration value="ReferenceElement"/>
<enumeration value="RelationshipElement"/>
<enumeration value="Submodel"/>
<enumeration value="SubmodelElement"/>
<enumeration value="SubmodelElementCollection"/>
<enumeration value="View"/>
</restriction>
</simpleType>
</attribute>
</extension>
</simpleContent>
</complexType>
<complexType name="keys_t">
<sequence>
<element maxOccurs="unbounded" minOccurs="0" ref="aas:key"/>
</sequence>
</complexType>
<complexType name="langString_t">
<simpleContent>
<extension base="string">
<attribute name="lang" type="string"/>
</extension>
</simpleContent>
</complexType>
<complexType name="langStringSet_t">
<sequence>
<element maxOccurs="unbounded" minOccurs="1" name="langString" type="aas:langString_t"/>
</sequence>
</complexType>
<complexType name="multiLanguageProperty_t">
<complexContent>
<extension base="aas:submodelElementAbstract_t">
<sequence>
<element maxOccurs="1" minOccurs="0" name="valueId" type="aas:reference_t"/>
<element maxOccurs="1" minOccurs="0" name="value" type="aas:langStringSet_t"/>
</sequence>
</extension>
</complexContent>
</complexType>
<complexType name="operation_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t">
      <sequence>
        <element maxOccurs="unbounded" minOccurs="0" name="inoutputVariable" type="aas:operationVariable_t"/>
        <element maxOccurs="unbounded" minOccurs="0" name="inputVariable" type="aas:operationVariable_t"/>
        <element maxOccurs="unbounded" minOccurs="0" name="outputVariable" type="aas:operationVariable_t"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<complexType name="operationVariable_t">
  <sequence>
    <element name="value" type="aas:submodelElement_t"/>
  </sequence>
</complexType>

<complexType name="pathType_t">
  <simpleContent>
    <extension base="string"/>
  </simpleContent>
</complexType>

<complexType name="property_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t">
      <sequence>
        <element maxOccurs="1" minOccurs="0" name="valueId" type="aas:reference_t"/>
        <element maxOccurs="1" minOccurs="0" name="value" type="aas:valueDataType_t"/>
        <element maxOccurs="1" minOccurs="1" name="valueType" type="aas:dataTypeDef_t"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<complexType name="qualifier_t">
  <sequence>
    <group ref="aas:hasSemantics"/>
    <element maxOccurs="1" minOccurs="0" name="valueId" type="aas:reference_t"/>
    <element maxOccurs="1" minOccurs="0" name="value" type="aas:valueDataType_t"/>
    <element maxOccurs="1" minOccurs="1" name="type" type="aas:qualifierType_t"/>
    <element maxOccurs="1" minOccurs="0" name="valueType" type="aas:dataTypeDef_t"/>
  </sequence>
</complexType>
<complexType name="qualifierType_t">
  <simpleContent>
    <extension base="string"/>
  </simpleContent>
</complexType>

<complexType name="range_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t">
      <sequence>
        <element maxOccurs="1" minOccurs="0" name="max" type="aas:valueDataType_t"/>
        <element maxOccurs="1" minOccurs="0" name="min" type="aas:valueDataType_t"/>
        <element minOccurs="1" name="valueType" type="aas:dataTypeDef_t"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<complexType name="referenceElement_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t">
      <sequence>
        <element maxOccurs="1" minOccurs="0" name="value" type="aas:reference_t"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<complexType name="references_t">
  <sequence>
    <element maxOccurs="unbounded" minOccurs="0" name="reference" type="aas:reference_t"/>
  </sequence>
</complexType>

<complexType name="relationshipElement_t">
  <complexContent>
    <extension base="aas:submodelElementAbstract_t">
      <sequence>
        <element name="first" type="aas:reference_t"/>
        <element name="second" type="aas:reference_t"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
<complexType name="semanticId_t">
   <complexContent>
      <extension base="aas:reference_t"/>
   </complexContent>
</complexType>

<complexType name="submodel_t">
   <sequence>
      <group ref="aas:identifiable"/>
      <group ref="aas:hasKind"/>
      <group ref="aas:hasSemantics"/>
      <group ref="aas:qualifiable"/>
      <group ref="aas:hasDataSpecification"/>
      <element name="submodelElements" type="aas:submodelElements_t"/>
   </sequence>
</complexType>

<complexType name="submodelElement_t">
   <choice>
      <element name="annotatedRelationshipElement" type="aas:annotatedRelationshipElement_t"/>
      <element name="basicEvent" type="aas:basicEvent_t"/>
      <element name="capability" type="aas:submodelElementAbstract_t"/>
      <element name="entity" type="aas:entity_t"/>
      <element name="operation" type="aas:operation_t"/>
      <element name="relationshipElement" type="aas:relationshipElement_t"/>
      <element name="submodelElementCollection" type="aas:submodelElementCollection_t"/>
      <group ref="aas:dataElement"/>
   </choice>
</complexType>

<complexType name="submodelElementAbstract_t">
   <sequence>
      <group ref="aas:referable"/>
      <group ref="aas:hasKind"/>
      <group ref="aas:hasSemantics"/>
      <group ref="aas:qualifiable"/>
      <group ref="aas:hasDataSpecification"/>
   </sequence>
</complexType>

<complexType name="submodelElementCollection_t">
   <complexContent>
      <extension base="aas:submodelElementAbstract_t">
      </extension>
   </complexContent>
</complexType>
<sequence>
    <element name="allowDuplicates" type="boolean"/>
    <element name="ordered" type="boolean"/>
    <element name="value" type="aas:submodelElements_t"/>
</sequence>
</extension>
</complexContent>
</complexType>
<complexType name="submodelElements_t">
    <sequence>
        <element maxOccurs="unbounded" minOccur="0" name="submodelElement" type="aas:submodelElement_t"/>
    </sequence>
</complexType>
<complexType name="submodelRefs_t">
    <sequence>
        <element maxOccurs="unbounded" minOccurs="0" name="submodelRef" type="aas:reference_t"/>
    </sequence>
</complexType>
<complexType name="submodels_t">
    <sequence>
        <element maxOccurs="unbounded" minOccurs="0" name="submodel" type="aas:submodel_t"/>
    </sequence>
</complexType>
<complexType name="valueDataType_t">
    <simpleContent>
        <extension base="anySimpleType"/>
    </simpleContent>
</complexType>
<complexType name="view_t">
    <sequence>
        <group ref="aas:referable"/>
        <group ref="aas:hasSemantics"/>
        <group ref="aas:hasDataSpecification"/>
        <element name="containedElements" type="aas:containedElements_t"/>
    </sequence>
</complexType>
<complexType name="views_t">
    <sequence>
        <element maxOccurs="unbounded" minOccurs="0" name="view" type="aas:view_t"/>
    </sequence>
</complexType>
<element name="aasenv" type="aas:aasenv_t"/>
<element name="key" type="aas:key_t"/>
ii. **AAS IEC61360 DATATYPE**
For IEC 61360, a data specification is made available, individually:

```xml
<?xml version="1.0" encoding="UTF-8"?>
  <attributeGroup name="keyTypes">  
    <attribute name="identifierType" use="optional">  
      <simpleType>
```
<restriction base="string">
  <enumeration value="Custom"/>
  <enumeration value="IRDI"/>
  <enumeration value="IRI"/>
</restriction>
</simpleType>
</attribute>
<attribute name="localKeyType" use="optional">
  <simpleType>
    <restriction base="string">
      <enumeration value="idShort"/>
      <enumeration value="IRDI"/>
      <enumeration value="IRI"/>
    </restriction>
  </simpleType>
</attribute>
</attributeGroup>
<complexType name="code_t">
  <choice minOccurs="1" maxOccurs="unbounded">
    <element maxOccurs="1" minOccurs="1" name="preferredName" type="IEC61360:langStringSet_t"/>
    <element maxOccurs="1" minOccurs="0" name="shortName" type="IEC61360:langStringSet_t"/>
    <element maxOccurs="1" minOccurs="0" name="unit" type="string"/>
    <element maxOccurs="1" minOccurs="0" name="unitId" type="IEC61360:reference_t"/>
    <element maxOccurs="1" minOccurs="0" name="sourceOfDefinition" type="string"/>
    <element maxOccurs="1" minOccurs="0" name="symbol" type="string"/>
    <element maxOccurs="1" minOccurs="0" name="dataType" type="IEC61360:dataTypeIEC61360_t"/>
    <element maxOccurs="1" minOccurs="0" name="definition" type="IEC61360:langStringSet_t"/>
    <element maxOccurs="1" minOccurs="0" name="valueFormat" type="string"/>
    <element maxOccurs="1" minOccurs="0" name="valueList" type="IEC61360:valueList_t"/>
    <element maxOccurs="1" minOccurs="0" name="value" type="IEC61360:valueDataType_t"/>
    <element maxOccurs="1" minOccurs="0" name="valueId" type="IEC61360:reference_t"/>
    <element maxOccurs="unbounded" minOccurs="0" name="levelType" type="IEC61360:levelType_t"/>
  </choice>
</complexType>
<complexType name="key_t">
  <simpleContent>
    <extension base="string">
      <attribute name="idType">
        <simpleType>
          <restriction base="string">
            <enumeration value="Custom"/>
            <enumeration value="FragmentId"/>
            <enumeration value="idShort"/>
            <enumeration value="IRDI"/>
          </restriction>
        </simpleType>
      </attribute>
    </extension>
  </simpleContent>
</complexType>
<enumeration value="IRI"/>
</restriction>
</simpleType>
</attribute>
<attribute name="local" type="boolean"/>
<attribute name="type">
</simpleType>
<restriction base="string">
<enumeration value="AccessPermissionRule"/>
<enumeration value="AnnotatedRelationshipElement"/>
<enumeration value="Asset"/>
<enumeration value="AssetAdministrationShell"/>
<enumeration value="BasicEvent"/>
<enumeration value="Blob"/>
<enumeration value="Capability"/>
<enumeration value="ConceptDescription"/>
<enumeration value="ConceptDictionary"/>
<enumeration value="DataElement"/>
<enumeration value="Entity"/>
<enumeration value="Event"/>
<enumeration value="File"/>
<enumeration value="FragmentReference"/>
<enumeration value="GlobalReference"/>
<enumeration value="MultiLanguageProperty"/>
<enumeration value="Operation"/>
<enumeration value="Property"/>
<enumeration value="Range"/>
<enumeration value="ReferenceElement"/>
<enumeration value="RelationshipElement"/>
<enumeration value="Submodel"/>
<enumeration value="SubmodelElement"/>
<enumeration value="SubmodelElementCollection"/>
<enumeration value="View"/>
</restriction>
</simpleType>
</attribute>
</extension>
</simpleContent>
</complexType>
<complexType name="keys_t">
<sequence>
  <element maxOccurs="unbounded" minOccurs="0" ref="IEC61360:key"/>
</sequence>
</complexType>
<complexType name="langString_t">
  <simpleContent>
    <extension base="string">
      <attribute name="lang" type="string"/>
    </extension>
  </simpleContent>
</complexType>
<complexType name="langStringSet_t">
  <sequence>
    <element maxOccurs="unbounded" minOccurs="1" name="langString" type="IEC61360:langString_t"/>
  </sequence>
</complexType>
<complexType name="reference_t">
  <sequence>
    <element name="keys" type="IEC61360:keys_t"/>
  </sequence>
</complexType>
<complexType name="valueDataType_t">
  <simpleContent>
    <extension base="anySimpleType"></extension>
  </simpleContent>
</complexType>
<complexType name="valueList_t">
  <sequence>
    <element maxOccurs="unbounded" minOccurs="1" name="valueReferencePair" type="IEC61360:valueReferencePair_t"/>
  </sequence>
</complexType>
<complexType name="valueReferencePair_t">
  <sequence>
    <element name="valueId" type="IEC61360:reference_t"/>
    <element name="value" type="IEC61360:valueDataType_t"/>
  </sequence>
</complexType>
<element name="key" type="IEC61360:key_t"/>
<simpleType name="dataTypeIEC61360_t">
  <restriction base="string">
    <enumeration value=""/>
    <enumeration value="BOOLEAN"/>
    <enumeration value="DATE"/>
    <enumeration value="RATIONAL"/>
    <enumeration value="RATIONAL_MEASURE"/>
    <enumeration value="REAL_COUNT"/>
    <enumeration value="REAL_CURRENCY"/>
  </restriction>
</simpleType>
iii. AAS ATTRIBUTE BASED ACCESS CONTROL MODEL

For Asset based Access Control a specification is made available individually:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"

targetNamespace="http://www.admin-shell.io/aas/abac/3/0"

elementFormDefault="qualified"

xmlns:aas="http://www.admin-shell.io/aas/3/0"
xmlns:abac="http://www.admin-shell.io/aas/abac/3/0">
<import schemaLocation="AAS.xsd" namespace="http://www.admin-shell.io/aas/3/0"></import>

<complexType name="security_t">

<sequence>

<element name="accessControlPolicyPoints"

type="abac:accessControlPolicyPoints_t" minOccurs="1" maxOccurs="1" />

<element name="certificates"

type="abac:certificates_t" minOccurs="0" maxOccurs="1" />

<element name="requiredCertificateExtensions"

type="aas:references_t" />

</sequence>

</complexType>
```
<complexType name="accessControlPolicyPoints_t">
    <sequence>
        <element name="policyAdministrationPoint" minOccurs="1" maxOccurs="1" type="abac:policyAdministrationPoint_t"></element>
        <element name="policyDecisionPoint" type="abac:policyDecisionPoint_t" minOccurs="1" maxOccurs="1"></element>
        <element name="policyEnforcementPoint" type="abac:policyEnforcementPoint_t" minOccurs="1" maxOccurs="1"></element>
        <element name="policyInformationPoints" type="abac:policyInformationPoints_t" minOccurs="0" maxOccurs="1"></element>
    </sequence>
</complexType>

<complexType name="policyAdministrationPoint_t">
    <sequence>
        <element name="localAccessControl" type="abac:accessControl_t" minOccurs="0" maxOccurs="1"></element>
        <element name="externalAccessControl" type="boolean" minOccurs="0" maxOccurs="1"></element>
    </sequence>
</complexType>

<complexType name="policyDecisionPoint_t">
    <sequence>
        <element name="externalPolicyDecisionPoint" type="boolean" minOccurs="1" maxOccurs="1"></element>
    </sequence>
</complexType>

<complexType name="policyEnforcementPoint_t">
    <sequence>
        <element name="externalPolicyEnforcementPoint" type="boolean" minOccurs="1" maxOccurs="1"></element>
    </sequence>
</complexType>

<complexType name="policyInformationPoints_t">
    <sequence>
        <element name="externalInformationPoints" type="boolean" minOccurs="1" maxOccurs="1"></element>
        <element name="internalInformationPoints" type="abac:internalInformationPoints" minOccurs="0" maxOccurs="1"></element>
    </sequence>
</complexType>

<complexType name="internalInformationPoints">
    <sequence>
        <element name="internalInformationPoint" type="aas:submodelRefs_t" minOccurs="0" maxOccurs="unbounded"></element>
    </sequence>
</complexType>
<complexType name="accessControl_t">
  <sequence>
    <element name="selectableSubjectAttributes" type="aas:reference_t" minOccurs="0" maxOccurs="1" />
    <element name="defaultSubjectAttributes" type="aas:reference_t" minOccurs="1" maxOccurs="1" />
    <element name="selectablePermissions" type="aas:reference_t" minOccurs="0" maxOccurs="1" />
    <element name="defaultPermissions" type="aas:reference_t" minOccurs="1" maxOccurs="1" />
    <element name="selectableEnvironmentAttributes" type="aas:reference_t" minOccurs="0" maxOccurs="1" />
    <element name="defaultEnvironmentAttributes" type="aas:reference_t" minOccurs="0" maxOccurs="1" />
    <element name="accessPermissionRules" type="abac:accessPermissionRules_t" minOccurs="0" maxOccurs="1" />
  </sequence>
</complexType>

<complexType name="permissionPerObject_t">
  <sequence>
    <element name="object" type="aas:reference_t" />
    <element name="targetObjectAttributes" type="abac:objectAttributes_t" minOccurs="0" maxOccurs="1" />
    <element name="permissions" type="abac:permissions_t" minOccurs="0" maxOccurs="1" />
  </sequence>
</complexType>

<complexType name="objectAttributes_t">
  <sequence>
    <element name="objectAttribute" type="aas:property_t" minOccurs="1" maxOccurs="unbounded" />
  </sequence>
</complexType>

<complexType name="permissions_t">
  <sequence>
    <element name="permission" type="aas:property_t" minOccurs="1" maxOccurs="1" />
    <element name="kindOfPermission" type="abac:permissionKind" />
  </sequence>
</complexType>

<simpleType name="permissionKind">
  <restriction base="string">
    <enumeration value="Allow" />
    <enumeration value="Deny" />
    <enumeration value="NotApplicable" />
    <enumeration value="Undefined" />
  </restriction>
</simpleType>
<complexType name="accessPermissionRule_t">
  <sequence>
    <group ref="aas:qualifiable"></group>
    <group ref="aas:referable"></group>
    <element name="targetSubjectAttributes" type="abac:subjectAttributes_t" minOccurs="1" maxOccurs="unbounded"></element>
    <element name="permissionsPerObject" type="abac:permissionPerObject_t" minOccurs="0" maxOccurs="unbounded"></element>
  </sequence>
</complexType>

<complexType name="subjectAttributes_t">
  <sequence>
    <element name="subjectAttribute" type="aas:property_t" minOccurs="1" maxOccurs="unbounded"></element>
  </sequence>
</complexType>

<complexType name="certificates_t">
  <sequence>
    <element name="certificate" type="abac:certificate_t" minOccurs="1" maxOccurs="unbounded"></element>
  </sequence>
</complexType>

<complexType name="certificate_t">
  <choice>
    <element name="blobCertificate" type="abac:blobCertificate_t"></element>
  </choice>
</complexType>

<element name="internalInformationPoints" type="aas:submodelRefs_t"/>

<complexType name="accessPermissionRules_t">
  <sequence>
    <element name="accessPermissionRule" type="abac:accessPermissionRule_t" minOccurs="0" maxOccurs="unbounded"></element>
  </sequence>
</complexType>

<complexType name="certificateAbstract_t">
  </complexType>
vi. **XML EXAMPLE**

For cross reference, a complete self-contained example is given, which relates to the unified example in Clause 7.3.

```xml
<?xml version="1.0" encoding="utf-8"?>
<aas:aasenv xmlns:aas="http://www.admin-shell.io/aas/3/0"
  <aas:assetAdministrationShells>
    <aas:assetAdministrationShell>
      <aas:idShort>ExampleMotor</aas:idShort>
      <aas:idShort/>
      <aas:identification idType="IRI">
        http://customer.com/aas/9175_7013_7091_9168
      </aas:identification>
      <aas:submodelRefs>
        <aas:submodelRef>
          <aas:keys>
            <aas:key idType="IRI" type="Submodel">
              http://i40.customer.com/instance/1/1/AC69B1CB44F07935
            </aas:key>
          </aas:keys>
        </aas:submodelRef>
      </aas:submodelRefs>
    </aas:assetAdministrationShell>
  </aas:assetAdministrationShells>
</aas:aasenv>
```
<aas:submodelRefs>
  <aas:submodelRef>
    <aas:keys>
      <aas:key idType="IRI" type="Submodel">
        http://i40.customer.com/type/1/1/1A7B62B529F19152
      </aas:key>
    </aas:keys>
  </aas:submodelRef>
  <aas:submodelRef>
    <aas:keys>
      <aas:key idType="IRI" type="Submodel">
        http://i40.customer.com/type/1/1/7A7104BDAB57E184
      </aas:key>
    </aas:keys>
  </aas:submodelRef>
</aas:submodelRefs>
<aas:assetInformation>
  <aas:globalAssetId>
    <aas:keys>
      <aas:key idType="IRI" type="Asset">
        http://customer.com/assets/KHBVZJSQKIY
      </aas:key>
    </aas:keys>
  </aas:globalAssetId>
  <aas:assetKind>Instance</aas:assetKind>
</aas:assetInformation>
</aas:assetAdministrationShell>
</aas:assetAdministrationShells>
<aas:assets>
  <aas:asset>
    <aas:idShort>ServoDCMotor</aas:idShort>
    <aas:identification idType="IRI">
      http://customer.com/assets/KHBVZJSQKIY
    </aas:identification>
  </aas:asset>
</aas:assets>
<aas:conceptDescriptions>
  <aas:conceptDescription>
    <aas:idShort>MaxRotationSpeed</aas:idShort>
  </aas:conceptDescription>
</aas:conceptDescriptions>
Höchste zulässige Drehzahl, mit welcher der Motor oder die Speiseeinheit betrieben werden darf

Greatest permissible rotation speed with which the motor or feeding unit may be operated

max. Drehzahl
Max. rotation speed

1/min
Sprachabhängiger Titel des Dokuments.

Titel

Title

Title

Titel

Title
<aas:keys>
  <aas:key idType="IRI" type="GlobalReference">
  </aas:key>
</aas:keys>

<aas:conceptDescription>
  <aas:idShort>
    RotationSpeed
  </aas:idShort>
  <aas:category>PROPERTY</aas:category>
  <aas:identification idType="IRI">
    http://customer.com/cd/1/1/18EBD56F6B43D895
  </aas:identification>
</aas:conceptDescription>

<aas:embeddedDataSpecification>
  <aas:dataSpecificationContent>
    <IEC61360:dataType>REAL_MEASURE</IEC61360:dataType>
    <IEC61360:definition>
      Aktuelle Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben wird
    </IEC61360:definition>
    <IEC61360:preferredName>
      Aktuelle Drehzahl
    </IEC61360:preferredName>
    <IEC61360:shortName>
      RotationSpeed
    </IEC61360:shortName>
  </aas:dataSpecificationContent>
</aas:embeddedDataSpecification>
1/min
</IEC61360:unit>
<IEC61360:unitId>
<IEC61360:keys>
<IEC61360:key idType= "IRDI" type= "GlobalReference">
0173-1#05-AAA650#002
</IEC61360:key>
</IEC61360:keys>
</IEC61360:unitId>
</aas:dataSpecificationIEC61360>
</aas:dataSpecificationContent>
</aas:dataSpecification>
</aas:embeddedDataSpecification>
</aas:conceptDescription>
</aas:conceptDescription>
<aas:idShort>
Document
</aas:idShort>
<aas:category>
ENTITY
</aas:category>
<aas:identification idType= "IRI">
</aas:identification>
</aas:embeddedDataSpecification>
</aas:dataSpecificationContent>
<aas:dataSpecificationIEC61360>
<IEC61360:dataType>URL</IEC61360:dataType>
<IEC61360:definition>
<IEC61360:langString lang= "DE">
Feste und geordnete Menge von für die Verwendung durch Personen bestimmte Informationen, die verwaltet und als Einheit zwischen Benutzern und System ausgetauscht werden kann.
</IEC61360:langString>
</IEC61360:definition>
<IEC61360:preferredName>
<IEC61360:langString lang= "DE">
Dokument
</IEC61360:langString>
</IEC61360:preferredName>
Eine Datei, die die DocumentVersion repräsentiert. Neben der obligatorischen PDF/A Datei können weitere Dateien angegeben werden.
Digitale Datei


http://i40.customer.com/type/1/1/1A7B62B529F19152

OperatingManual


http://i40.customer.com/type/1/1/1A7B62B529F19152

OperatingManual
Operating Manual

Technical Data

MaxRotationSpeed

PARAMETER
0173-1#02-BAA120#008

</aas:key>
</aas:keys>
</aas:semanticId>
<aas:value>
5000
</aas:value>
<aas:valueType>
integer
</aas:valueType>
</aas:property>
</aas:submodelElement>
</aas:submodelElements>
</aas:submodel>
<aas:submodel>
<aas:idShort>
OperationalData
</aas:idShort>
<aas:identification idType="IRI">
http://i40.customer.com/instance/1/1/AC69B1CB44F07935
</aas:identification>
<aas:kind>Instance</aas:kind>
<aas:submodelElements>
<aas:submodelElement>
<aas:property>
<aas:idShort>
RotationSpeed
</aas:idShort>
<aas:category>
VARIABLE
</aas:category>
<aas:kind>Instance</aas:kind>
<aas:semanticId>
<aas:keys>
<aas:key idType="IRI" type="ConceptDescription">
http://customer.com/cd/1/1/18EBD56F6B43D895
</aas:key>
</aas:keys>
</aas:semanticId>
<aas:value>
4370
</aas:value>
<aas:valueType>
integer
</aas:valueType>
</aas:property>
</aas:submodelElement>
</aas:submodelElements>
</aas:submodel>
Note: \& designate line-wrap for purpose of layout
ANNEX G. JSON SCHEMA AND COMPLETE EXAMPLE

i. JSON SCHEMA FOR THE ASSET ADMINISTRATION SHELL ENVIRONMENT

The following schema uses JSON Schema in version 2019-09 to allow validation of JSON files.

Table 26 JSON schema

```json
{
  "$schema": "https://json-schema.org/draft/2019-09/schema",
  "title": "AssetAdministrationShellEnvironment",
  "$id": "http://www.admin-shell.io/schema/json/V3.0RC01",
  "type": "object",
  "required": [
    "assetAdministrationShells",
    "submodels",
    "assets",
    "conceptDescriptions"
  ],
  "properties": {
    "assetAdministrationShells": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/AssetAdministrationShell"
      }
    },
    "submodels": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Submodel"
      }
    },
    "assets": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Asset"
      }
    },
    "conceptDescriptions": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/ConceptDescription"
      }
    }
  }
}
```

41 see: [http://json-schema.org/](http://json-schema.org/)
"type": "array",
"items": {
    "$ref": "#/definitions/Referable"
}

"definitions": {
"Referable": {
    "allOf": [
        {
            "$ref": "#/definitions/HasExtensions"
        },
        {
            "properties": {
                "idShort": {
                    "type": "string"
                },
                "category": {
                    "type": "string"
                },
                "displayName": {
                    "type": "string"
                },
                "description": {
                    "type": "array",
                    "items": {
                        "$ref": "#/definitions/LangString"
                    }
                },
                "modelType": {
                    "$ref": "#/definitions/ModelType"
                }
            }
        }
    ],
    "required": [
        "modelType",
        "idShort"
    ]
}

"Identifiable": {
    "allOf": [
    ]
}
DETAILS OF THE ADMINISTRATION SHELL - PART 1

```json
{
  "properties": {
    "identification": {
      "$ref": "#/definitions/Identifier"
    },
    "administration": {
      "$ref": "#/definitions/AdministrativeInformation"
    }
  },
  "required": [
    "identification"
  ]
}
```

```json
"Qualifiable": {
  "type": "object",
  "properties": {
    "qualifiers": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Constraint"
      }
    }
  }
}
```

```json
"HasSemantics": {
  "type": "object",
  "properties": {
    "semanticId": {
      "$ref": "#/definitions/Reference"
    }
  }
}
```

```json
"HasDataSpecification": {
  "type": "object",
  "properties": {
    "embeddedDataSpecifications": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/EmbeddedDataSpecification"
      }
    }
  }
}
```
"hasExtensions": {
  "type": "object",
  "properties": {
    "extensions": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Extension"
      }
    }
  }
}

"extension": {
  "allOf": [
    {
      "$ref": "#/definitions/HasSemantics"
    },
    {
      "properties": {
        "name": {
          "type": "string"
        },
        "valueType": {
          "type": "string",
          "enum": [
            "anyUri",
            "base64Binary",
            "boolean",
            "date",
            "dateTime",
            "dateTimeStamp",
            "decimal",
            "integer",
            "long",
            "int",
            "short",
            "byte",
            "nonNegativeInteger",
            "positiveInteger",
            "unsignedLong"
          ]
        } // valueType
      }
    }
  ]
}
"unsignedInt",
"unsignedShort",
"unsignedByte",
"nonPositiveInteger",
"negativeInteger",
"double",
"duration",
"dayTimeDuration",
"yearMonthDuration",
"float",
"gDay",
"gMonth",
"gMonthDay",
"gYear",
"gYearMonth",
"hexBinary",
"NOTATION",
"QName",
"string",
"normalizedString",
"token",
"language",
"Name",
"NCName",
"ENTITY",
"ID",
"IDREF",
"NMTOKEN",
"time"
]
}
"value":{
 "type":"string"
}
"refersTo":{
 "$ref":"#/definitions/Reference"
}
}

"required":{
 "name"
}
}
"AssetAdministrationShell": {
  "allOf": [
  {
    "$ref": "/definitions/Identifiable"
  },
  {
    "$ref": "/definitions/HasDataSpecification"
  },
  {
    "properties": {
      "derivedFrom": {
        "$ref": "/definitions/Reference"
      },
      "assetInformation": {
        "$ref": "/definitions/AssetInformation"
      },
      "submodels": {
        "type": "array",
        "items": {
          "$ref": "/definitions/Reference"
        }
      },
      "views": {
        "type": "array",
        "items": {
          "$ref": "/definitions/View"
        }
      },
      "security": {
        "$ref": "/definitions/Security"
      }
    }
  },
  "required": [
    "assetInformation"
  ]
},

"Identifier": {
  "type": "object",
  "properties": {
    "id": {
      "$ref": "/definitions/Identifiable"
    }
  }
}
"type": "string"
},
"idType": {
  "$ref": "#/definitions/KeyType"
}
},
"required": [
  "id",
  "idType"
]
},
"KeyType": {
  "type": "string",
  "enum": [
    "Custom",
    "IRDI",
    "IRI",
    "IdShort",
    "FragmentId"
  ]
},
"AdministrativeInformation": {
  "type": "object",
  "properties": {
    "version": {
      "type": "string"
    },
    "revision": {
      "type": "string"
    }
  }
},
"LangString": {
  "type": "object",
  "properties": {
    "language": {
      "type": "string"
    },
    "text": {
      "type": "string"
    }
  }
},
"required": [
"language",
"text"
]
}
"Reference":{
"type":"object",
"properties":{
"keys":{
"type":"array",
"items":{
"$ref": "#/definitions/Key"
}
}
}
"required": [
"keys"
]
}
"Key":{
"type":"object",
"properties":{
"type":{
"$ref": "#/definitions/KeyElements"
}
"idType":{
"$ref": "#/definitions/KeyType"
}
"value":{
"type": "string"
}
"required": [
"type",
"idType",
"value"
]
}
"KeyElements":{
"type": "string",
"enum": [
"Asset",
"AssetAdministrationShell",
"ConceptDescription",
"Description",
"Resource",
"ResourceAdministrationShell",
"ResourceQuantity",
"Threat",
"ThreatAdministrationShell",
"Type'
"Submodel",
"AccessPermissionRule",
"AnnotatedRelationshipElement",
"BasicEvent",
"Blob",
"Capability",
"DataElement",
"File",
"Entity",
"Event",
"MultiLanguageProperty",
"Operation",
"Property",
"Range",
"ReferenceElement",
"RelationshipElement",
"SubmodelElement",
"SubmodelElementCollection",
"View",
"GlobalReference",
"FragmentReference"
]
},

"ModelTypes": {
  "type": "string",
  "enum": [
    "Asset",
    "AssetAdministrationShell",
    "ConceptDescription",
    "Submodel",
    "AccessPermissionRule",
    "AnnotatedRelationshipElement",
    "BasicEvent",
    "Blob",
    "Capability",
    "DataElement",
    "File",
    "Entity",
    "Event",
    "MultiLanguageProperty",
    "Operation",
    "Property",
    "Range"
  ]
}
"ReferenceElement",
"RelationshipElement",
"SubmodelElement",
"SubmodelElementCollection",
"View",
"GlobalReference",
"FragmentReference",
"Constraint",
"Formula",
"Qualifier"
]
}
"ModelType":{
"type":"object",
"properties":{
"name":{
"$ref": "#/definitions/ModelTypes"
}
},
"required": [
"name"
]
}
"EmbeddedDataSpecification":{
"type":"object",
"properties":{
"dataSpecification":{
"$ref": "#/definitions/Reference"
},
"dataSpecificationContent":{
"$ref": "#/definitions/DataSpecificationContent"
}
},
"required": [
"dataSpecification",
"dataSpecificationContent"
]
}
"DataSpecificationContent":{
"oneOf": [
{
"$ref": "#/definitions/DataSpecificationIEC61360Content"
}]}
{
  "$ref": "/definitions/DataSpecificationPhysicalUnitContent"
}

"DataSpecificationPhysicalUnitContent": {
  "type": "object",
  "properties": {
    "unitName": {
      "type": "string"
    },
    "unitSymbol": {
      "type": "string"
    },
    "definition": {
      "type": "array",
      "items": {
        "$ref": "/definitions/LangString"
      }
    },
    "siNotation": {
      "type": "string"
    },
    "siName": {
      "type": "string"
    },
    "dinNotation": {
      "type": "string"
    },
    "eceName": {
      "type": "string"
    },
    "eceCode": {
      "type": "string"
    },
    "nistName": {
      "type": "string"
    },
    "sourceOfDefinition": {
      "type": "string"
    },
    "conversionFactor": {
      "type": "string"
    }
  }
}
"registrationAuthorityId": {
  "type": "string"
},
"supplier": {
  "type": "string"
}
}
"required": [
  "unitName",
  "unitSymbol",
  "definition"
]
}
"DataSpecificationIEC61360Content": {
  "allOf": [
    {
      "$ref": "#/definitions/ValueObject"
    },
    {
      "type": "object",
      "properties": {
        "dataType": {
          "enum": [
            "DATE",
            "STRING",
            "STRING_TRANSLATABLE",
            "REAL_MEASURE",
            "REAL_COUNT",
            "REAL_CURRENCY",
            "BOOLEAN",
            "URL",
            "RATIONAL",
            "RATIONAL_MEASURE",
            "TIME",
            "TIMESTAMP",
            "INTEGER_COUNT",
            "INTEGER_MEASURE",
            "INTEGER_CURRENCY"
          ]
        }
      }
    }
  ],
  "definition": {
    "type": "array",

"items": { 
  "$ref": "/definitions/LangString"
}

"preferredName": { 
  "type": "array",
  "items": {
    "$ref": "/definitions/LangString"
  }
}

"shortName": { 
  "type": "array",
  "items": {
    "$ref": "/definitions/LangString"
  }
}

"sourceOfDefinition": { 
  "type": "string"
}

"symbol": { 
  "type": "string"
}

"unit": { 
  "type": "string"
}

"unitId": { 
  "$ref": "/definitions/Reference"
}

"valueFormat": { 
  "type": "string"
}

"valueList": { 
  "$ref": "/definitions/ValueList"
}

"levelType": { 
  "type": "array",
  "items": {
    "$ref": "/definitions/LevelType"
  }
}

"required": [
  "preferredName"
]
"LevelType": {  
  "type": "string",  
  "enum": [  
    "Min",  
    "Max",  
    "Nom",  
    "Typ"  
  ]
},

"ValueList": {  
  "type": "object",  
  "properties": {  
    "valueReferencePairTypes": {  
      "type": "array",  
      "minItems": 1,  
      "items": {  
        "$ref": "/definitions/ValueReferencePairType"  
      }  
    }  
  }  
},

"ValueReferencePairType": {  
  "allOf": [  
    {  
      "$ref": "/definitions/ValueObject"  
    }  
  ]
},

"ValueObject": {  
  "type": "object",  
  "properties": {  
    "value": {  
      "type": "string"  
    },  
    "valueId": {  
      "$ref": "/definitions/Reference"  
    }  
  }  
}
"valueType": {
  "type": "string",
  "enum": [
    "anyUri",
    "base64Binary",
    "boolean",
    "date",
    "dateTime",
    "dateTimeStamp",
    "decimal",
    "integer",
    "long",
    "int",
    "short",
    "byte",
    "nonNegativeInteger",
    "positiveInteger",
    "unsignedLong",
    "unsignedInt",
    "unsignedShort",
    "unsignedByte",
    "nonPositiveInteger",
    "negativeInteger",
    "double",
    "duration",
    "dayTimeDuration",
    "yearMonthDuration",
    "float",
    "gDay",
    "gMonth",
    "gMonthDay",
    "gYear",
    "gYearMonth",
    "hexBinary",
    "NOTATION",
    "QName",
    "string",
    "normalizedString",
    "token",
    "language",
    "Name",
    "NCName"},}
"ENTITY",
"ID",
"IDREF",
"NMTOKEN",
"time"
]
}

"Asset": {
  "allOf": [
    {
      "$ref": "#/definitions/Identifiable"
    },
    {
      "$ref": "#/definitions/HasDataSpecification"
    }
  ]
}

"AssetInformation": {
  "allOf": [
    {
      "properties": {
        "assetKind": {
          "$ref": "#/definitions/AssetKind"
        },
        "globalAssetId": {
          "$ref": "#/definitions/Reference"
        },
        "specificAssetIds": {
          "type": "array",
          "items": {
            "$ref": "#/definitions/IdentifierKeyValuePair"
          }
        },
        "billOfMaterial": {
          "type": "array",
          "items": {
            "$ref": "#/definitions/Reference"
          }
        }
      },
      "thumbnail": {
        "$ref": "#/definitions/File"
      }
    }]
  }
}
"required": [  "assetKind"
]
]
]
].
]*IdentifierKeyValuePair": {
  "allOf": [
  {  
    "$ref": "#/definitions/HasSemantics"
  },
  {  
    "properties": {
      "key": {
        "dataType": "string"
      },
      "value": {
        "dataType": "string"
      },
      "subjectId": {
        "$ref": "#/definitions/Reference"
      }
    },
    "required": [
      "key",
      "value",
      "subjectId"
    ]
  }
  ],
  "AssetKind": {
    "type": "string",
    "enum": [
      "Type",
      "Instance"
    ]
  },
  "ModelingKind": {
    "type": "string",
    "enum": [
"Template",
"Instance"}
].

"Submodel":{
  "allOf":[
  
    {"$ref":"#/definitions/Identifiable"
    },
    {"$ref":"#/definitions/HasDataSpecification"
    },
    {"$ref":"#/definitions/Qualifiable"
    },
    {"$ref":"#/definitions/HasSemantics"
    },
    {
      "properties":{
        "kind":{
          "$ref":"#/definitions/ModelingKind"
        },
        "submodelElements":{
          "type":"array",
          "items":{
            "$ref":"#/definitions/SubmodelElement"
          }
        }
      }
    }
  ]
},

"Constraint":{
  "type": "object",
  "properties":{
    "modelType":{
      "$ref": "#/definitions/ModelType"
    }
  }
},

"required": ["modelType"]
"Operation": {
  "allOf": [
    {
      "$ref": "#/definitions/SubmodelElement"
    },
    {
      "properties": {
        "inputVariable": {
          "type": "array",
          "items": {
            "$ref": "#/definitions/OperationVariable"
          }
        }
      }
    },
    {
      "outputVariable": {
        "type": "array",
        "items": {
          "$ref": "#/definitions/OperationVariable"
        }
      }
    },
    {
      "inoutputVariable": {
        "type": "array",
        "items": {
          "$ref": "#/definitions/OperationVariable"
        }
      }
    }
  ]
},
"OperationVariable": {
  "type": "object",
  "properties": {
    "value": {
      "oneOf": [
        {
          "$ref": "#/definitions/Blob"
        },
        {
          "$ref": "#/definitions/File"
        },
        {
          "$ref": "#/definitions/Capability"
        }
      ]
    }
  }
}
{ "$ref": "#/definitions/Entity" }
{ "$ref": "#/definitions/Event" }
{ "$ref": "#/definitions/BasicEvent" }
{ "$ref": "#/definitions/MultiLanguageProperty" }
{ "$ref": "#/definitions/Operation" }
{ "$ref": "#/definitions/Property" }
{ "$ref": "#/definitions/Range" }
{ "$ref": "#/definitions/ReferenceElement" }
{ "$ref": "#/definitions/RelationshipElement" }
{ "$ref": "#/definitions/SubmodelElementCollection" }
"required": [ "value" ]
."SubmodelElement": { "allOf": [ { "$ref": "#/definitions/Referable" } ] }
{
  "$ref":"#/definitions/HasDataSpecification"
},
{
  "$ref":"#/definitions/HasSemantics"
},
{
  "$ref":"#/definitions/Qualifiable"
},
{
  "properties": {
    "kind": {
      "$ref":"#/definitions/ModelingKind"
    },
    "idShort": {
      "dataTpye": "string"
    }
  },
  "required": [
    "idShort"
  ]
},
"Event": {
  "allOf": [
    {
      "$ref": "#/definitions/SubmodelElement"
    }
  ]
},
"BasicEvent": {
  "allOf": [
    {
      "$ref": "#/definitions/Event"
    }
  ],
  "properties": {
    "observed": {
      "$ref": "#/definitions/Reference"
    }
  },
  "required": [
"observed"
[
]
]
],
"EntityType": {
  "type": "string",
  "enum": [
    "CoManagedEntity",
    "SelfManagedEntity"
  ]
],
"Entity": {
  "allOf": [
    {
      "$ref": "/definitions/SubmodelElement"
    },
    {
      "properties": {
        "statements": {
          "type": "array",
          "items": {
            "$ref": "/definitions/SubmodelElement"
          }
        },
        "entityType": {
          "$ref": "/definitions/EntityType"
        },
        "globalAssetId": {
          "$ref": "/definitions/Reference"
        },
        "specificAssetIds": {
          "$ref": "/definitions/IdentifierKeyValuePair"
        }
      }
    },
    {"required": []
      "entityType"
    }
  ]
},
"View": {
  "allOf": [
    
  ]
}
{
  "$ref": "#/definitions/Referable"
}.
{
  "$ref": "#/definitions/HasDataSpecification"
}.
{
  "$ref": "#/definitions/HasSemantics"
}.
{
  "properties": {
    "containedElements": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Reference"
      }
    }
  }
}
"ConceptDescription": {
  "allOf": [ 
    {
      "$ref": "#/definitions/Identifiable"
    },
    {
      "$ref": "#/definitions/HasDataSpecification"
    }]
}.
{
  "properties": {
    "isCaseOf": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Reference"
      }
    }
  }
}
"Capability": {
  "allOf": [ 
  ]}.
{  
  "$ref": "#/definitions/SubmodelElement"
}

"Property": {
  "allOf": [
  
  ]
},

"Range": {
  "allOf": [
  
  ]
},

"properties": {
  "valueType": {
  "type": "string",
  "enum": [
  "anyUri",
  "base64Binary",
  "boolean",
  "date",
  "dateTime",
  "dateTimeStamp",
  "decimal",
  "integer",
  "long",
  "int",
  "short",
  "byte",
  "nonNegativeInteger",
  "positiveInteger",
  "unsignedLong",
  "unsignedInt",
  "unsignedShort",
  "unsignedByte",
}
"nonPositiveInteger",
"negativeInteger",
"double",
"duration",
"dayTimeDuration",
"yearMonthDuration",
"float",
"gDay",
"gMonth",
"gMonthDay",
"gYear",
"gYearMonth",
"hexBinary",
"NOTATION",
"QName",
"string",
"normalizedString",
"token",
"language",
"Name",
"NCName",
"ENTITY",
"ID",
"IDREF",
"NMTOKEN",
"time",
]
}
"min":{
"type":"string"
}
"max":{
"type":"string"
}
"required":[]
"valueType"
]
}
[
"MultiLanguageProperty":{
"allOf": [}
{
  "$ref": "#/definitions/SubmodelElement"
},
{
  "properties": {
    "value": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/LangString"
      }
    },
    "valueId": {
      "$ref": "#/definitions/Reference"
    }
  }
}
"File": {
  "allOf": [
    {
      "$ref": "#/definitions/SubmodelElement"
    },
    {
      "properties": {
        "value": {
          "type": "string"
        },
        "mimeType": {
          "type": "string"
        }
      }
    },
    "required": [
      "mimeType"
    ]
  ]
},
"Blob": {
  "allOf": [
    {
      "$ref": "#/definitions/SubmodelElement"
    }
  ]
}
{  
  "properties": {  
    "value": {  
      "type": "string"  
    },  
    "mimeType": {  
      "type": "string"  
    }  
  },  
  "required": [  
    "mimeType"  
  ]  
},  
"ReferenceElement": {  
  "allOf": [  
    {  
      "$ref": "/definitions/SubmodelElement"  
    },  
    {  
      "properties": {  
        "value": {  
          "$ref": "#/definitions/Reference"  
        }  
      }  
    }  
  ]  
},  
"SubmodelElementCollection": {  
  "allOf": [  
    {  
      "$ref": "/definitions/SubmodelElement"  
    },  
    {  
      "properties": {  
        "value": {  
          "type": "array",  
          "items": {  
            "oneOf": [  
              {  
                "$ref": "#/definitions/Blob"  
              }  
            ]  
          }  
        }  
      }  
    }  
  ]  
}
{
  "$ref": "#/definitions/File"
},
{
  "$ref": "#/definitions/Capability"
},
{
  "$ref": "#/definitions/Entity"
},
{
  "$ref": "#/definitions/Event"
},
{
  "$ref": "#/definitions/BasicEvent"
},
{
  "$ref": "#/definitions/MultiLanguageProperty"
},
{
  "$ref": "#/definitions/Operation"
},
{
  "$ref": "#/definitions/Property"
},
{
  "$ref": "#/definitions/Range"
},
{
  "$ref": "#/definitions/ReferenceElement"
},
{
  "$ref": "#/definitions/RelationshipElement"
},
{
  "$ref": "#/definitions/SubmodelElementCollection"
}]
,
"allowDuplicates": {
  "type": "boolean"
},
"ordered": {

"type":"boolean"
}
}
}

"RelationshipElement": {
  "allOf": [
    {
      "$ref": "/definitions/SubmodelElement"
    },
    {
      "properties": {
        "first": {
          "$ref": "/definitions/Reference"
        },
        "second": {
          "$ref": "/definitions/Reference"
        }
      },
      "required": [
        "first",
        "second"
      ]
    }]
  }
},

"AnnotatedRelationshipElement": {
  "allOf": [
    {
      "$ref": "/definitions/RelationshipElement"
    },
    {
      "properties": {
        "annotation": {
          "type": "array",
          "items": {
            "oneOf": [
              {
                "$ref": "/definitions/Blob"
              },
              {
                "$ref": "/definitions/File"
              }
            ]
          }
        }
      }
    }]
  }
},
"Formula": {
  "allOf": [
    {
      "$ref": "/definitions/Constraint"
    },
    {
      "properties": {
        "dependsOn": {
          "type": "array",
          "items": {
            "$ref": "/definitions/Reference"
          }
        }
      }
    }
  ],
  "Security": {
    "type": "object",
    "properties": {
      "accessControlPolicyPoints": {
        "$ref": "/definitions/AccessControlPolicyPoints"
      },
      "certificate": {
        "type": "array",
        "items": {
          "oneOf": [
            {
              "$ref": "/definitions/BlobCertificate"
            }
          ]
        }
      },
      "requiredCertificateExtension": {
        "type": "array",
        "items": {
          "$ref": "/definitions/Reference"
        }
      }
    }
  }
}
"required": [
  "accessControlPolicyPoints"
]
"Certificate": {
  "type": "object"
},
"BlobCertificate": {
  "allOf": [
  {
    "$ref": "/definitions/Certificate"
  },
  {
    "properties": {
      "blobCertificate": {
        "$ref": "/definitions/Blob"
      },
      "containedExtension": {
        "type": "array",
        "items": {
          "$ref": "/definitions/Reference"
        }
      }
    }
  }
  ]
},
"AccessControlPolicyPoints": {
  "type": "object",
  "properties": {
    "policyAdministrationPoint": {
      "$ref": "/definitions/PolicyAdministrationPoint"
    },
    "policyDecisionPoint": {
      "$ref": "/definitions/PolicyDecisionPoint"
    },
    "policyEnforcementPoint": {
      "$ref": "/definitions/PolicyEnforcementPoint"
    },
    "policyInformationPoints": {
      "$ref": "/definitions/PolicyInformationPoints"
    }
  }
}
"required": [
  "policyAdministrationPoint",
  "policyDecisionPoint",
  "policyEnforcementPoint"
]
].

*PolicyAdministrationPoint*: {
  "type": "object",
  "properties": {
    "localAccessControl": {
      "$ref": "/definitions/AccessControl"
    },
    "externalAccessControl": {
      "type": "boolean"
    }
  }
}

"required": [
  "externalAccessControl"
]
].

*PolicyInformationPoints*: {
  "type": "object",
  "properties": {
    "internalInformationPoint": {
      "type": "array",
      "items": {
        "$ref": "/definitions/Reference"
      }
    },
    "externalInformationPoint": {
      "type": "boolean"
    }
  }
}

"required": [
  "externalInformationPoint"
]
].

*PolicyEnforcementPoint*: {
  "type": "object",
  "properties": {
    "externalPolicyEnforcementPoint": {
      "type": "boolean"
    }
  }
}
"required": [
  "externalPolicyEnforcementPoint"
]
},
"PolicyDecisionPoint": {
  "type": "object",
  "properties": {
    "externalPolicyDecisionPoints": {
      "type": "boolean"
    }
  }
},
"required": [
  "externalPolicyDecisionPoints"
]
},
"AccessControl": {
  "type": "object",
  "properties": {
    "selectableSubjectAttributes": {
      "$ref": "#/definitions/Reference"
    },
    "defaultSubjectAttributes": {
      "$ref": "#/definitions/Reference"
    },
    "selectablePermissions": {
      "$ref": "#/definitions/Reference"
    },
    "defaultPermissions": {
      "$ref": "#/definitions/Reference"
    },
    "selectableEnvironmentAttributes": {
      "$ref": "#/definitions/Reference"
    },
    "defaultEnvironmentAttributes": {
      "$ref": "#/definitions/Reference"
    },
    "accessPermissionRule": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/AccessPermissionRule"
      }
    }
  }
}
"AccessPermissionRule": {
  "allOf": [
    {
      "$ref": "/definitions/Referable"
    },
    {
      "$ref": "/definitions/Qualifiable"
    }
  ],
  "properties": {
    "targetSubjectAttributes": {
      "type": "array",
      "items": {
        "$ref": "/definitions/SubjectAttributes"
      },
      "minItems": 1
    },
    "permissionsPerObject": {
      "type": "array",
      "items": {
        "$ref": "/definitions/PermissionsPerObject"
      }
    }
  }
},
"required": [
  "targetSubjectAttributes"
]
},
"SubjectAttributes": {
  "type": "object",
  "properties": {
    "subjectAttributes": {
      "type": "array",
      "items": {
        "$ref": "/definitions/Reference"
      },
      "minItems": 1
    }
  }
}
"PermissionsPerObject": {
  "type": "object",
  "properties": {
    "object": {
      "$ref": "#/definitions/Reference"
    },
    "targetObjectAttributes": {
      "$ref": "#/definitions/ObjectAttributes"
    },
    "permission": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Permission"
      }
    }
  }
},
"ObjectAttributes": {
  "type": "object",
  "properties": {
    "objectAttribute": {
      "type": "array",
      "items": {
        "$ref": "#/definitions/Property"
      },
      "minItems": 1
    }
  }
},
"Permission": {
  "type": "object",
  "properties": {
    "permission": {
      "$ref": "#/definitions/Reference"
    },
    "kindOfPermission": {
      "type": "string",
      "enum": [
        "Allow",
        "Deny",
        "NotApplicable",
        "Undefined"
      ]
    }
  }
}
ii. **JSON EXAMPLE**

For cross reference, a complete self-contained example is given, which relates to the unified example in Clause 7.3.

Table 27 JSON example

```json
{
  "assetAdministrationShells": [{
    "modelType": {
      "name": "AssetAdministrationShell"
    },
    "idShort": "ExampleMotor",
    "identification": {
      "idType": "IRI",
      "id": "http://customer.com/aas/9175_7013_7091_9168"
    },
    "assetInformation": {
      "assetKind": "Instance",
      "globalAssetId": {
        "keys": [
          {
            "type": "Asset",
            "value": "http://customer.com/assets/KHBVZJSQKIY"
          },
          {
            "idType": "IRI"
          }
        ]
      }
    },
    "specificAssetIds": {
      "key": "EquipmentID",
      "value": "538fd1b3-f99f-4a52-9c75-72e9fa921270",
      "subjectId": {
        "keys": [
    ```
"keys": [  {
    "type": "Submodel",
    "value": "http://i40.customer.com/instance/1/1/AC69B1CB44F07935",
    "idType": "IRI"
  },  
],  
"keys": [  {
    "type": "Submodel",
    "value": "http://i40.customer.com/type/1/1/A7B62B529F19152",
    "idType": "IRI"
  },  
],  
"assets": [  {
    "modelType": {  
      "name": "Asset"
    },  
    "idShort": "ServoDCMotor",
    "identification": {  
      "idType": "IRI",
      "id": "http://customer.com/assets/KHBVZJSKIQY"
    }
  },  
],  
"submodels": [  {
    "modelType": {  
      "name": "Submodel"
    },  
    "semanticId": {  
      "keys": [  
        {  
          "type": "GlobalReference",
          "value": "0173-1#01-AFZ615#016",
          "idType": "IRDI"
        }
      ]
    }
  },
"kind":"Instance",
"idShort":"TechnicalData",
"identification":{
  "idType":"IRI",
  "id":"http://i40.customer.com/type/1/1/7A7104BDAB57E184"
},
"submodelElements": [
  {
    "modelType":{
      "name":"Property"
    },
    "kind":"Instance",
    "semanticId":{
      "keys":[
        {
          "type":"ConceptDescription",
          "value":"0173-1#02-BAAI20#008",
          "idType":"IRDI"
        }
      ],
      "idShort":"MaxRotationSpeed",
      "category":"PARAMETER",
      "value":"5000",
      "valueType":"integer"
    }
  },
  {
    "modelType":{
      "name":"Submodel"
    },
    "kind":"Instance",
    "idShort":"Documentation",
    "identification":{
      "idType":"IRI",
      "id":"http://i40.customer.com/type/1/1/1A7B62B529F19152"
    },
    "submodelElements": [
      {}
    }
  }
]
DETAILS OF THE ADMINISTRATION SHELL - PART 1

"modelType":{
  "name":"SubmodelElementCollection"
},
"kind":"Instance",
"semanticId":{
  "keys":[
    {
      "type":"ConceptDescription",
      "idType":"IRI"
    }
  ],
  "idShort":"OperatingManual",
  "value":{
    "modelType":{
      "name":"Property"
    },
    "kind":"Instance",
    "semanticId":{
      "keys":[
        {
          "type":"ConceptDescription",
          "value":"www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Description/Title",
          "idType":"IRI"
        }
      ],
      "idShort":"Title",
      "value":"OperatingManual",
      "valueType":"langString"
    }
  }
},
{ "modelType":{
  "name":"File"
},
"kind":"Instance",
"semanticId":{
  "keys":[
    {
      "type":"ConceptDescription",
    }
  ],
  "idShort":null,
  "value":null,
  "valueType":null"}
"idType":"IRI"
}
]
}
"idShort":"DigitalFile_PDF",
"mimeType":"application/pdf",
"value":"/aasx/OperatingManual.pdf"
}
].
"ordered":false,
"allowDuplicates":false
}
]
}
{
"modelType":{
 "name":"Submodel"
}
"kind":"Instance",
"idShort":"OperationalData",
"identification":{
 "idType":"IRI",
 "id":"http://i40.customer.com/instance/1/1/AC69B1CB44F07935"
}
"submodelElements":[
{
"modelType":{
 "name":"Property"
}
"kind":"Instance",
"semanticId":{
 "keys":[
 {"type":"ConceptDescription",
 "value":"http://customer.com/cd/1/1/8EBD56F6B43D895",
 "idType":"IRI"
 }
 ]
 "idShort":"RotationSpeed",
 "category":"VARIABLE",
 "value":"4370",
 "valueType":"integer"}
"conceptDescriptions":
{
  "modelType":{
    "name":"ConceptDescription"
  },
  "idShort":"Title",
  "identification":{
    "idType":"IRI",
    "id":"www.vdi2770.com/blatt/Entwurf/Okt18/cd/Description/Title"
  },
  "embeddedDataSpecifications":
  {
    "dataSpecification":{
      "keys":{
        {"type":"GlobalReference", "value":"http://adminshell.io/DataSpecificationTemplates/DataSpecificationIEC61360", "idType":"IRI"}
      }
    },
    "dataSpecificationContent":{
      "preferredName":{
        {"language":"EN", "text":"Title"}
      },
      {"language":"DE", "text":"Titel"}
    },
    "shortName":{
      {"language":"EN", "text":"Title"}
    }
  }
}
"embeddedDataSpecifications":{
  "dataSpecification":{
    "keys":[]
  },
  "dataSpecificationContent":{
    "preferredName":{
      {
        "language":"de",
        "text":"max.Drehzahl"
      },
      {
        "language":"en",
        "text":"Max.rotationspeed"
      }
    },
    "shortName":[]
  },
  "unit":"l/min",
  "unitId":{
    "keys":{
      {"type":"GlobalReference",
       "value":"0173-1#05-AAA650#002",
       "idType":"IRDI"
      }
    }
  },
  "sourceOfDefinition":",
  "dataType":"REAL_MEASURE",
  "definition":{
    {"language":"de",
     "text":"Höchstzulässige Drehzahl mit welcher der Motor oder die Speiseeinheit betrieben werden darf"
    },
    {"language":"en",
     "text":"Greatest permissible rotationspeed with which the motor or feeding unit may be operated"
    }
  }
}
"modelType":{
  "name":"ConceptDescription"
},
"idShort":"RotationSpeed",
"category":"PROPERTY",
"identification":{
  "idType":"IRI",
  "id":"http://customer.com/cd/I/I/18EBD56F6B43D895"
},
"embeddedDataSpecifications":[
  {
    "dataSpecification":{
      "keys":[
        {
          "type":"GlobalReference",
          "idType":"IRI"
        }
      ]
    },
    "dataSpecificationContent":{
      "preferredName":[
        {
          "language":"DE",
          "text":"AktuelleDrehzahl"
        },
        {
          "language":"EN",
          "text":"Actualrotationspeed"
        }
      ],
      "shortName":[
        {
          "language":"DE",
          "text":"AktuelleDrehzahl"
        },
        {
          "language":"EN",
          "text":null
        }
      ]
    }
  }
]
"text":"ActualRotationSpeed"
]

"unit":"1/min",
"unitId":{
  "keys":[
    {
      "type":"GlobalReference",
      "value":"0173-1#05-AAA650#002",
      "idType":"IRDI"
    }
  
  
  
  "sourceOfDefinition":"
  "dataType":"REAL_MEASURE",
  "definition":{
    {
      "language":"DE",
      "text":"Aktuelle Drehzahl, mit welcher der Motor oder die Speiseeinheit betrieben wird"
    },
    {
      "language":"EN",
      "text":"Actual rotationspeed with which the motor or feedingunit is operated"
    }
  
  
  
  
  }"modelType":{
  "name":"ConceptDescription"
}

"idShort":"Document",
"identification":{
  "idType":"IRI",
  "id":"www.vdi2770.com/blatt/Entwurf/Okt18/cd/Document"
}

"embeddedDataSpecifications":[
  {
    "dataSpecification":{
      "keys":[
        {
          "key":"
        }
      
      
      
      
      }
    }
  }
}
"type":"GlobalReference",
"idType":"IRI",
}
]
"dataSpecificationContent":{
"preferredName":[
],
"shortName":[
{
"language":"EN",
"text":"Document"
},
{
"language":"DE",
"text":"Dokument"
}
],
"unit":"
"sourceOfDefinition":"ISO15519-1:2010",
"dataType":"STRING",
"definition":[
{
"language":"DE",
"text":"Feste und geordnete Menge von für die Verwendung durch Personen bestimmte Informationen, die verwaltet und als Einheit zwischen Benutzern und System ausgetauscht werden kann."
}
]
}
ANNEX H. RDF SCHEMA AND COMPLETE EXAMPLE

i. RDF DATA MODEL FOR THE ASSET ADMINISTRATION SHELL

```rml
@prefix aas: <https://admin-shell.io/aas/3/0/RC01/> .
@prefix iec61360: <https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/> .
@prefix phys_unit: <https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/> .
@prefix dash: <http://datashapes.org/dash#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix dcterms: <http://purl.org/dc/terms/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .
@prefix vann: <http://purl.org/vocab/vann/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@base <https://admin-shell.io/aas/3/0/RC01/> .

<https://admin-shell.io/aas/3/0/RC01/> rdf:type owl:Ontology ;
   vann:preferredNamespaceUri "https://admin-shell.io/aas/3/0/RC01/"^^xsd:anyURI ;
   owl:versionInfo "3.0.RC01" ;
   rdfs:comment "This ontology represents the data model for the Asset Administration Shell according to the specification 'Details of the Asset Administration Shell - Part 1 - Version 3.0.RC01'."^^xsd:string ;
   skos:prefLabel "aas"^^xsd:string ;
   vann:preferredNamespacePrefix "aas"^^xsd:string ;
   rdfs:isDefinedBy <https://admin-shell.io/aas/3/0/RC01/> ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessControl
aas:AccessControl rdf:type owl:Class ;
   rdfs:comment "Access Control defines the local access control policy administration point. Access Control has the major task to define the access permission rules."^^xsd:string ;
   rdfs:label "Access Control"^^xsd:string ;
.
### https://admin-shell.io/aas/3/0/RC01/AccessControl/accessPermissionRule
<https://admin-shell.io/aas/3/0/RC01/AccessControl/accessPermissionRule> rdf:type owl:ObjectProperty ;
   rdfs:comment "Access permission rules of the AAS describing the rights assigned to (already authenticated) subjects to access elements of the AAS."^^xsd:string ;
   rdfs:label "has access permission rule"^^xsd:string ;
   rdfs:domain aas:AccessControl ;
```
### https://admin-shell.io/aas/3/0/RC01/AccessControl/selectableEnvironmentAttributes
<https://admin-shell.io/aas/3/0/RC01/AccessControl/selectableEnvironmentAttributes> rdf:type owl:ObjectProperty ;
  rdfs:comment "Reference to a submodel defining which environment attributes can be accessed via the permission rules."@en ;
  rdfs:label "has selectable environment attributes"^^xsd:string ;
  rdfs:domain aas:AccessControl ;
  rdfs:range aas:Submodel ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessControl/defaultEnvironmentAttributes
<https://admin-shell.io/aas/3/0/RC01/AccessControl/defaultEnvironmentAttributes> rdf:type owl:ObjectProperty ;
  rdfs:comment "Reference to a submodel defining default environment attributes, i.e. attributes that are not describing the asset itself. The submodel is of kind=Type. At the same time the values of these environment attributes need to be accessible when evaluating the access permission rules. This is realized as a policy information point."@en ;
  rdfs:label "has default environment attributes"^^xsd:string ;
  rdfs:domain aas:AccessControl ;
  rdfs:range aas:Submodel ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints
aas:AccessControlPolicyPoints rdf:type owl:Class ;
  rdfs:comment "Container for access control policy points."@en ;

### https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyAdministrationPoint
<https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyAdministrationPoint> rdf:type owl:ObjectProperty ;
  rdfs:comment "The access control administration policy point of the AAS."@en ;
  rdfs:label "has policy administration point"^^xsd:string ;
  rdfs:domain aas:AccessControlPolicyPoints ;
  rdfs:range aas:PolicyAdministrationPoint ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyDecisionPoint
<https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyDecisionPoint> rdf:type owl:ObjectProperty ;
  rdfs:comment "The access control policy decision point of the AAS."@en ;
  rdfs:label "has policy decision point"^^xsd:string ;
  rdfs:domain aas:AccessControlPolicyPoints ;
  rdfs:range aas:PolicyDecisionPoint ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyEnforcementPoint
<https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyEnforcementPoint> rdf:type owl:ObjectProperty ;
  rdfs:comment "The access control policy enforcement point of the AAS."@en ;
```
### https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyInformationPoints
aas:AccessControlPolicyPoints rdf:type owl:Class ;
   rdfs:subClassOf aas:Referable ;
   rdfs:subClassOf aas:Qualifiable ;
   rdfs:comment "The access control policy information points of the AAS." @en ;
   rdfs:label "has policy information point"^^xsd:string ;
   rdfs:domain aas:AccessControlPolicyPoints ;
   rdfs:range aas:PolicyInformationPoints ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessPermissionRule
aas:AccessPermissionRule rdf:type owl:Class ;
   rdfs:subClassOf aas:Referable ;
   rdfs:subClassOf aas:Qualifiable ;
   rdfs:comment "Table that defines access permissions per authenticated subject for a set of objects (referable elements)." @en ;
   rdfs:label "Access Permission Rule"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessPermissionRule/permissionsPerObject
aas:AccessPermissionRule/permissionsPerObject rdf:type owl:ObjectProperty ;
   rdfs:comment "Set of object-permission pairs that define the permissions per object within the access permission rule." @en ;
   rdfs:domain aas:AccessPermissionRule ;
   rdfs:range aas:PermissionsPerObject ;
.

### https://admin-shell.io/aas/3/0/RC01/AccessPermissionRule/targetSubjectAttributes
aas:AccessPermissionRule/targetSubjectAttributes rdf:type owl:ObjectProperty ;
   rdfs:comment "Target subject attributes that need to be fulfilled by the accessing subject to get the permissions defined by this rule." @en ;
   rdfs:domain aas:AccessPermissionRule ;
   rdfs:range aas:SubjectAttributes ;
.

### https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation
aas:AdministrativeInformation rdf:type owl:Class ;
   rdfs:subClassOf aas:HasDataSpecification ;
```
Every Identifiable may have administrative information. Administrative information includes for example:

- Information about the version of the element
- Information about who created or who made the last change to the element
- Information about the languages available in case the element contains text, for translating purposes also a master or default language may be defined.

In the first version of the AAS metamodel only version information as defined by IEC 61360 is defined. In later versions additional attributes may be added.

```xml
rdfs:comment "Every Identifiable may have administrative information. Administrative information includes for example information about the version of the element, information about who created or who made the last change to the element, and information about the languages available in case the element contains text, for translating purposes also a master or default language may be defined. In the first version of the AAS metamodel only version information as defined by IEC 61360 is defined. In later versions additional attributes may be added."@en ;
rdfs:label "Administrative Information"^^xsd:string ;
```

### https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation/version

```xml
<https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation/version> rdf:type owl:DatatypeProperty ;
rdfs:subPropertyOf dcterms:hasVersion ;
rdfs:domain aas:AdministrativeInformation ;
rdfs:range xsd:string ;
sh:pattern ".+" ;
rdfs:comment "Version of the element."@en ;
rdfs:label "has version"^^xsd:string ;
```

### https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation/revision

```xml
<https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation/revision> rdf:type owl:DatatypeProperty ;
rdfs:subPropertyOf dcterms:hasVersion ;
rdfs:comment "Revision of the element."@en ;
skos:note "Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision either."@en ;
rdfs:label "has revision"^^xsd:string ;
rdfs:domain aas:AdministrativeInformation ;
rdfs:range xsd:string ;
sh:pattern ".+" ;
```

### https://admin-shell.io/aas/3/0/RC01/AnnotatedRelationshipElement

```xml
aas:AnnotatedRelationshipElement rdf:type owl:Class ;
rdfs:subClassOf aas:RelationshipElement ;
rdfs:comment "An annotated relationship element is an relationship element that can be annotated with additional data elements."@en ;
rdfs:label "Annotated Relationship Element"^^xsd:string ;
```

### https://admin-shell.io/aas/3/0/RC01/AnnotatedRelationshipElement/annotation

```xml
<https://admin-shell.io/aas/3/0/RC01/AnnotatedRelationshipElement/annotation> rdf:type owl:ObjectProperty ;
rdfs:comment "Annotations that hold for the relationships between the two elements."@en ;
rdfs:label "has annotation"^^xsd:string ;
```
DETAILS OF THE ADMINISTRATION SHELL - PART 1

```xml
rdfs:domain aas:AnnotatedRelationshipElement;
rdfs:range aas:DataElement;
.

### https://admin-shell.io/aas/3/0/RC01/Asset
aas:Asset rdf:type owl:Class;
rdfs:subClassOf aas:HasDataSpecification, aas:Identifiable;
skos:altLabel "Object"@en;
skos:definition "Clearly identifiable asset for the Administration Shell"@en;
skos:prefLabel "Asset"@en;
rdfs:label "Asset"^^xsd:string;
skos:definition "Eindeutig identifizierbarer Gegenstand, der aufgrund seiner Bedeutung in der Informationswelt verwaltet wird"@de;

rdfs:comment "An Asset describes meta data of an asset that is represented by an AAS. The asset may either represent an asset type or an asset instance. The asset has a globally unique identifier plus – if needed – additional domain specific (proprietary) identifiers."@en;
skos:note "Objects may be known in the form of a type or of an instance. An object in the planning phase is known as a type"@en;
.

### https://admin-shell.io/aas/3/0/RC01/AssetInformation
aas:AssetInformation rdf:type owl:Class;
rdfs:comment "In AssetInformation identifying meta data of the asset that is represented by an AAS is defined."@en;
rdfs:comment "The asset may either represent an asset type or an asset instance."@en;
rdfs:comment "The asset has a globally unique identifier plus – if needed – additional domain specific (proprietary) identifiers. However, to support the corner case of very first phase of lifecycle where a stabilised/constant global asset identifier does not already exist, the corresponding attribute "globalAssetId" is optional."@en;
rdfs:label "has Asset Identification Model"^^xsd:string;
.

### https://admin-shell.io/aas/3/0/RC01/AssetInformation/assetKind
<https://admin-shell.io/aas/3/0/RC01/AssetInformation/assetKind> rdf:type owl:ObjectProperty;
rdfs:domain aas:AssetInformation;
rdfs:range aas:AssetKind;
rdfs:label "has assetKind"^^xsd:string;
rdfs:comment "Denotes whether the Asset of of kind 'Type' or 'Instance'."@en;
.

### https://admin-shell.io/aas/3/0/RC01/AssetInformation/globalAssetId
<https://admin-shell.io/aas/3/0/RC01/AssetInformation/globalAssetId> rdf:type owl:ObjectProperty;
rdfs:domain aas:AssetInformation;
rdfs:range aas:Reference;
```
**Annex 305**

rdfs:comment "Reference to either an Asset object or a global reference to the asset the AAS is representing."@en ;

rdfs:comment "This attribute is required as soon as the AAS is exchanged via partners in the life cycle of the asset. In a first phase of the life cycle the asset might not yet have a global id but already an internal identifier. The internal identifier would be modelled via "externalAssetId"."@en ;

rdfs:label "has global asset id"^^xsd:string ;

skos:note "Constraint AASd-023: AssetInformation/globalAssetId either is a reference to an Asset object or a global reference."@en ;

###  https://admin-shell.io/aas/3/0/RC01/AssetInformation/externalAssetId

<https://admin-shell.io/aas/3/0/RC01/AssetInformation/externalAssetId> rdf:type owl:ObjectProperty ;

rdfs:domain aas:AssetInformation ;

rdfs:range aas:IdentifierKeyValuePair ;

rdfs:comment "Additional domain specific external, typically proprietary Identifier for the asset like e.g. serial number etc."@en ;

rdfs:label "has external asset id"^^xsd:string ;

###  https://admin-shell.io/aas/3/0/RC01/AssetInformation/billOfMaterial

<https://admin-shell.io/aas/3/0/RC01/AssetInformation/billOfMaterial> rdf:type owl:ObjectProperty ;

rdfs:domain aas:AssetInformation ;

rdfs:range aas:Submodel ;

rdfs:comment "A reference to a Submodel that defines the bill of material of the asset represented by the AAS. This submodel contains a set of entities describing the material used to compose the composite I4.0 Component."@en ;

rdfs:label "has Bill of Material"^^xsd:string ;

###  https://admin-shell.io/aas/3/0/RC01/AssetInformation/thumbnail

<https://admin-shell.io/aas/3/0/RC01/AssetInformation/thumbnail> rdf:type owl:ObjectProperty ;

rdfs:domain aas:AssetInformation ;

rdfs:range aas:File ;

rdfs:label "has thumbnail"^^xsd:string ;

rdfs:comment "Thumbnail of the asset represented by the asset administration shell."@en ;

###  https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell

aas:AssetAdministrationShell rdf:type owl:Class ;

rdfs:subClassOf aas:HasDataSpecification , aas:Identifiable ;

rdfs:label "Asset Administration Shell"^^xsd:string ;

skos:altLabel "Administration Shell"@en , "Verwaltungsschale"@de ;

skos:definition "Describes the Administration Shell for Assets, Products, Components, e.g. Machines"@en ;

rdfs:comment "Describes the Administration Shell for Assets, Products, Components, e.g. Machines"@en ;
rdfs:range aas:View ;
  rdfs:comment "Points to the different views associated to the Administration Shell via the Submodels." @en ;
  rdfs:label "has View"^^xsd:string ;
  skos:prefLabel "view"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/AssetKind
aas:AssetKind rdf:type owl:Class ;
  rdfs:comment "Enumeration for denoting whether an element is a type or an instance." @en ;
  rdfs:label "Asset Kind"^^xsd:string ;
  owl:oneOf (  
    <https://admin-shell.io/aas/3/0/RC01/AssetKind/INSTANCE> 
    <https://admin-shell.io/aas/3/0/RC01/AssetKind/TYPE>  
  ) ;
.

###  https://admin-shell.io/aas/3/0/RC01/AssetKind/INSTANCE
<https://admin-shell.io/aas/3/0/RC01/AssetKind/INSTANCE> rdf:type aas:AssetKind ;
  rdfs:comment "Concrete, clearly identifiable component of a certain type." @en ;
  rdfs:label "Asset Instance"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/AssetKind/TYPE
<https://admin-shell.io/aas/3/0/RC01/AssetKind/TYPE> rdf:type aas:AssetKind ;
  rdfs:comment "hardware or software element which specifies the common attributes shared by all instances of the type." @en ;
  rdfs:label "Asset Type"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/BasicEvent
aas:BasicEvent rdf:type owl:Class ;
  rdfs:subClassOf aas:Event ;
  rdfs:label "Basic Event"^^xsd:string ;
  rdfs:comment "A basic event." @en ;
.

###  https://admin-shell.io/aas/3/0/RC01/BasicEvent/observed
<https://admin-shell.io/aas/3/0/RC01/BasicEvent/observed> rdf:type owl:ObjectProperty ;
  rdfs:comment "Reference to the data or other elements that are being observed." @en ;
  rdfs:label "observed by"^^xsd:string ;
  rdfs:domain aas:BasicEvent ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

rdfs:range aas:Reference ;
.

###  https://admin-shell.io/aas/3/0/RC01/Blob
aas:Blob rdf:type owl:Class ;
    rdfs:subClassOf aas:DataElement ;
    rdfs:comment "A BLOB is a data element that represents a file that is contained with its source code in the value attribute." @en ;
    rdfs:label "Blob Data Element"^^xsd:string ;
    skos:note "Constraint AASd-057: The semanticId of a File or Blob submodel element shall only reference a ConceptDescription with the category DOCUMENT." @en ;
.

###  https://admin-shell.io/aas/3/0/RC01/Blob/mimeType
<https://admin-shell.io/aas/3/0/RC01/Blob/mimeType> rdf:type owl:DatatypeProperty ;
    rdfs:domain aas:Blob ;
    rdfs:range xsd:string ;
    sh:pattern ".+" ;
    rdfs:comment "Mime type of the content of the BLOB. The mime type states which file extension the file has. Valid values are e.g. ‘application/json’, ‘application/xls’, ‘image/jpg’ The allowed values are defined as in RFC2046." @en ;
    rdfs:label "has mimetype"^^xsd:string ;
    rdfs:seeAlso "http://uri4uri.net/vocab.html/#MimetypeDatatype"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/Blob/value
<https://admin-shell.io/aas/3/0/RC01/Blob/value> rdf:type owl:ObjectProperty ;
    rdfs:domain aas:Blob ;
    rdfs:range aas:BlobType ;
    rdfs:comment "The value of the BLOB instance of a blob data element." @en ;
    skos:note "In contrast to the file property the file content is stored directly as value in the Blob data element." @en ;
    rdfs:label "has value"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/BlobCertificate
aas:BlobCertificate rdf:type owl:Class ;
    rdfs:subClassOf aas:Certificate ;
    rdfs:comment "Certificate provided as BLOB." @en ;
    rdfs:label "Blob Certificate"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/BlobCertificate/blobCertificate
  rdfs:comment "Certificate as BLOB."@en ;
  rdfs:label "Blob Certificate"^^xsd:string ;
  rdfs:domain aas:BlobCertificate ;
  rdfs:range xsd:byte ;
.

### https://admin-shell.io/aas/3/0/RC01/BlobCertificate/containedExtension

  rdfs:comment "Extensions contained in the certificate."@en ;
  rdfs:label "contains extension"^^xsd:string ;
  rdfs:domain aas:BlobCertificate ;
  rdfs:range aas:Reference ;
.

### https://admin-shell.io/aas/3/0/RC01/BlobCertificate/lastCertificate

  rdfs:comment "Denotes whether this certificate is the certificate that last added last."@en ;
  rdfs:label "is last certificate"^^xsd:string ;
  rdfs:domain aas:BlobCertificate ;
  rdfs:range xsd:boolean ;
.

### https://admin-shell.io/aas/3/0/RC01/Capability

aas:Capability rdf:type owl:Class ;
  rdfs:subClassOf aas:SubmodelElement ;
  rdfs:comment "A capability is the implementation-independent description of the potential of an asset to achieve a certain effect in the physical or virtual world."@en ;
  rdfs:label "Capability"^^xsd:string ;
  skos:note "Constraint AASd-058: If the semanticId of a Capability submodel element references a ConceptDescription then the ConceptDescription/category shall be CAPABILITY."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/Category

aas:Category rdf:type owl:Class ;
  rdfs:comment "A enumeration for data elements except for files and blobs."@en ;
  rdfs:label "Category"^^xsd:string ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

### https://admin-shell.io/aas/3/0/RC01/Category/CONSTANT
<https://admin-shell.io/aas/3/0/RC01/Category/CONSTANT> rdf:type aas:Category ;
  rdfs:comment "A constant property is a property with a value that does not change over time. In eCl@ss this kind of category has the category 'Coded Value'." @en ;
  rdfs:label "Constant"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Category/PARAMETER
<https://admin-shell.io/aas/3/0/RC01/Category/PARAMETER> rdf:type aas:Category ;
  rdfs:comment "A parameter property is a property that is once set and then typically does not change over time. This is for example the case for configuration parameters." @en ;
  rdfs:label "Parameter"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Category/VARIABLE
<https://admin-shell.io/aas/3/0/RC01/Category/VARIABLE> rdf:type aas:Category ;
  rdfs:comment "A variable property is a property that is calculated during runtime, i.e. its value is a runtime value." @en ;
  rdfs:label "Variable"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Certificate
aas:Certificate rdf:type owl:Class ;
  dash:abstract true ;
  rdfs:comment "A technical certificate proofing the identity through cryptographic measures." @en ;
  rdfs:label "Certificate"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Certificate/policyAdministrationPoint
<https://admin-shell.io/aas/3/0/RC01/Certificate/policyAdministrationPoint> rdf:type owl:ObjectProperty ;
  rdfs:comment "The access control administration policy point of the AAS." @en ;
  rdfs:label "has policy administration point"^^xsd:string ;
  rdfs:domain aas:Certificate ;
  rdfs:range aas:PolicyAdministrationPoint ;
.

### https://admin-shell.io/aas/3/0/RC01/ConceptDescription
aas:ConceptDescription rdf:type owl:Class ;
  rdfs:subClassOf aas:HasDataSpecification , aas:Identifiable ;
  rdfs:label "Concept Description"^^xsd:string ;
The semantics of a property or other elements that may have a semantic description is defined by a concept description. The description of the concept should follow a standardized schema (realized as data specification template)."@en ;

skos:note "Constraint AASd-051: A ConceptDescription shall have one of the following categories: VALUE, PROPERTY, REFERENCE, DOCUMENT, CAPABILITY, RELATIONSHIP, COLLECTION, FUNCTION, EVENT, ENTITY, APPLICATION_CLASS, QUALIFIER, VIEW. Default: PROPERTY."@en ;

### https://admin-shell.io/aas/3/0/RC01/ConceptDescription/content
<https://admin-shell.io/aas/3/0/RC01/ConceptDescription/content> rdf:type owl:ObjectProperty ;

rdfs:comment "Link from a ConceptDescription to its explaining DataSpecificationContent."@en ;

rdfs:domain aas:ConceptDescription ;

rdfs:range aas:DataSpecificationContent ;

### https://admin-shell.io/aas/3/0/RC01/ConceptDescription/isCaseOf
<https://admin-shell.io/aas/3/0/RC01/ConceptDescription/isCaseOf> rdf:type owl:ObjectProperty ;

rdfs:comment "Reference to an external definition the concept is compatible to or was derived from."@en ;

skos:note "Compare to is-case-of relationship in ISO 13584-32 & IEC EN 61360."@en ;

rdfs:domain aas:ConceptDescription ;

rdfs:range aas:Reference ;

### https://admin-shell.io/aas/3/0/RC01/Constraint
aas:Constraint rdf:type owl:Class ;

dash:abstract true ;

rdfs:comment "A constraint is used to further qualify an element."@en ;

rdfs:label "Constraint"^^xsd:string ;

skos:prefLabel "Constraint"@en ;

### https://admin-shell.io/aas/3/0/RC01/DataElement
aas:DataElement rdf:type owl:Class ;

dash:abstract true ;

rdfs:comment "A data element is a submodel element that is not further composed out of other submodel elements. A data element is a submodel element that has a value. The type of value differs for different subtypes of data elements."@en ;

rdfs:label "Data Element"^^xsd:string ;
###  https://admin-shell.io/aas/3/0/RC01/DataSpecificationContent

aas:DataSpecificationContent rdf:type owl:Class ;
    rdfs:label "Data Specification Content"^^xsd:string ;
    rdfs:comment "DataSpecificationContent contains the additional attributes to be added to the element instance that references the data specification template and meta information about the template itself."@en ;
.


iec61360:DataSpecificationIEC61360 rdf:type owl:Class ;
    rdfs:subClassOf aas:DataSpecificationContent ;
    rdfs:label "Data Specification IEC 61360"^^xsd:string ;
    rdfs:comment "Data Specification Template for defining Property Descriptions conformant to IEC 61360."@en ;
    skos:note "Constraint AASd-075: For all ConceptDescriptions using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) values for the attributes not being marked as mandatory or optional in tables Table 9, Table 10, Table 11 and Table 12 depending on its category are ignored and handled as undefined."@en ;
.

###  https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/DataSpecificationIEC61360/dataType

    rdfs:label "has datatype"^^xsd:string ;
    rdfs:domain iec61360:DataSpecificationIEC61360 ;
    rdfs:range iec61360:DataTypeIEC61360 ;
    skos:note "Constraint AASd-070: For a ConceptDescription with category PROPERTY or VALUE using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) DataSpecificationIEC61360/dataType is mandatory and shall be defined."@en ;
    skos:note "Constraint AASd-072: For a ConceptDescription with category DOCUMENT using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) DataSpecificationIEC61360/dataType shall be one of the following values: STRING or URL."@en ;
    skos:note "Constraint AASd-073: For a ConceptDescription with category QUALIFIER using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) DataSpecificationIEC61360/dataType is mandatory and shall be defined."@en ;
.

Constraint AASd-074: For all ConceptDescriptions except for ConceptDescriptions of category VALUE using data specification template IEC61360 (http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) - DataSpecificationIEC61360/definition is mandatory and shall be defined at least in English."@en ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

rdfs:label "has source of definition"^^xsd:string ;
  rdfs:domain iec61360:DataSpecificationIEC61360 ;
  rdfs:range xsd:string ;
  sh:pattern ".+" ;
.

  rdfs:label "has symbol"^^xsd:string ;
  rdfs:domain iec61360:DataSpecificationIEC61360 ;
  rdfs:range xsd:string ;
  sh:pattern ".+" ;
.

  rdfs:label "has unit"^^xsd:string ;
  rdfs:domain iec61360:DataSpecificationIEC61360 ;
  rdfs:range xsd:string ;
  sh:pattern ".+" ;
.

  rdfs:label "has unit id"^^xsd:string ;
  rdfs:domain iec61360:DataSpecificationIEC61360 ;
  rdfs:range aas:Reference ;
.

  rdfs:label "has value format"^^xsd:string ;
  rdfs:domain iec61360:DataSpecificationIEC61360 ;
  rdfs:range xsd:string ;
  sh:pattern ".+" ;
.
### Property 'Value' Description

The 'Value' property is an owl:DatatypeProperty that can be used to specify a value for a concept. It has the following properties:

- rdfs:label: "has value"^^xsd:string
- rdfs:domain: iec61360:DataSpecificationIEC61360
- rdfs:range: xsd:string
- sh:pattern: ".+"

### Property 'Value List' Description

The 'Value List' property is an owl:DatatypeProperty that can be used to specify a list of values for a concept. It has the following properties:

- rdfs:label: "has value list"^^xsd:string
- rdfs:comment: "The Type 'Value List' lists all the allowed values for a concept description for which the allowed values are listed in an enumeration. The value list is a set of value reference pairs." @en
- rdfs:domain: iec61360:DataSpecificationIEC61360
- rdfs:range: xsd:string
- sh:pattern: ".+"

### Property 'Value ID' Description

The 'Value ID' property is an owl:ObjectProperty that can be used to specify a value ID for a concept. It has the following properties:

- rdfs:label: "has value id"^^xsd:string
- rdfs:domain: iec61360:DataSpecificationIEC61360
- rdfs:range: aas:Reference

### Physical Unit Data Specification

The 'Conversion Factor' property is an owl:DatatypeProperty that can be used to specify a conversion factor for a physical unit. It has the following properties:

- rdfs:label: "has conversion factor"^^xsd:string
- rdfs:domain: phys_unit:
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/definition
phys_unit:definition rdf:type owl:DatatypeProperty;
  rdfs:label "has definition"^^xsd:string;
  rdfs:domain phys_unit;
  rdfs:range rdf:langString;

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/dinNotation
phys_unit:dinNotation rdf:type owl:DatatypeProperty;
  rdfs:label "has DIN notation"^^xsd:string;
  rdfs:domain phys_unit;
  rdfs:range xsd:string;
  sh:pattern ".+";

phys_unit:eceCode rdf:type owl:DatatypeProperty;
  rdfs:label "has ECE code"^^xsd:string;
  rdfs:domain phys_unit;
  rdfs:range xsd:string;
  sh:pattern ".+";

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/eceName
phys_unit:eceName rdf:type owl:DatatypeProperty;
  rdfs:label "has ECE name"^^xsd:string;
  rdfs:domain phys_unit;
  rdfs:range xsd:string;
  sh:pattern ".+";

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/nistName
phys_unit:nistName rdf:type owl:DatatypeProperty;
  rdfs:label "has NIST name"^^xsd:string;
  rdfs:domain phys_unit;
  rdfs:range xsd:string;
sh:pattern ".+";
.

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/siName

phys_unit:siName rdf:type owl:DatatypeProperty;
   rdfs:label "has SI name"^^xsd:string;
   rdfs:domain phys_unit:;
   rdfs:range xsd:string;
   sh:pattern ".+";
.

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/siNotation

phys_unit:siNotation rdf:type owl:DatatypeProperty;
   rdfs:label "has SI notation"^^xsd:string;
   rdfs:domain phys_unit:;
   rdfs:range xsd:string;
   sh:pattern ".+";
.

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/registrationAuthorityId

phys_unit:registrationAuthorityId rdf:type owl:DatatypeProperty;
   rdfs:label "has registration authority"^^xsd:string;
   rdfs:domain phys_unit:;
   rdfs:range xsd:string;
   sh:pattern ".+";
.

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/supplier

phys_unit:supplier rdf:type owl:DatatypeProperty;
   rdfs:label "has supplier"^^xsd:string;
   rdfs:domain phys_unit:;
   rdfs:range xsd:string;
   sh:pattern ".+";
.

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/unitName

phys_unit:unitName rdf:type owl:DatatypeProperty;
   rdfs:label "unit has name"^^xsd:string;
   rdfs:domain phys_unit:;
   rdfs:range xsd:string;
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/unitSymbol

```
phys_unit:unitSymbol rdf:type owl:DatatypeProperty ;
  rdfs:label "unit has symbol"^^xsd:string ;
  rdfs:domain phys_unit ;
  rdfs:range xsd:string ;
  sh:pattern ".+" ;
```  

### https://admin-shell.io/aas/3/0/RC01/Entity

```
aas:Entity rdf:type owl:Class ;
  rdfs:subClassOf aas:SubmodelElement ;
  rdfs:label "Entity"^^xsd:string ;
  rdfs:comment "An entity is a submodel element that is used to model entities."@en ;
  skos:note "Constraint AASd-056: The semanticId of a Entity submodel element shall only reference a ConceptDescription with the category ENTITY. The ConceptDescription describes the elements assigned to the entity via Entity/statement."@en ;
```  

### https://admin-shell.io/aas/3/0/RC01/Entity/globalAssetId

```
<https://admin-shell.io/aas/3/0/RC01/Entity/globalAssetId> rdf:type owl:ObjectProperty ;
  rdfs:label "has global asset id"^^xsd:string ;
  rdfs:domain aas:Entity ;
  rdfs:range aas:Reference ;
  rdfs:comment "Reference to the asset the entity is representing."@en ;
  skos:note "The asset attribute must be set if entityType is set to ‘SelfManagedEntity’. It is empty otherwise."@en ;
  skos:note "Constraint AASd-014: Either the attribute globalAssetId or externalAssetId of an Entity must be set if Entity/entityType is set to “SelfManagedEntity”. They are not existing otherwise."@en ;
```  

### https://admin-shell.io/aas/3/0/RC01/Entity/externalAssetId

```
<https://admin-shell.io/aas/3/0/RC01/Entity/externalAssetId> rdf:type owl:ObjectProperty ;
  rdfs:label "has external asset id"^^xsd:string ;
  rdfs:domain aas:Entity ;
  rdfs:range aas:IdentifierKeyValuePair ;
  rdfs:comment "Reference to an identifier key value pair representing an external identifier of the asset represented by the asset administration shell."@en ;
  skos:note "The asset attribute must be set if entityType is set to ‘SelfManagedEntity’. It is empty otherwise."@en ;
  skos:note "Constraint AASd-014: Either the attribute globalAssetId or externalAssetId of an Entity must be set if Entity/entityType is set to “SelfManagedEntity”. They are not existing otherwise."@en ;
```
### https://admin-shell.io/aas/3/0/RC01/Entity/entityType

<a href="https://admin-shell.io/aas/3/0/RC01/Entity/entityType">https://admin-shell.io/aas/3/0/RC01/Entity/entityType</a> rdf:type owl:ObjectProperty;

rdfs:label "has entity type"^^xsd:string;

rdfs:domain aas:Entity;

rdfs:range aas:EntityType;

rdfs:comment "Describes whether the entity is a co-managed entity or a self-managed entity."@en;

### https://admin-shell.io/aas/3/0/RC01/Entity/statement


rdfs:label "has statement"^^xsd:string;

rdfs:comment "Describes statements applicable to the entity by a set of submodel elements, typically with a qualified value."@en;

rdfs:domain aas:Entity;

rdfs:range aas:SubmodelElement;

### https://admin-shell.io/aas/3/0/RC01/EntityType

aas:EntityType rdf:type owl:Class;

rdfs:label "Entity Type"^^xsd:string;

rdfs:comment "Enumeration for denoting whether an entity is a self-managed entity or a co-managed entity."@en;

owl:oneOf (<a href="https://admin-shell.io/aas/3/0/RC01/EntityType/CO_MANAGED_ENTITY">https://admin-shell.io/aas/3/0/RC01/EntityType/CO_MANAGED_ENTITY</a> <a href="https://admin-shell.io/aas/3/0/RC01/EntityType/SELF_MANAGED_ENTITY">https://admin-shell.io/aas/3/0/RC01/EntityType/SELF_MANAGED_ENTITY</a>);

### https://admin-shell.io/aas/3/0/RC01/Entity/CO_MANAGED_ENTITY


rdfs:comment "For co-managed entities there is no separate AAS. Co-managed entities need to be part of a self-managed entity."@en;

rdfs:label "Co-managed Entity"^^xsd:string;

### https://admin-shell.io/aas/3/0/RC01/Entity/SELF_MANAGED_ENTITY


rdfs:comment "Self-Managed Entities have their own AAS but can be part of the bill of material of a composite self-managed entity. The asset of an I4.0 Component is a self-managed entity per definition."@en;

rdfs:label "Self-managed Entity"^^xsd:string;

### https://admin-shell.io/aas/3/0/RC01/Event

aas:Event rdf:type owl:Class;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

rdfs:subClassOf aas:SubmodelElement ;
dash:abstract true ;
rdfs:label "Event"^^xsd:string ;
rdfs:comment 'An event.'@en ;
skos:note "Constraint AASd-061: The semanticId of a Event submodel element shall only reference a ConceptDescription with the category EVENT."@en ;

### https://admin-shell.io/aas/3/0/RC01/EventElement
aas:EventElement rdf:type owl:Class ;
rdfs:subClassOf aas:SubmodelElement ;
rdfs:label "Event Element"^^xsd:string ;
rdfs:comment "Defines the necessary information for sending or receiving events."@en ;
skos:note "non-normative, just only for discussion (as of November 2019)."@en ;

### https://admin-shell.io/aas/3/0/RC01/EventMessage
aas:EventMessage rdf:type owl:Class ;
rdfs:subClassOf aas:SubmodelElement ;
rdfs:label "Event Message"^^xsd:string ;
rdfs:comment "Defines the necessary information of an event instance sent out or received."@en ;
skos:note "non-normative, just only for discussion (as of November 2019)."@en ;

### https://admin-shell.io/aas/3/0/RC01/File
aas:File rdf:type owl:Class ;
rdfs:subClassOf aas:SubmodelElement ;
rdfs:comment "A File is a data element that represents a file via its path description."@en ;
rdfs:label "File Submodel Element"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/File/mimeType
<https://admin-shell.io/aas/3/0/RC01/File/mimeType> rdf:type owl:DatatypeProperty ;
rdfs:domain aas:File ;
rdfs:range xsd:string ;
sh:pattern ".+" ;
rdfs:comment "Mime type of the content of the File."@en ;
rdfs:label "has mimetype"^^xsd:string ;
rdfs:seeAlso "http://uri4uri.net/vocab.html/#MimetypeDatatype"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/File/value

<https://admin-shell.io/aas/3/0/RC01/File/value> rdf:type owl:ObjectProperty ;
  rdfs:domain aas:File ;
  rdfs:range aas:PathType ;
  rdfs:comment "Path and name of the referenced file (with file extension). The path can be absolute or relative."@en ;
  rdfs:label "has value"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Formula

aas:Formula rdf:type owl:Class ;
  rdfs:subClassOf aas:Constraint ;
  dc:description "A formula is used to describe constraints by a logical expression."@en ;
  rdfs:label "Formula"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Formula/dependsOn

<https://admin-shell.io/aas/3/0/RC01/Formula/dependsOn> rdf:type owl:ObjectProperty ;
  rdfs:domain aas:Formula ;
  rdfs:range aas:Reference ;
  rdfs:comment "A formula may depend on referable or even external global elements - assumed that can be referenced and their value may be evaluated that are used in the logical expression."@en ;
  rdfs:label "depends on"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/HasDataSpecification

aas:HasDataSpecification rdf:type owl:Class ;
  dash:abstract true ;
  rdfs:comment "Element that can have be extended by using data specification templates. A data specification template defines the additional attributes an element may or shall have. The data specifications used are explicitly specified with their id."@en ;
  rdfs:label "Has Data Specification"^^xsd:string ;
  skos:note "Constraint AASd-050: If the DataSpecificationContent DataSpecificationIEC61360 is used for an element then the value of hasDataSpecification/dataSpecification shall contain the global reference to the IRI of the corresponding data specification template https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/HasDataSpecification/dataSpecification

  rdfs:comment "Global reference to the data specification template used by the element."@en ;
  rdfs:label "has Data Specification"^^xsd:string ;
  rdfs:domain aas:HasDataSpecification ;
  rdfs:range aas:Reference ;
.
DETAILS OF THE ADMINISTRATION SHELL - PART 1

### graphql://admin-shell.io/aas/3/0/RC01/HasKind

```
aas:HasKind rdf:type owl:Class ;
    dash:abstract true ;
    rdfs:comment "An element with a kind is an element that can either represent a type or an instance. Default for an element is that it is representing an instance."@en ;
    rdfs:label "Has Kind"^^xsd:string ;
```

### graphql://admin-shell.io/aas/3/0/RC01/HasKind/kind

```
<https://admin-shell.io/aas/3/0/RC01/HasKind/kind> rdf:type owl:ObjectProperty ;
    rdfs:domain aas:HasKind ;
    rdfs:range aas:ModelingKind ;
    rdfs:label "has kind"^^xsd:string ;
    rdfs:comment "ModelingKind of the element: either type or instance."@en ;
```

### graphql://admin-shell.io/aas/3/0/RC01/HasSemantics

```
aas:HasSemantics rdf:type owl:Class ;
    dash:abstract true ;
    rdfs:label "Has Semantics"^^xsd:string ;
    rdfs:comment "Element that can have a semantic definition. Identifier of the semantic definition of the element. It is called semantic id of the element. The semantic id may either reference an external global id or it may reference a referable model element of kind=Type that defines the semantics of the element."@en ;
    skos:note "In many cases the idShort is identical to the English short name within the semantic definition as referenced vi aits semantic id."@en ;
```

### graphql://admin-shell.io/aas/3/0/RC01/HasSemantics/semanticId

```
<https://admin-shell.io/aas/3/0/RC01/HasSemantics/semanticId> rdf:type owl:ObjectProperty ;
    rdfs:subPropertyOf rdfs:seeAlso ;
    rdfs:label "has semantic ID"^^xsd:string ;
    skos:altLabel "has Semantic Expression"@en ;
    rdfs:comment "Points to the Expression Semantic of the Submodels"@en ;
    rdfs:comment "The semantic id might refer to an external information source, which explains the formulation of the submodel (for example an PDF if a standard)."@en ;
    rdfs:domain aas:HasSemantics ;
    rdfs:range aas:Reference ;
```

### graphql://admin-shell.io/aas/3/0/RC01/Identifiable

```
aas:Identifiable rdf:type owl:Class ;
    dash:abstract true ;
```
rdfs:subClassOf aas:Referable;
  rdfs:comment "An element that has a globally unique identifier."@en;
  rdfs:label "Identifiable"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Identifiable/administration

<https://admin-shell.io/aas/3/0/RC01/Identifiable/administration> rdf:type owl:ObjectProperty ;
  rdfs:comment "Administrative information of an identifiable element."@en ;
  skos:note "Some of the administrative information like the version number might need to be part of the identification."@en ;
  rdfs:label "has administration"^^xsd:string ;
  rdfs:domain aas:Identifiable ;
  rdfs:range aas:AdministrativeInformation ;
.

### https://admin-shell.io/aas/3/0/RC01/Identifiable/identification

<https://admin-shell.io/aas/3/0/RC01/Identifiable/identification> rdf:type owl:ObjectProperty ;
  rdfs:domain aas:Identifiable ;
  rdfs:range aas:Identifier ;
  rdfs:label "has identification"^^xsd:string ;
  rdfs:comment "The globally unique identification of the element."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/IdentifiableElements

aas:IdentifiableElements rdf:type owl:Class ;
  rdfs:subClassOf aas:ReferableElements ;
  rdfs:label "Identifiable Element"^^xsd:string ;
  rdfs:comment "Enumeration of all identifiable elements within an asset administration shell that are not identifiable"@en ;
  owl:oneOf ( 
    <https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET>
    <https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET_ADMINISTRATION_SHELL>
    <https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/CONCEPT_DESCRIPTION>
    <https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/SUBMODEL>
  ) ;
.

### https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET

<https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET> rdf:type aas:IdentifiableElements ;
  rdfs:label "Asset"^^xsd:string ;
.
### https://admin-shell.io/aas/3.0/RC01/IdentifiableElements/ASSET_ADMINISTRATION_SHELL

<https://admin-shell.io/aas/3.0/RC01/IdentifiableElements/ASSET_ADMINISTRATION_SHELL> rdf:type aas:IdentifiableElements;
  rdfs:label "Asset Administration Shell"^^xsd:string ;

### https://admin-shell.io/aas/3.0/RC01/IdentifiableElements/CONCEPT_DESCRIPTION

<https://admin-shell.io/aas/3.0/RC01/IdentifiableElements/CONCEPT_DESCRIPTION> rdf:type aas:IdentifiableElements;
  rdfs:label "Concept Description"^^xsd:string ;

### https://admin-shell.io/aas/3.0/RC01/IdentifiableElements/SUBMODEL

<https://admin-shell.io/aas/3.0/RC01/IdentifiableElements/SUBMODEL> rdf:type aas:IdentifiableElements;
  rdfs:label "Submodel"^^xsd:string ;

### https://admin-shell.io/aas/3.0/RC01/Identifier

aas:Identifier rdf:type owl:Class;
  rdfs:comment "Used to uniquely identify an entity by using an identifier."@en;
  rdfs:label "Identifier"^^xsd:string ;

### https://admin-shell.io/aas/3.0/RC01/Identifier/id

<https://admin-shell.io/aas/3.0/RC01/Identifier/id> rdf:type owl:DatatypeProperty;
  rdfs:domain aas:Identifier;
  rdfs:range rdfs:Literal;
  rdfs:comment "A globally unique identifier which might not be a URI. Its type is defined in idType."@en;
  rdfs:label "has identification"^^xsd:string ;

### https://admin-shell.io/aas/3.0/RC01/Identifier/idType

<https://admin-shell.io/aas/3.0/RC01/Identifier/idType> rdf:type owl:ObjectProperty;
  rdfs:comment "Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration 'IdentifierType'."@en;
  rdfs:domain aas:Identifier;
  rdfs:range aas:IdentifierType;
  rdfs:label "has idType"^^xsd:string ;

### https://admin-shell.io/aas/3.0/RC01/IdentifierType

aas:IdentifierType rdf:type owl:Class ;
rdfs:subClassOf aas:KeyType ;
  rdfs:label "Identifier Type"^^xsd:string ;
  rdfs:comment "Enumeration of different types of Identifiers for global identification"^^en ;

owl:oneOf (  
  <https://admin-shell.io/aas/3.0/RC01/IdentifierType/IRDI>
  <https://admin-shell.io/aas/3.0/RC01/IdentifierType/IRI>
  <https://admin-shell.io/aas/3.0/RC01/IdentifierType/CUSTOM>
); .

### https://admin-shell.io/aas/3.0/RC01/IdentifierType/IRDI
<https://admin-shell.io/aas/3.0/RC01/IdentifierType/IRDI> rdf:type aas:IdentifierType ;
  rdfs:label "IRDI"^^xsd:string ;
  rdfs:comment "IRDI according to ISO29002-5 as an Identifier scheme for properties and classifications."^^en ;
.

### https://admin-shell.io/aas/3.0/RC01/IdentifierType/IRI
<https://admin-shell.io/aas/3.0/RC01/IdentifierType/IRI> rdf:type aas:IdentifierType ;
  rdfs:label "IRI"^^xsd:string ;
  rdfs:comment "IRI. Should only be used if unicode symbols are used that are not allowed in URL."^^en ;
.

### https://admin-shell.io/aas/3.0/RC01/IdentifierType/CUSTOM
<https://admin-shell.io/aas/3.0/RC01/IdentifierType/CUSTOM> rdf:Type aas:IdentifierType ;
  rdfs:label "Custom"^^xsd:string ;
  rdfs:comment "Custom identifiers like GUIDs (globally unique Identifiers)"^^en ;
.

### https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair
aas:IdentifierKeyValuePair rdf:type owl:Class ;
  rdfs:subClassOf aas:HasSemantics ;
  rdfs:label "identifier key value pair"^^xsd:string ;
  rdfs:comment "An IdentifierKeyValuePair describes a generic identifier as key-value pair."^^en ;
.

### https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/key
<https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/key> rdf:type owl:DatatypeProperty ;
  rdfs:domain aas:IdentifierKeyValuePair ;
  rdfs:range xsd:string ;
  sh:pattern ".+" ;
### https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/value
<https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/value> rdf:type owl:ObjectProperty ;
  rdfs:domain aas:IdentifierKeyValuePair ;
  rdfs:range rdfs:Literal ;
  rdfs:comment "The value of the identifier with the corresponding key."@en ;
  rdfs:label "has IdentifierKeyValuePair.value"^^xsd:string ;
.

### https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/externalSubjectId
<https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/externalSubjectId> rdf:type owl:ObjectProperty ;
  rdfs:domain aas:IdentifierKeyValuePair ;
  rdfs:range aas:Reference ;
  rdfs:comment "The (external) subject the key belongs to or has meaning to."@en ;
  rdfs:label "has IdentifierKeyValuePair.externalSubjectId"^^xsd:string ;
.

### https://admin-shell.io/aas/3.0/RC01/Key
aas:Key rdf:type owl:Class ;
  rdfs:comment "A key is a reference to an element by its id."@en ;
  rdfs:label "Key"^^xsd:string ;
.

### https://admin-shell.io/aas/3.0/RC01/Key/idType
<https://admin-shell.io/aas/3.0/RC01/Key/idType> rdf:type owl:ObjectProperty ;
  rdfs:comment "Type of the key value. In case of idType = idShort local shall be true. In case type=GlobalReference idType shall not be IdShort."@en ;
  rdfs:domain aas:Key ;
  rdfs:range aas:KeyType ;
  rdfs:label "has key type"^^xsd:string ;
  skos:note "Constraint AASd-080: In case Key/type == idShort local shall be true. In case type=GlobalReference idType shall not be IdShort."@en ;
  skos:note "Constraint AASd-081: In case Key/type==AssetAdministrationShell Key/idType shall not be any LocalKeyType (IdShort, FragmentId)."@en ;
.

### https://admin-shell.io/aas/3.0/RC01/Key/type
<https://admin-shell.io/aas/3.0/RC01/Key/type> rdf:type owl:ObjectProperty ;
Denote which kind of entity is referenced. In case type = GlobalReference then the element is a global unique id. In all other cases the key references a model element of the same or of another AAS. The name of the model element is explicitly listed."@en ;

dfs:label "has type"^^xsd:string ;
dfs:domain aas:Key ;
dfs:range aas:KeyElements ;
.

###  https://admin-shell.io/aas/3/0/RC01/Key/value

<https://admin-shell.io/aas/3/0/RC01/Key/value> rdf:type owl:DatatypeProperty ;
dfs:comment "The key value, for example an IRDI if the idType=IRDI."@en ;
dfs:label "has value"^^xsd:string ;
dfs:domain aas:Key ;
dfs:range xsd:string ;
sh:pattern ".+" ;
.

###  https://admin-shell.io/aas/3/0/RC01/KeyElements

aas:KeyElements rdf:type owl:Class ;
dfs:label "Key Elements"^^xsd:string ;
dfs:comment "Enumeration of different key value types within a key. Contains KeyElements, ReferableElements, and IdentifiableElements."@en ;
owl:oneOf (  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/ACCESS_PERMISSION_RULE>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/ANNOTATED_RELATIONSHIP_ELEMENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/BASIC_EVENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/BLOB>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/CAPABILITY>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/CONCEPT_DICTIONARY>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/GLOBAL_REFERENCE_KEY_ELEMENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/DATA_ELEMENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/FILE>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/ENTITY>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/EVENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/MULTI_LANGUAGE_PROPERTY>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/OPERATION>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/PROPERTY>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/RANGE>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/REFERENCE_ELEMENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/RELATIONSHIP_ELEMENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT>  
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT_COLLECTION>
## https://admin-shell.io/aas/3/0/RC01/KeyElements/GLOBAL_REFERENCE
<https://admin-shell.io/aas/3/0/RC01/KeyElements/GLOBAL_REFERENCE> rdf:type aas:KeyElements ;
  rdfs:label "Global Reference"^^xsd:string ;
  rdfs:comment "reference to an element not belonging to an asset administration shell"@en ;

## https://admin-shell.io/aas/3/0/RC01/KeyElements/FRAGMENT_REFERENCE
<https://admin-shell.io/aas/3/0/RC01/KeyElements/FRAGMENT_REFERENCE> rdf:type aas:KeyElements ;
  rdfs:label "Fragment Reference"^^xsd:string ;

## https://admin-shell.io/aas/3/0/RC01/KeyType
aas:KeyType rdf:type owl:Class ;
  rdfs:label "Key Type"^^xsd:string ;
  rdfs:comment "Enumeration of different key value types within a key. Contains IdentifierType and LocalKeyType."@en ;
  owl:oneOf ( 
    <https://admin-shell.io/aas/3/0/RC01/IdentifierType/IRDI>
    <https://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI>
    <https://admin-shell.io/aas/3/0/RC01/IdentifierType/CUSTOM>
    <https://admin-shell.io/aas/3/0/RC01/LocalKeyType/IDSHORT>
    <https://admin-shell.io/aas/3/0/RC01/LocalKeyType/FRAGMENT_ID>
  ) ;

## https://admin-shell.io/aas/3/0/RC01/LevelType
aas:LevelType rdf:type owl:Class ;
  rdfs:label "Level Type"^^xsd:string ;
rdfs:comment "Enumeration of different level types within a DataSpecificationIEC61360. Contains Min, Max, Nom, and Typ." @en ;

owl:oneOf (
  <https://admin-shell.io/aas/3/0/RC01/LevelType/MIN>
  <https://admin-shell.io/aas/3/0/RC01/LevelType/MAX>
  <https://admin-shell.io/aas/3/0/RC01/LevelType/NOM>
  <https://admin-shell.io/aas/3/0/RC01/LevelType/Typ>
)
.

###  https://admin-shell.io/aas/3/0/RC01/LocalKeyType

<https://admin-shell.io/aas/3/0/RC01/LocalKeyType> rdf:type owl:Class ;

rdfs:subClassOf aas:KeyType ;

rdfs:label "Local Key Type"^^xsd:string ;

rdfs:comment "Enumeration of different key value types within a key." @en ;

owl:oneOf (  
  <https://admin-shell.io/aas/3/0/RC01/LocalKeyType/IDSHORT>
DETAILS OF THE ADMINISTRATION SHELL - PART 1

```xml
<https://admin-shell.io/aas/3/0/RC01/LocalKeyType/FRAGMENT_ID>

) ;
.
.

###  https://admin-shell.io/aas/3/0/RC01/LocalKeyType/IDSHORT
<https://admin-shell.io/aas/3/0/RC01/LocalKeyType/IDSHORT> rdf:type aas:LocalKeyType;
  rdfs:label "IdShort"^^xsd:string;
  rdfs:comment "idShort of a referable element"@en;
.

###  https://admin-shell.io/aas/3/0/RC01/LocalKeyType/FRAGMENT_ID
<https://admin-shell.io/aas/3/0/RC01/LocalKeyType/FRAGMENT_ID> rdf:Type aas:LocalKeyType;
  rdfs:label "FragmentId"^^xsd:string;
  rdfs:comment "Identifier of a fragment within a file"@en;
.

###  https://admin-shell.io/aas/3/0/RC01/ModelingKind
aas:ModelingKind rdf:type owl:Class;
  rdfs:comment "Enumeration for denoting whether an element is a type or an instance."@en;
  rdfs:label "Kind"^^xsd:string;
  owl:oneOf (aas:INSTANCE aas:TEMPLATE);
).
.

###  https://admin-shell.io/aas/3/0/RC01/ModelingKind/INSTANCE
<https://admin-shell.io/aas/3/0/RC01/ModelingKind/INSTANCE> rdf:type aas:ModelingKind;
  rdfs:comment "Concrete, clearly identifiable component of a certain template."@en;
  skos:note "It becomes an individual entity of a template, for example a device model, by defining specific property values."@en;
  skos:note "In an object oriented view, an instance denotes an object (of a template) (class)."@en;
  rdfs:label "Instance"^^xsd:string;
.
.
###  https://admin-shell.io/aas/3/0/RC01/ModelingKind/TEMPLATE
<https://admin-shell.io/aas/3/0/RC01/ModelingKind/TEMPLATE> rdf:type aas:ModelingKind;
  rdfs:comment "Software element which specifies the common attributes shared by all instances of the template."@en;
  rdfs:label "Template"^^xsd:string;
.
.
###  https://admin-shell.io/aas/3/0/RC01/MultiLanguageProperty
```
**aas:MultiLanguageProperty rdf:type owl:Class ;**

rdfs:subClassOf aas:DataElement ;

rdfs:comment "A property is a data element that has a multi language value."@en ;

rdfs:label "Multi Language Property"^^xsd:string ;

.

### https://admin-shell.io/aas/3/0/RC01/MultiLanguageProperty/value

<https://admin-shell.io/aas/3/0/RC01/MultiLanguageProperty/value> rdf:type owl:ObjectProperty ;

rdfs:comment "The value of the property instance."@en ;

rdfs:label "has value"^^xsd:string ;

rdfs:domain aas:MultiLanguageProperty ;

rdfs:range rdf:langString ;

skos:note "Constraint AASd-052b: If the semanticId of a MultiLanguageProperty references a ConceptDescription then the ConceptDescription/category shall be one of following values: PROPERTY."@en ;

skos:note "Constraint AASd-012: If both, the MultiLanguageProperty/value and the MultiLanguageProperty/valueId are present then for each string in a specific language the meaning must be the same as specified in MultiLanguageProperty/valueId."@en ;

skos:note "Constraint AASd-067: If the semanticId of a MultiLanguageProperty references a ConceptDescription then DataSpecificationIEC61360/dataType shall be STRING_TRANSLATABLE."@en ;

.

### https://admin-shell.io/aas/3/0/RC01/MultiLanguageProperty/valueId

<https://admin-shell.io/aas/3/0/RC01/MultiLanguageProperty/valueId> rdf:type owl:ObjectProperty ;

rdfs:comment "Reference to the global unique id of a coded value."@en ;

rdfs:label "hsv value Id"^^xsd:string ;

rdfs:domain aas:MultiLanguageProperty ;

rdfs:range aas:Reference ;

.

### https://admin-shell.io/aas/3/0/RC01/ObjectAttributes

aas:ObjectAttributes rdf:type owl:Class ;

rdfs:comment "A set of data elements that describe object attributes. These attributes need to refer to a data element within an existing submodel."@en ;

rdfs:label "Object Attributes"^^xsd:string ;

.

### https://admin-shell.io/aas/3/0/RC01/ObjectAttributes/objectAttribute

<https://admin-shell.io/aas/3/0/RC01/ObjectAttributes/objectAttribute> rdf:type owl:ObjectProperty ;

rdfs:comment "A data elements that further classifies an object."@en ;

rdfs:label "has object attribute"^^xsd:string ;

rdfs:domain aas:ObjectAttributes ;

rdfs:range aas:DataElement ;

.
### https://admin-shell.io/aas/3/0/RC01/Operation
aas:Operation rdf:type owl:Class ;
    rdfs:subClassOf aas:SubmodelElement ;
    rdfs:comment "An operation is a submodel element with input and output variables."@en ;
    rdfs:label "Operation"^^xsd:string ;
    skos:note "Constraint AASd-060: The semanticId of a Operation submodel element shall only reference a ConceptDescription with the category FUNCTION."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/Operation/inputVariable
<https://admin-shell.io/aas/3/0/RC01/Operation/inputVariable> rdf:type owl:ObjectProperty ;
    rdfs:comment "Input parameter of the operation."@en ;
    rdfs:label "has input variable"^^xsd:string ;
    rdfs:domain aas:Operation ;
    rdfs:range aas:OperationVariable ;
.

### https://admin-shell.io/aas/3/0/RC01/Operation/inoutputVariable
<https://admin-shell.io/aas/3/0/RC01/Operation/inoutputVariable> rdf:type owl:ObjectProperty ;
    rdfs:comment "Parameter that is input and output of the operation."@en ;
    rdfs:label "has input/output variable"^^xsd:string ;
    rdfs:domain aas:Operation ;
    rdfs:range aas:OperationVariable ;
.

### https://admin-shell.io/aas/3/0/RC01/Operation/outputVariable
<https://admin-shell.io/aas/3/0/RC01/Operation/outputVariable> rdf:type owl:ObjectProperty ;
    rdfs:comment "Output parameter of the operation."@en ;
    rdfs:label "has output variable"^^xsd:string ;
    rdfs:domain aas:Operation ;
    rdfs:range aas:OperationVariable ;
.

### https://admin-shell.io/aas/3/0/RC01/OperationVariable
aas:OperationVariable rdf:type owl:Class ;
    rdfs:comment "An operation variable is a submodel element that is used as input or output variable of an operation."@en ;
    rdfs:label "Operation Variable"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/OperationVariable/value
### https://admin-shell.io/aas/3/0/RC01/Permission

aas:Permission rdf:type owl:Class ;
  rdfs:comment "Description of a single permission."@en ;
  rdfs:label "Permission"^^xsd:string ;
  rdfs:domain aas:Operation ;
  rdfs:range aas:SubmodelElement ;
.

### https://admin-shell.io/aas/3/0/RC01/Permission/hasKindOfPermission

aas:KindOfPermission rdf:type owl:ObjectProperty ;
  rdfs:comment "Description of the kind of permission. Possible kind of permission also include the denial of the permission."@en ;
  rdfs:label "has kind of permission"^^xsd:string ;
  rdfs:domain aas:Permission ;
  rdfs:range aas:PermissionKind ;
.

### https://admin-shell.io/aas/3/0/RC01/Permission/permission

aas:Permission rdf:type owl:ObjectProperty ;
  rdfs:comment "Reference to a property that defines the semantics of the permission."@en ;
  skos:note "Constraint AASs-010: The property referenced in Permission/permission shall have the category 'CONSTANT'."@en ;
  skos:note "Constraint AASs-011: The property referenced in Permission/permission shall be part of the submodel that is referenced within the 'selectablePermissions' attribute of 'AccessControl'."@en ;
  rdfs:label "has permission"^^xsd:string ;
  rdfs:domain aas:Permission ;
  rdfs:range aas:Property ;
.

### https://admin-shell.io/aas/3/0/RC01/PermissionKind

aas:PermissionKind rdf:type owl:Class ;
  rdfs:comment "Enumeration of the kind of permissions that is given to the assignment of a permission to a subject."@en ;
  rdfs:label "Permission Kind"^^xsd:string ;
  owl:oneOf ( <https://admin-shell.io/aas/3/0/RC01/PermissionKind/ALLOW> , <https://admin-shell.io/aas/3/0/RC01/PermissionKind/DENY> )
### https://admin-shell.io/aas/3/0/RC01/PermissionKind/ALLOW
<https://admin-shell.io/aas/3/0/RC01/PermissionKind/ALLOW> rdf:type aas:PermissionKind ;
  rdfs:label "allow"^^xsd:string ;
  rdfs:comment "Allow the permission given to the subject."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/PermissionKind/DENY
<https://admin-shell.io/aas/3/0/RC01/PermissionKind/DENY> rdf:type aas:PermissionKind ;
  rdfs:label "deny"^^xsd:string ;
  rdfs:comment "Explicitly deny the permission given to the subject."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/PermissionKind/NOT_APPLICABLE
<https://admin-shell.io/aas/3/0/RC01/PermissionKind/NOT_APPLICABLE> rdf:type aas:PermissionKind ;
  rdfs:label "not applicable"^^xsd:string ;
  rdfs:comment "The permission is not applicable to the subject."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/PermissionKind/UNDEFINED
<https://admin-shell.io/aas/3/0/RC01/PermissionKind/UNDEFINED> rdf:type aas:PermissionKind ;
  rdfs:label "undefined"^^xsd:string ;
  rdfs:comment "It is undefined whether the permission is allowed, not applicable or denied to the subject."@en ;
.

### aas:PermissionsPerObject
aas:PermissionsPerObject rdf:type owl:Class ;
  rdfs:comment "Table that defines access permissions for a specified object. The object is any referable element in the AAS. Additionally object attributes can be defined that further specify the kind of object the permissions apply to."@en ;
  rdfs:label "Permission Per Object"^^xsd:string ;
.

### aas:PermissionsPerObject/object
<https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/object> rdf:type owl:ObjectProperty ;
  rdfs:comment "Element to which permission shall be assigned."@en ;
  rdfs:label "has object"^^xsd:string ;
  rdfs:domain aas:PermissionsPerObject ;
  rdfs:range aas:Referable ;
### https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/permission
<https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/permission> rdf:type owl:ObjectProperty ;
  rdfs:comment "Permissions assigned to the object. The permissions hold for all subjects as specified in the access permission rule."@en ;
  rdfs:label "has object permission"^^xsd:string ;
  rdfs:domain aas:PermissionsPerObject ;
  rdfs:range aas:Permission ;
.

### https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/targetObjectAttributes
<https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/targetObjectAttributes> rdf:type owl:ObjectProperty ;
  rdfs:comment "Target object attributes that need to be fulfilled so that the access permissions apply to the accessing subject."@en ;
  rdfs:label "has target object attributes"^^xsd:string ;
  rdfs:domain aas:PermissionsPerObject ;
  rdfs:range aas:ObjectAttributes ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint
aas:PolicyAdministrationPoint rdf:type owl:Class ;
  rdfs:comment "Definition of a security administration point (PDP)."@en ;
  rdfs:label "Policy Administration Point"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint/localAccessControl
<https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint/localAccessControl> rdf:type owl:ObjectProperty ;
  rdfs:comment "The policy administration point of access control as realized by the AAS itself."@en ;
  skos:note "Constraint AASd-009: Either there is an external policy administration point endpoint defined or the AAS has its own access control."@en ;
  rdfs:label "has local access control"^^xsd:string ;
  rdfs:domain aas:PolicyAdministrationPoint ;
  rdfs:range aas:AccessControl ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint/externalAccessControl
<https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint/externalAccessControl> rdf:type owl:ObjectProperty ;
  rdfs:comment "Endpoint to an external access control defining a policy administration point to be used by the AAS."@en ;
  rdfs:label "has external access control"^^xsd:string ;
  rdfs:domain aas:PolicyAdministrationPoint ;
### https://admin-shell.io/aas/3/0/RC01/PolicyDecisionPoint
aas:PolicyDecisionPoint rdf:type owl:Class ;
  rdfs:comment "Defines a security policy decision point (PDP)." @en ;
  rdfs:label "Policy Decision Point"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyDecisionPoint/externalPolicyDecisionPoints
<https://admin-shell.io/aas/3/0/RC01/PolicyDecisionPoint/externalPolicyDecisionPoints> rdf:type owl:DatatypeProperty ;
  rdfs:comment "If externalPolicyDecisionPoints True then Endpoints to external available decision points taking into consideration for access control for the AAS need to be configured." @en ;
  rdfs:label "is external policy decision point defined"^^xsd:string ;
  rdfs:domain aas:PolicyDecisionPoint ;
  rdfs:range xsd:boolean ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyEnforcementPoints
aas:PolicyEnforcementPoints rdf:type owl:Class ;
  rdfs:comment "Defines the security policy enforcement points (PEP)." @en ;
  rdfs:label "Policy Enforcement Point"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyEnforcementPoints/externalPolicyEnforcementPoint
<https://admin-shell.io/aas/3/0/RC01/PolicyEnforcementPoint/externalPolicyEnforcementPoint> rdf:type owl:DatatypeProperty ;
  rdfs:comment "If externalPolicyEnforcementPoint True then an Endpoint to external available enforcement point taking needs to be configured for the AAS." @en ;
  rdfs:label "is external policy enforcement point defined"^^xsd:string ;
  rdfs:domain aas:PolicyEnforcementPoint ;
  rdfs:range xsd:boolean ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints
aas:PolicyInformationPoints rdf:type owl:Class ;
  rdfs:comment "Defines the security policy information points (PIP). Serves as the retrieval source of attributes, or the data required for policy evaluation to provide the information needed by the policy decision point to make the decisions." @en ;
  rdfs:label "Policy Information Points"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints/externalInformationPoints
<https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints/externalInformationPoints> rdf:type owl:ObjectProperty;
  rdfs:comment "If externalInformationPoints True then at least one Endpoint to external available information needs to be configured for the AAS."@en;
  rdfs:label "has external information point"^^xsd:string;
  rdfs:domain aas:PolicyInformationPoints;
  rdfs:range aas:Endpoint;
.

### https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints/internalInformationPoint

<https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints/internalInformationPoint> rdf:type owl:ObjectProperty;
  rdfs:comment "References to submodels defining information used by security access permission rules."@en;
  rdfs:label "has internal information point"^^xsd:string;
  rdfs:domain aas:PolicyInformationPoints;
  rdfs:range aas:Submodel;
.

### https://admin-shell.io/aas/3/0/RC01/Property

aas:Property rdf:type owl:Class;
  rdfs:subClassOf aas:DataElement;
  rdfs:comment "A property is a data element that has a single value."@en;
  rdfs:label "Property"^^xsd:string;
  skos:note "Constraint AASd-052a: If the semanticId of a Property references a ConceptDescription then the ConceptDescription/category shall be one of following values: VALUE, PROPERTY."@en;
  skos:note "Constraint AASd-065: If the semanticId of a Property or MultiLanguageProperty references a ConceptDescription with the category VALUE then the value of the property is identical to DataSpecificationIEC61360/value and the valueId of the property is identical to DataSpecificationIEC61360/valueId."@en;
  skos:note "Constraint AASd-066: If the semanticId of a Property or MultiLanguageProperty references a ConceptDescription with the category PROPERTY and DataSpecificationIEC61360/valueList is defined the value and valueId of the property is identical to one of the value reference pair types references in the value list, i.e. ValueReferencePairType/value or ValueReferencePairType/valueId, resp."@en;
.

### https://admin-shell.io/aas/3/0/RC01/Property/category

<https://admin-shell.io/aas/3/0/RC01/Property/category> rdf:type owl:ObjectProperty;
  rdfs:label "has property category"^^xsd:string;
  rdfs:comment "The following categories are defined for properties and multi-language properties: CONSTANT, PARAMETER, and VARIABLE."@en;
  rdfs:domain aas:Property;
  rdfs:range aas:Category;
.

### https://admin-shell.io/aas/3/0/RC01/Property/value

<https://admin-shell.io/aas/3/0/RC01/Property/value> rdf:type owl:ObjectProperty;
### https://admin-shell.io/aas/3/0/RC01/Property/valueId

<https://admin-shell.io/aas/3/0/RC01/Property/valueId> rdf:type owl:ObjectProperty ;
  rdfs:comment "Reference to the global unique id of a coded value."@en ;
  rdfs:label "has property value id"^^xsd:string ;
  skos:note "Constraint AASd-007: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId."@en ;
  rdfs:domain aas:Property ;
  rdfs:range aas:Reference ;
.

### https://admin-shell.io/aas/3/0/RC01/Qualifiable

aas:Qualifiable rdf:type owl:Class ;
  dash:abstract true ;
  rdfs:comment "Additional qualification of a qualifiable element."@en ;
  skos:note "Constraint AASd-021: Every qualifiable can only have one qualifier with the same Qualifier/type."@en ;
  rdfs:label "Qualifiable"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/Qualifiable/qualifier

<https://admin-shell.io/aas/3/0/RC01/Qualifiable/qualifier> rdf:type owl:ObjectProperty ;
  rdfs:comment "Additional qualification of a qualifiable element."@en ;
  rdfs:label "has qualifier"^^xsd:string ;
  rdfs:domain aas:Qualifiable ;
  rdfs:range aas:Constraint ;
.

### https://admin-shell.io/aas/3/0/RC01/Qualifier

aas:Qualifier rdf:type owl:Class ;
  rdfs:subClassOf aas:Constraint ;
  rdfs:subClassOf aas:HasSemantics ;
  rdfs:comment "A qualifier is a type-value pair that makes additional statements w.r.t. the value of the element."@en ;
  rdfs:label "Qualifier"^^xsd:string ;
  skos:note "Constraint AASd-063: The semanticId of a Qualifier shall only reference a ConceptDescription with the category QUALIFIER."@en ;
.

rdfs:comment "The value of the property instance."@en ;
rdfs:label "has property value"^^xsd:string ;
rdfs:domain aas:Property ;
rdfs:range rdfs:Literal ;
.
###  https://admin-shell.io/aas/3/0/RC01/Qualifier/type
<https://admin-shell.io/aas/3/0/RC01/Qualifier/type> rdf:type owl:DatatypeProperty ;

rdfs:comment "The qualifier type describes the type of the qualifier that is applied to the element."@en ;

rdfs:label "has qualifier type"^^xsd:string ;

rdfs:domain aas:Qualifier ;

rdfs:range xsd:string ;

sh:pattern ".+" ;
.

###  https://admin-shell.io/aas/3/0/RC01/Qualifier/value
<https://admin-shell.io/aas/3/0/RC01/Qualifier/value> rdf:type owl:ObjectProperty ;

rdfs:comment "The qualifier value is the value of the qualifier."@en ;

rdfs:label "has qualifier value"^^xsd:string ;

skos:note "Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the short name of the referenced coded value in qualifierValueId."@en ;

skos:note "Constraint AASd-020: The value of Qualifier/value shall be consistent to the data type as defined in Qualifier/valueType."@en ;

rdfs:domain aas:Qualifier ;

rdfs:range rdfs:Literal ;
.

###  https://admin-shell.io/aas/3/0/RC01/Qualifier/valueId
<https://admin-shell.io/aas/3/0/RC01/Qualifier/valueId> rdf:type owl:ObjectProperty ;

rdfs:comment "Reference to the global unique id of a coded value."@en ;

rdfs:label "has qualifier value id"^^xsd:string ;

rdfs:domain aas:Qualifier ;

rdfs:range aas:Reference ;
.

###  https://admin-shell.io/aas/3/0/RC01/Range
aas:Range rdf:type owl:Class ;

rdfs:subClassOf aas:DataElement ;

rdfs:comment "An element that is referable by its idShort. This id is not globally unique. This id is unique within the name space of the element."@en ;

rdfs:label "Range"^^xsd:string ;

skos:note "Constraint AASd-053: The semanticId of a Range submodel element shall only reference a ConceptDescription with the category PROPERTY."@en ;

skos:note "Constraint AASd-068: If the semanticId of a Range references a ConceptDescription then DataSpecificationIEC61360/dataType shall be a numerical one, i.e. REAL_* or RATIONAL_*."@en ;

skos:note "Constraint AASd-069: If the semanticId of a Range references a ConceptDescription then DataSpecificationIEC61360/levelType shall be identical to the set {Min,Max}."@en ;
.
.
###  https://admin-shell.io/aas/3/0/RC01/Range/max
<https://admin-shell.io/aas/3/0/RC01/Range/max> rdf:type owl:ObjectProperty ;
   rdfs:domain aas:Range ;
   rdfs:range rdfs:Literal ;
   rdfs:label "has maximum value"^^xsd:string ;
   rdfs:comment "The maximum value of the range."@en  .

###  https://admin-shell.io/aas/3/0/RC01/Range/min
<https://admin-shell.io/aas/3/0/RC01/Range/min> rdf:type owl:ObjectProperty ;
   rdfs:domain aas:Range ;
   rdfs:range rdfs:Literal ;
   rdfs:label "has minimum value"^^xsd:string ;
   rdfs:comment "The minimum value of the range."@en  .

###  https://admin-shell.io/aas/3/0/RC01/HasExtensions
aas:HasExtensions rdf:type owl:Class ;
   dash:abstract true ;
   rdfs:comment "Element that can be extended by proprietary extensions."@en ;
   rdfs:label "HasExtensions"^^xsd:string ;

###  https://admin-shell.io/aas/3/0/RC01/HasExtensions/extension
<https://admin-shell.io/aas/3/0/RC01/HasExtensions/extension> rdf:type owl:ObjectProperty ;
   rdfs:label "has extension"^^xsd:string ;
   rdfs:comment "An extension of the element."@en ;
   rdfs:domain aas:HasExtensions;
   rdfs:range aas:Extension; 

###  https://admin-shell.io/aas/3/0/RC01/Extension
aas:Extension rdf:type owl:Class ;
   rdfs:subClassOf aas:HasSemantics ;
   rdfs:comment "Single extension of an element."@en ;
   rdfs:label "Extensions"^^xsd:string ;
   skos:note "Constraint AASd-077: The name of an extension within HasExtensions needs to be unique."@en ;
###  https://admin-shell.io/aas/3/0/RC01/Extension/name

<https://admin-shell.io/aas/3/0/RC01/Extension/name> rdf:type owl:DatatypeProperty ;
  rdfs:label "has extension name"^^xsd:string ;
  rdfs:comment "An extension of the element."@en ;
  rdfs:domain aas:Extension ;
  rdfs:range xsd:string ;
  sh:pattern "+" ;
.

###  https://admin-shell.io/aas/3/0/RC01/Extension/valueType

<https://admin-shell.io/aas/3/0/RC01/Extension/valueType> rdf:type owl:DatatypeProperty ;
  rdfs:label "has extension value type"^^xsd:string ;
  rdfs:comment "Type of the value of the extension."@en ;
  rdfs:domain aas:Extension ;
  rdfs:range xsd:string ;
  sh:pattern "+" ;
.

###  https://admin-shell.io/aas/3/0/RC01/Extension/value

<https://admin-shell.io/aas/3/0/RC01/Extension/value> rdf:type owl:ObjectProperty ;
  rdfs:label "has extension value"^^xsd:string ;
  rdfs:comment "Value of the extension."@en ;
  rdfs:domain aas:Extension ;
  rdfs:range aas:ValueDataType ;
.

###  https://admin-shell.io/aas/3/0/RC01/Extension/refersTo

<https://admin-shell.io/aas/3/0/RC01/Extension/refersTo> rdf:type owl:ObjectProperty ;
  rdfs:label "has extension reference to"^^xsd:string ;
  rdfs:comment "Reference to an element the extension refers to."@en ;
  rdfs:domain aas:Extension ;
  rdfs:range aas:Reference ;
.

###  https://admin-shell.io/aas/3/0/RC01/Referable

aas:Referable rdf:type owl:Class ;
  dash:abstract true ;
  rdfs:comment "An element that is referable by its idShort. This id is not globally unique. This id is unique within the name space of the element."@en ;
  rdfs:label "Referable"^^xsd:string ;
.

ANNEX | 341
### https://admin-shell.io/aas/3/0/RC01/Referable/category

<nhttps://admin-shell.io/aas/3/0/RC01/Referable/category> rdf:type owl:DatatypeProperty ;
    rdfs:label "has category"^^xsd:string ;
    rdfs:comment "The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints."@en ;
    rdfs:domain aas:Referable ;
    rdfs:range xsd:string ;
    sh:pattern ".+" ;
.

### https://admin-shell.io/aas/3/0/RC01/Referable/description

<nhttps://admin-shell.io/aas/3/0/RC01/Referable/description> rdf:type owl:DatatypeProperty ;
    rdfs:subPropertyOf rdfs:comment ;
    rdfs:label "has description"^^xsd:string ;
    rdfs:domain aas:Referable ;
    rdfs:range rdf:langString ;
    rdfs:comment "Description or comments on the element. The description can be provided in several languages."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/Referable/displayName

<nhttps://admin-shell.io/aas/3/0/RC01/Referable/displayName> rdf:type owl:DatatypeProperty ;
    rdfs:subPropertyOf rdfs:comment ;
    rdfs:label "has display name"^^xsd:string ;
    rdfs:domain aas:Referable ;
    rdfs:range rdf:langString ;
    rdfs:comment "Display name. Can be provided in several languages."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/Referable/idShort

<nhttps://admin-shell.io/aas/3/0/RC01/Referable/idShort> rdf:type owl:DatatypeProperty ;
    rdfs:subPropertyOf dcterms:identifier ;
    rdfs:label "has short id"^^xsd:string ;
    rdfs:comment "Identifying string of the element within its name space."@en ;
    skos:note "Constraint AASd-002: idShort shall only feature letters, digits, underscore ('_'); starting with a small letter. I.e. [a-z][a-zA-Z0-9_]*."@en ;
    skos:note "Constraint AASd-003: idShort shall be matched case-insensitive."@en ;
    skos:note "Constraint AASd-022: idShort of non-identifiable referables shall be unique in its namespace."@en ;
    skos:note "Note: In case the element is a property and the property has a semantic definition (HasSemantics) the idShort is typically identical to the short name in English. "@en ;
Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the 'BrowserPath' in OPC UA.

- skos:note "Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the 'BrowserPath' in OPC UA."@en ;
  - rdfs:domain aas:Referable ;
  - rdfs:range xsd:string ;
  - sh:pattern ".+" ;

### https://admin-shell.io/aas/3/0/RC01/Referable/parent

- <https://admin-shell.io/aas/3/0/RC01/Referable/parent> rdf:type owl:ObjectProperty ;
  - rdfs:comment "Reference to the next referable parent element of the element."@en ;
  - skos:note "Constraint AASd-004: Add parent in case of non-identifiable elements."@en ;
  - skos:note "This element is used to ease navigation in the model and thus it enables more performant"@en ;
  - rdfs:label "has parent"^^xsd:string ;
  - rdfs:domain aas:Referable ;
  - rdfs:range aas:Referable ;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements

- aas:ReferableElements rdf:type owl:Class ;
  - rdfs:subClassOf aas:KeyElements ;
  - rdfs:label "Referable Elements"^^xsd:string ;
  - rdfs:comment "Enumeration of all referable elements within an asset administration shell. Contains IdentifiableElements"@en ;
  - owl:oneOf (}
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/ACCESS_PERMISSION_RULE>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/ANNOTATED_RELATIONSHIP_ELEMENT>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/BASIC_EVENT>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/BLOB>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/CAPABILITY>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/CONCEPT_DICTIONARY>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/GLOBAL_REFERENCE_KEY_ELEMENT>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/DATA_ELEMENT>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/FILE>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/ENTITY>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/EVENT>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/MULTI_LANGUAGE_PROPERTY>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/OPERATION>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/PROPERTY>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/RANGE>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/REFERENCE_ELEMENT>
    - <https://admin-shell.io/aas/3/0/RC01/ReferableElements/RELATIONSHIP_ELEMENT>
<https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT>

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT_COLLECTION>

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/VIEW>

<https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET>

<https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET_ADMINISTRATION_SHELL>

<https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/CONCEPT_DESCRIPTION>

<https://admin-shell.io/aas/3/0/RC01/IdentifiableElements/SUBMODEL>

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/ACCESS_PERMISSION_RULE


rdfs:label "Access Permission Rule"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/ANNOTATED_RELATIONSHIP_ELEMENT

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/ANNOTATED_RELATIONSHIP_ELEMENT> rdf:type aas:ReferableElements ;

rdfs:label "Annotated relationship element"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/BASIC_EVENT


rdfs:label "Basic Event"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/BLOB


rdfs:label "Blob"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/CAPABILITY


rdfs:label "Capability"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/CONCEPT_DICTIONARY


rdfs:label "Concept Dictionary"^^xsd:string ;
### https://admin-shell.io/aas/3/0/RC01/ReferableElements/DATA_ELEMENT

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/DATA_ELEMENT> rdf:type aas:ReferableElements ;
   rdfs:label "Data Element"^^xsd:string ;
   skos:note "Data Element is abstract, i.e. if a key uses 'DataElement' the reference may be a Property, a File etc."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/ENTITY

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/ENTITY> rdf:type aas:ReferableElements ;
   rdfs:label "Entity"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/EVENT

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/EVENT> rdf:type aas:ReferableElements ;
   rdfs:label "Event"^^xsd:string ;
   skos:note "Event is abstract"@en ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/MULTI_LANGUAGE_PROPERTY

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/MULTI_LANGUAGE_PROPERTY> rdf:type aas:ReferableElements ;
   rdfs:label "Multi-language Property"^^xsd:string ;
   rdfs:comment "Property with a value that can be provided in multiple languages."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/OPERATION

   rdfs:label "Operation"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/PROPERTY

   rdfs:label "Property"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/RANGE

   rdfs:label "Range"^^xsd:string ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/REFERENCE_ELEMENT

   rdfs:label "Reference Element"^^xsd:string ;
### https://admin-shell.io/aas/3/0/RC01/ReferableElements/RELATIONSHIPT_ELEMENT

    rdfs:label "Relationship Element"^^xsd:string;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT

<https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT> rdf:type aas:ReferableElements;
    rdfs:label "Submodel Element"^^xsd:string;
    skos:note "Submodel Element is abstract, i.e. if a key uses “SubmodelElement” the reference may be a Property, a SubmodelElementCollection, an Operation etc."@en;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/SUBMODEL_ELEMENT_COLLECTION

    rdfs:label "Submodel Element Collection"^^xsd:string;
    rdfs:comment "Collection of Submodel Elements"@en;

### https://admin-shell.io/aas/3/0/RC01/ReferableElements/VIEW

    rdfs:label "View"^^xsd:string;

### https://admin-shell.io/aas/3/0/RC01/Reference

aas:Reference rdf:type owl:Class;
    rdfs:comment "Reference to either a model element of the same or another AAs or to an external entity. A reference is an ordered list of keys, each key referencing an element. The complete list of keys may for example be concatenated to a path that then gives unique access to an element or entity."@en;
    rdfs:label "Reference"^^xsd:string;

### https://admin-shell.io/aas/3/0/RC01/Reference/key

<https://admin-shell.io/aas/3/0/RC01/Reference/key> rdf:type owl:ObjectProperty;
    rdfs:comment "Unique reference in its name space."@en;
    rdfs:label "has key"^^xsd:string;
    rdfs:domain aas:Reference;
    rdfs:range aas:Key;

### https://admin-shell.io/aas/3/0/RC01/ReferenceElement
aas:ReferenceElement rdf:type owl:Class ;
   rdfs:subClassOf aas:DataElement ;
   rdfs:comment "A reference element is a data element that defines a logical reference to another element within the same or another AAS or a reference to an external object or entity."@en ;
   rdfs:label "Reference Element"^^xsd:string ;
   skos:note "Constraint AASd-054: The semanticId of a ReferenceElement shall only reference a ConceptDescription with the category REFERENCE."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/ReferenceElement/value
<https://admin-shell.io/aas/3/0/RC01/ReferenceElement/value> rdf:type owl:ObjectProperty ;
   rdfs:comment "Reference to any other referable element of the same or any other AAS or a reference to an external object or entity."@en ;
   rdfs:label "has reference value"^^xsd:string ;
   rdfs:domain aas:ReferenceElement ;
   rdfs:range aas:Reference ;
.

### https://admin-shell.io/aas/3/0/RC01/RelationshipElement
aas:RelationshipElement rdf:type owl:Class ;
   rdfs:subClassOf aas:SubmodelElement ;
   dc:description "A relationship element is used to define a relationship between two referable elements."@en ;
   rdfs:label "Relationship Element"^^xsd:string ;
   skos:note "Constraint AASd-055: The semanticId of a RelationshipElement or a AnnotatedRelationshipElement shall only reference a ConceptDescription with the category RELATIONSHIP."@en ;
.

### https://admin-shell.io/aas/3/0/RC01/RelationshipElement/first
<https://admin-shell.io/aas/3/0/RC01/RelationshipElement/first> rdf:type owl:ObjectProperty ;
   rdfs:comment "First element in the relationship taking the role of the subject."@en ;
   rdfs:label "has first relationship"^^xsd:string ;
   rdfs:domain aas:RelationshipElement ;
   rdfs:range aas:Referable ;
.

### https://admin-shell.io/aas/3/0/RC01/RelationshipElement/second
<https://admin-shell.io/aas/3/0/RC01/RelationshipElement/second> rdf:type owl:ObjectProperty ;
   rdfs:comment "Second element in the relationship taking the role of the object."@en ;
   rdfs:label "has second relationship"^^xsd:string ;
   rdfs:domain aas:RelationshipElement ;
   rdfs:range aas:Referable ;
.
DETAILS OF THE ADMINISTRATION SHELL - PART 1

###  https://admin-shell.io/aas/3/0/RC01/Security

aas:Security rdf:type owl:Class ;
   rdfs:comment "Container for security relevant information of the AAS." @en ;
   rdfs:label "Security"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/Security/accessControlPolicyPoints

<https://admin-shell.io/aas/3/0/RC01/Security/accessControlPolicyPoints> rdf:type owl:ObjectProperty ;
   rdfs:comment "Access control policy points of the AAS." @en ;
   rdfs:label "has access control policy points"^^xsd:string ;
   rdfs:domain aas:Security ;
   rdfs:range aas:PolicyAdministrationPoint ;
.

###  https://admin-shell.io/aas/3/0/RC01/Security/certificate

<https://admin-shell.io/aas/3/0/RC01/Security/certificate> rdf:type owl:ObjectProperty ;
   rdfs:comment "Certificates of the AAS." @en ;
   rdfs:label "has certificate"^^xsd:string ;
   rdfs:domain aas:Security ;
   rdfs:range aas:Certificate ;
.

###  https://admin-shell.io/aas/3/0/RC01/Security/requiredCertificateExtension

   rdfs:comment "Certificate extensions as required by the AAS." @en ;
   rdfs:label "has required certificate extension"^^xsd:string ;
   rdfs:domain aas:Security ;
   rdfs:range aas:Reference ;
.

###  https://admin-shell.io/aas/3/0/RC01/SubjectAttributes

aas:SubjectAttributes rdf:type owl:Class ;
   rdfs:comment "A set of data elements that further classifies a specific subject." @en ;
   rdfs:label "Subject Attributes"^^xsd:string ;
.

###  https://admin-shell.io/aas/3/0/RC01/SubjectAttributes/subjectAttribute

<https://admin-shell.io/aas/3/0/RC01/SubjectAttributes/subjectAttribute> rdf:type owl:ObjectProperty ;
   rdfs:comment "A data element that further classifies a specific subject." @en ;
skos:note "Constraint AASs-015: The data element SubjectAttributes/subjectAttribute shall be part of the submodel that is referenced within the 'selectableSubjectAttributes' attribute of 'AccessControl'." @en ;

rdfs:label "has subject attribute"^^xsd:string ;

rdfs:domain aas:SubjectAttributes ;

rdfs:range aas:DataElement ;

### https://admin-shell.io/aas/3/0/RC01/Submodel

aas:Submodel rdf:type owl:Class ;

rdfs:subClassOf aas:HasDataSpecification ;

rdfs:subClassOf aas:HasKind ;

rdfs:subClassOf aas:HasSemantics ;

rdfs:subClassOf aas:Identifiable ;

rdfs:subClassOf aas:Qualifiable ;

rdfs:comment "A Submodel defines a specific aspect of the asset represented by the AAS. A submodel is used to structure the virtual representation and technical functionality of an Administration Shell into distinguishable parts. Each submodel refers to a well-defined domain or subject matter. Submodels can become standardized and thus become submodels types. Submodels can have different life-cycles." @en ,

"Describe the different types of Data related to the I4.0 Asset" @en ;

rdfs:label "Submodel"^^xsd:string ;

skos:note "Constraint AASd-062: The semanticId of a Submodel shall only reference a ConceptDescription with the category APPLICATION_CLASS." @en ;

### https://admin-shell.io/aas/3/0/RC01/Submodel/submodelElement

<https://admin-shell.io/aas/3/0/RC01/Submodel/submodelElement> rdf:type owl:ObjectProperty ;

rdfs:domain aas:Submodel ;

rdfs:range aas:SubmodelElement ;

rdfs:comment "A submodel consists of zero or more submodel elements." @en ;

rdfs:label "has Submodel Element"^^xsd:string ;

### https://admin-shell.io/aas/3/0/RC01/SubmodelElement

aas:SubmodelElement rdf:type owl:Class ;

rdfs:subClassOf aas:HasDataSpecification ;

rdfs:subClassOf aas:HasKind ;

rdfs:subClassOf aas:HasSemantics ;

rdfs:subClassOf aas:Qualifiable ;

rdfs:subClassOf aas:Referable ;

dash:abstract true ;

rdfs:comment "A submodel element is an element suitable for the description and differentiation of assets." @en ;

rdfs:label "Submodel Element"^^xsd:string ;
The concept of type and instance applies to submodel elements. Properties are special submodel elements. The property types are defined in dictionaries (like the IEC Common Data Dictionary or eCl@ss), they do not have a value. The property type (kind=Type) is also called data element type in some standards. The property instances (kind=Instance) typically have a value. A property instance is also called property-value pair in certain standards.

###  https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection

aas:SubmodelElementCollection rdf:type owl:Class ;
   rdfs:subClassOf aas:SubmodelElement ;
   rdfs:comment "A submodel element collection is a set or list of submodel elements."@en ;
   rdfs:label "Submodel Element Collection"^^xsd:string ;
   skos:note "Constraint AASd-059: If the semanticId of a SubmodelElementCollection references a ConceptDescription then the category of the ConceptDescription shall be COLLECTION or ENTITY."@en ;
   skos:note "Constraint AASd-092: If the semanticId of a SubmodelElementCollection/allowDuplicates == false references a ConceptDescription then the ConceptDescription/category shall be ENTITY."@en ;
   skos:note "Constraint AASd-093: If the semanticId of a SubmodelElementCollection/allowDuplicates == true references a ConceptDescription then the ConceptDescription/category shall be COLLECTION."@en ;

###  https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/allowDuplicates

<https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/allowDuplicates> rdf:type owl:DatatypeProperty ;
   rdfs:comment "If allowDuplicates=true then it is allowed that the collection contains the same element several times. Default = false"@en ;
   rdfs:label "allow duplicates"^^xsd:string ;
   rdfs:domain aas:SubmodelElementCollection ;
   rdfs:range xsd:boolean ;
   skos:note "Constraint AASd-026: If allowDuplicates==false then it is not allowed that the collection contains several elements with the same semantics (i.e. the same semanticId)."@en ;

###  https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/ordered

<https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/ordered> rdf:type owl:DatatypeProperty ;
   rdfs:comment "If ordered=false then the elements in the property collection are not ordered. If ordered=true then the elements in the collection are ordered. Default = false"@en ;
   rdfs:label "ordered"^^xsd:string ;
   rdfs:domain aas:SubmodelElementCollection ;
   rdfs:range xsd:boolean ;

###  https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/value

<https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/value> rdf:type owl:ObjectProperty ;
   rdfs:comment "Submodel element contained in the collection."@en ;
### https://admin-shell.io/aas/3/0/RC01/View

aas:View rdf:type owl:Class;

rdfs:subClassOf aas:HasDataSpecification, aas:Referable, aas:HasSemantics;
rdfs:comment "A view is a collection of referable elements w.r.t. to a specific viewpoint of one or more stakeholders."@en;

rdfs:label "View"^^xsd:string;

skos:note "Constraint AASd-064: If the semanticId of a View references a ConceptDescription then the category of the ConceptDescription shall be VIEW."@en;

### https://admin-shell.io/aas/3/0/RC01/View/containedElement

<https://admin-shell.io/aas/3/0/RC01/View/containedElement> rdf:type owl:ObjectProperty;

rdfs:comment "Referable elements that are contained in the view."@en;

rdfs:label "contains element"^^xsd:string;

rdfs:domain aas:View;

rdfs:range aas:Referable;

### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/DataTypeIEC61360

iec61360:DataTypeIEC61360 rdf:type owl:Class;

rdfs:label "Data Type IEC61360"^^xsd:string;

rdfs:comment "Enumeration of all IEC 61360 defined data types."@en;

owl:oneOf (  
iec61360:DATE
.iec61360:STRING
.iec61360:STRING_TRANSLATABLE
.iec61360:INTEGER_MEASURE
.iec61360:INTEGER_COUNT
.iec61360:INTEGER_CURRENCY
.iec61360:REAL_MEASURE
.iec61360:REAL_COUNT
.iec61360:REAL_CURRENCY
.iec61360:BOOLEAN
.iec61360:URL
.iec61360:RATIONAL
)
iec61360:RATIONAL_MEASURE
iec61360:TIME
iec61360:TIMESTAMP
)
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/DATE
iec61360:DATE rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "date according to IEC61360"^^xsd:string ;
  rdfs:seeAlso xsd:date ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/BOOLEAN
iec61360:BOOLEAN rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "boolean according to IEC61360"^^xsd:string ;
  rdfs:seeAlso xsd:boolean ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/INTEGER_CURRENCY
iec61360:INTEGER_CURRENCY rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "integer currency according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/INTEGER_COUNT
iec61360:INTEGER_COUNT rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "integer count according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/INTEGER_MEASURE
iec61360:INTEGER_MEASURE rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "integer measure according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/REAL_COUNT
iec61360:REAL_COUNT rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "real count according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/REAL_MEASURE
iec61360:REAL_MEASURE rdf:type iec61360:DataTypeIEC61360 ;
  rdfs:label "real measure according to IEC61360"^^xsd:string ;
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/STRING

`iec61360:STRING` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "string according to IEC61360"^^xsd:string ;
  rdfs:seeAlso xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/STRING_TRANSLATABLE

`iec61360:STRING_TRANSLATABLE` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "translatable string according to IEC61360"^^xsd:string ;
  rdfs:seeAlso rdf:langString ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/RATIONAL_MEASURE

`iec61360:RATIONAL_MEASURE` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "retional measure according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/RATIONAL

`iec61360:RATIONAL` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "retional according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/TIME

`iec61360:TIME` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "time accordin according to IEC61360"^^xsd:string ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/TIMESTAMP

`iec61360:TIMESTAMP` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "time stamp according to IEC61360"^^xsd:string ;
  rdfs:seeAlso xsd:dateTime ;
.
### https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/URL

`iec61360:URL` rdf:type `iec61360:DataTypeIEC61360` ;
  rdfs:label "url according to IEC61360"^^xsd:string ;
.
ii. **RDF SCHEMA FOR THE ASSET ADMINISTRATION SHELL**

```html
@prefix aas: <https://admin-shell.io/aas/3/0/RC01/> .
@prefix iec61360: <https://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/3/0/RC01/> .
@prefix phys_unit: <https://admin-shell.io/DataSpecificationTemplates/DataSpecificationPhysicalUnit/3/0/RC01/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .
@prefix sh: <http://www.w3.org/ns/shacl#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

# Metadata

```html
<https://admin-shell.io/aas/3/0/RC01/> a owl:Ontology ;
owl:imports <http://datashapes.org/dash> ;
owl:imports sh: ;
sh:declare [
  a sh:PrefixDeclaration ;
  sh:namespace "https://admin-shell.io/aas/3/0/RC01/"^^xsd:anyURI ;
  sh:prefix "aas"^^xsd:string ;
] ; .
```

aas:AccessControlShape a sh:NodeShape ;
sh:targetClass aas:AccessControl ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControl/accessPermissionRule> ;
  sh:class aas:AccessPermissionRule ;
  sh:minCount 0 ;
  sh:message "A <i>accessPermissionRule</i> must point to a <i>AccessPermissionRule</i>.">^xsd:string ;
  sh:name "AccessControl.accessPermissionRule"^^xsd:string ;
] ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControl/selectableSubjectAttributes> ;
  sh:class aas:Submodel ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one <i>selectableSubjectAttributes</i> pointing to a <i>Submodel</i> is allowed."^xsd:string ;
```
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3.0/RC01/AccessControl/defaultSubjectAttributes> ;
  sh:class aas:Submodel ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one <i>defaultSubjectAttributes</i> pointing to a <i>Submodel</i> is required."^^xsd:string ;
  sh:name "AccessControl.defaultSubjectAttributes"^^xsd:string ;
}

sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3.0/RC01/AccessControl/selectablePermissions> ;
  sh:class aas:Submodel ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one <i>selectablePermissions</i> pointing to a <i>Submodel</i> is allowed."^^xsd:string ;
  sh:name "AccessControl.selectablePermissions"^^xsd:string ;
}

sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3.0/RC01/AccessControl/defaultPermissions> ;
  sh:class aas:Submodel ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one <i>defaultPermissions</i> pointing to a <i>Submodel</i> is required."^^xsd:string ;
  sh:name "AccessControl.defaultPermissions"^^xsd:string ;
}

sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3.0/RC01/AccessControl/selectableEnvironmentAttributes> ;
  sh:class aas:Submodel ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one <i>selectableEnvironmentAttributes</i> pointing to a <i>Submodel</i> is allowed."^^xsd:string ;
  sh:name "AccessControl.selectableEnvironmentAttributes"^^xsd:string ;
}
```
sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControl/defaultEnvironmentAttributes> ;
sh:class aas:Submodel ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:message "Only one <i>defaultEnvironmentAttributes</i> pointing to a <i>Submodel</i> is allowed."^^xsd:string ;
sh:name "AccessControl.defaultEnvironmentAttributes"^^xsd:string ;
]

aas:AccessControlPolicyPointsShape a sh:NodeShape ;
sh:targetClass aas:AccessControlPolicyPoints ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyAdministrationPoint> ;
  sh:class aas:PolicyAdministrationPoint ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one <i>policyAdministrationPoint</i> pointing to a <i>PolicyAdministrationPoint</i> is required."^^xsd:string ;
  sh:name "AccessControlPolicyPoints.policyAdministrationPoint"^^xsd:string ;
]

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyDecisionPoint> ;
  sh:class aas:PolicyDecisionPoint ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one <i>policyDecisionPoint</i> pointing to a <i>PolicyDecisionPoint</i> is required."^^xsd:string ;
  sh:name "AccessControlPolicyPoints.policyDecisionPoint"^^xsd:string ;
]

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyEnforcementPoint> ;
  sh:class aas:PolicyEnforcementPoint ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one <i>policyEnforcementPoint</i> pointing to a <i>PolicyEnforcementPoint</i> is required."^^xsd:string ;
  sh:name "AccessControlPolicyPoints.policyEnforcementPoint"^^xsd:string ;
]
```

a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AccessControlPolicyPoints/policyInformationPoints> ;
  sh:class aas:PolicyInformationPoints ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one <i>policyInformationPoints</i> pointing to a <i>PolicyInformationPoints</i> is allowed."^^xsd:string ;
  sh:name "AccessControlPolicyPoints.policyInformationPoints"^^xsd:string ;
 ] ;
 .

aas:AccessPermissionRuleShape a sh:NodeShape ;
  sh:targetClass aas:AccessPermissionRule ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/AccessPermissionRule/permissionsPerObject> ;
    sh:class aas:PermissionsPerObject ;
    sh:minCount 0 ;
    sh:message "A <i>permissionsPerObject</i> must point to a <i>PermissionsPerObject</i>."^^xsd:string ;
    sh:name "AccessPermissionRule.permissionsPerObject"^^xsd:string ;
  ] ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/AccessPermissionRule/targetSubjectAttributes> ;
    sh:class aas:SubjectAttributes ;
    sh:minCount 1 ;
    sh:maxCount 1 ;
    sh:message "Exactly one <i>targetSubjectAttributes</i> pointing to a <i>SubjectAttributes</i> is required."^^xsd:string ;
    sh:name "AccessPermissionRule.targetSubjectAttributes"^^xsd:string ;
  ] ;
 .

aas:AdministrativeInformationShape a sh:NodeShape ;
  sh:targetClass aas:AdministrativeInformation ;
  rdfs:subClassOf aas:HasDataSpecificationShape ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation/revision> ;
    sh:datatype xsd:string ;
    sh:maxCount 1 ;
sh:minCount 0 ;
sh:message "<b>AdministrativeInformationShape</b>: Only one value for <i>revision</i> is allowed."^^xsd:string ;
sh:name "revision"^^xsd:string ;
sh:nodeKind sh:Literal ;
]

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AdministrativeInformation/version> ;
  sh:datatype xsd:string ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one value for <i>version</i> is allowed."^^xsd:string ;
  sh:name "version"^^xsd:string ;
  sh:nodeKind sh:Literal ;
] ;
.

aas:AnnotatedRelationshipElementShape a sh:NodeShape ;
sh:targetClass aas:AnnotatedRelationshipElement ;
rdfs:subClassOf aas:RelationshipElementShape ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AnnotatedRelationshipElement/annotation> ;
  sh:class aas:DataElement ;
  sh:minCount 0 ;
  sh:message "An <i>annotation</i> must point to a DataElement."^^xsd:string ;
  sh:name "annotation"^^xsd:string ;
] ;
.

aas:AssetShape a sh:NodeShape ;
sh:targetClass aas:Asset ;
rdfs:subClassOf aas:HasDataSpecificationShape ;
rdfs:subClassOf aas:IdentifiableShape ;

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Asset/assetIdentificationModel> ;
  sh:class aas:Reference ;
  sh:maxCount 1 ;
] ;
[469x793]ANNEX
[515x793]| 359

sh:minCount 0 ;
sh:message "Only one <i>assetIdentificationModel</i> is allowed."^^xsd:string ;
sh:name "Asset.assetIdentificationModel"^^xsd:string ;
]
.

aas:AssetInformationShape a sh:NodeShape ;
sh:targetClass aas:AssetInformation ;
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/AssetInformation/assetkind> ;
sh:class aas:AssetKind ;
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>assetkind</i> attribute having an <i>AssetKind</i> entity is required."^^xsd:string ;
sh:name "AssetInformation.assetkind"^^xsd:string ;
]

sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/AssetInformation/globalAssetId> ;
sh:class aas:Reference ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:message "Only one <i>globalAssetId</i> attribute having a <i>reference</i> entity is required."^^xsd:string ;
sh:name "AssetInformation.globalAssetId"^^xsd:string ;
]

sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/AssetInformation/externalAssetId> ;
sh:class aas:IdentifierKeyValuePair ;
sh:minCount 0 ;
sh:message "A <i>externalAssetId</i> must point to an <i>IdentifierKeyValuePair</i>."^^xsd:string ;
sh:name "AssetInformation.externalAssetId"^^xsd:string ;
]

sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/AssetInformation/billOfMaterial> ;
sh:class aas:Reference;
sh:minCount 0;
sh:message "A <i>billOfMaterial</i> must point to a <i>reference</i>."^^xsd:string;
sh:name "AssetInformation.billOfMaterial"^^xsd:string;
]

sh:property [a sh:PropertyShape;
sh:path <https://admin-shell.io/aas/3/0/RC01/AssetInformation/thumbnail>;
sh:class aas:File;
sh:maxCount 1;
sh:minCount 0;
sh:message "Only one <i>thumbnail</i> attribute having a <i>file</i> entity is required."^^xsd:string;
sh:name "AssetInformation.thumbnail"^^xsd:string;
]

aas:IdentifierKeyValuePairShape a sh:NodeShape;
sh:targetClass aas:IdentifierKeyValuePair;
rdfs:subClassOf aas:HasSemantics;

sh:property [a sh:PropertyShape;
sh:path <https://admin-shell.io/aas/3/0/RC01/IdentifierKeyValuePair/key>;
sh:datatype xsd:string;
sh:maxCount 1;
sh:minCount 1;
sh:message "A <i>key</i> has exactly one string."^^xsd:string;
sh:name "IdentifierKeyValuePair.key"^^xsd:string;
]

sh:property [a sh:PropertyShape;
sh:path <https://admin-shell.io/aas/3/0/RC01/IdentifierKeyValuePair/value>;
sh:nodeKind sh:Literal;
sh:maxCount 1;
sh:minCount 1;
sh:message "Exactly one <i>value</i> is allowed."^^xsd:string;
sh:name "IdentifierKeyValuePair.value"^^xsd:string;
]

sh:property [
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3.0/RC01/IdentifierKeyValuePair/externalSubjectId> ;
sh:class aas:Reference ;
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>externalSubjectId</i> attribute having an <i>reference</i> entity is required."^^xsd:string ;
sh:name "IdentifierKeyValuePair.externalSubjectId"^^xsd:string ;
]
.

aas:AssetAdministrationShellShape a sh:NodeShape ;
sh:targetClass aas:AssetAdministrationShell ;
rdfs:subClassOf aas:HasDataSpecificationShape ;
rdfs:subClassOf aas:IdentifiableShape ;
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3.0/RC01/AssetAdministrationShell/assetInformation> ;
sh:class aas:AssetInformation ;
sh:maxCount 1 ;
sh:message "Exactly one <i>assetInformation</i> attribute having an <i>AssetInformation</i> entity is required."^^xsd:string ;
sh:minCount 1 ;
sh:name "assetInformation"^^xsd:string ;
] ;
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3.0/RC01/AssetAdministrationShell/derivedFrom> ;
sh:class aas:Reference ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:message "Only one <i>derivedFrom</i> attribute having an <i>reference</i> entity is allowed."^^xsd:string ;
sh:name "derivedFrom"^^xsd:string ;
] ;
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3.0/RC01/AssetAdministrationShell/security> ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:class aas:Security ;
sh:message "Only one <i>security</i> attribute to a <i>security</i> entity is required."^^xsd:string ;
sh:name "security"^^xsd:string ;
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel> ;
  sh:minCount 0 ;
  sh:class aas:Reference ;
  sh:message "<i>hasSubmodel</i> must have a <i>reference</i> entity pointing to a Submodel."^^xsd:string ;
  sh:name "submodel"^^xsd:string ;
}

sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/view> ;
  sh:minCount 0 ;
  sh:class aas:View ;
  sh:message "<i>view</i> must point to a View"^^xsd:string ;
  sh:name "view"^^xsd:string ;
}

aas:BasicEventShape a sh:NodeShape ;
  rdfs:subClassOf aas:EventShape ;
  sh:targetClass aas:BasicEvent ;
  sh:property {
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/BasicEvent/observed> ;
    sh:minCount 1 ;
    sh:maxCount 1 ;
    sh:class aas:Reference ;
    sh:message "Exactly one <i>observed</i> attribute linking to a <i>Reference</i> is required."^^xsd:string ;
    sh:name "observed"^^xsd:string ;
  }

aas:BlobShape a sh:NodeShape ;
  rdfs:subClassOf aas:DataElementShape ;
  sh:targetClass aas:Blob ;
  sh:property {
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Blob/mimeType> ;
  }
sh:datatype xsd:boolean ;
sh:message "Exactly one <i>lastCertificate</i> pointing to a <i>boolean</i> is required."^^xsd:string ;
sh:name "BlobCertificate.lastCertificate"^^xsd:string ;
] ;
.

aas:CapabilityShape a sh:NodeShape ;
rdfs:subClassOf aas:SubmodelElementShape ;
sh:targetClass aas:Capability ;
.

aas:CertificateShape a sh:NodeShape ;
sh:targetClass aas:Certificate ;
sh:property [  
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Certificate/policyAdministrationPoint> ;
sh:minCount 1 ;
sh:maxCount 1 ;
sh:class aas:PolicyAdministrationPoint ;
sh:message "Exactly one <i>policyAdministrationPoint</i> pointing to a <i>PolicyAdministrationPoint</i> is required."^^xsd:string ;
sh:name "Certificate.policyAdministrationPoint"^^xsd:string ;
] ;
.

aas:ConceptDescriptionShape a sh:NodeShape ;
sh:targetClass aas:ConceptDescription ;
rdfs:subClassOf aas:HasDataSpecificationShape ;
rdfs:subClassOf aas:IdentifiableShape ;
sh:property [  
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/ConceptDescription/content> ;
sh:minCount 0 ;
sh:class aas:DataSpecificationContent ;
sh:message "<i>content</i> must link to a <i>DataSpecificationContent</i> entity."^^xsd:string ;
sh:name "ConceptDescription.content"^^xsd:string ;
] ;
sh:property [  
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/ConceptDescription/isCaseOf> ;
sh:minCount 0 ;
sh:class aas:Reference ;
  sh:message "<i>isCaseOf</i> must have a <i>reference</i> entity."^^xsd:string ;
  sh:name "ConceptDescription.isCaseOf"^^xsd:string ;
]
.

aas:DataElementShape a sh:NodeShape ;
  rdfs:subClassOf aas:SubmodelElementShape ;
  sh:targetClass aas:DataElement ;
.

iec61360:DataSpecificationIEC61360 a sh:NodeShape ;
  sh:targetClass iec61360:DataSpecificationIEC61360 ;
  sh:property [ a sh:PropertyShape ;
    sh:maxCount 1 ;
    sh:message "Exactly one <i>datatype</i> is required."^^xsd:string ;
    sh:minCount 1 ;
    sh:name "datatype"^^xsd:string ;
  ] ;
  sh:property [ a sh:PropertyShape ;
    sh:message "A <i>definition</i> must have a LangString"^^xsd:string ;
    sh:minCount 0 ;
    sh:datatype rdf:langString ;
    sh:name "definition"^^xsd:string ;
  ] ;
  sh:property [ a sh:PropertyShape ;
    sh:message "A <i>levelType</i> must point to a LevelType"^^xsd:string ;
    sh:minCount 0 ;
    sh:class aas:LevelType ;
    sh:name "levelType"^^xsd:string ;
  ] ;
sh:property {
  a sh:PropertyShape ;
  sh:message "Exactly one <i>preferredName</i> is required"^^xsd:string ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:datatype rdf:langString ;
  sh:name "preferredName"^^xsd:string ;
} ;
sh:property {
  a sh:PropertyShape ;
  sh:maxCount 1 ;
  sh:message "A <i>shortName</i> must have a LangString"^^xsd:string ;
  sh:minCount 0 ;
  sh:datatype rdf:langString ;
  sh:name "shortName"^^xsd:string ;
} ;
sh:property {
  a sh:PropertyShape ;
  sh:maxCount 1 ;
  sh:message "A <i>symbol</i> must have a string"^^xsd:string ;
  sh:minCount 0 ;
  sh:datatype xsd:string ;
  sh:name "symbol"^^xsd:string ;
} ;
sh:property {
  a sh:PropertyShape ;
  sh:maxCount 1 ;
  sh:message "A <i>unit</i> must have a String"^^xsd:string ;
  sh:minCount 0 ;
  sh:datatype xsd:string ;
  sh:name "unit"^^xsd:string ;
} ;
sh:property {
  a sh:PropertyShape ;
sh:maxCount 1 ;
sh:message "A &lt;i&gt;sourceOfDefinition&lt;/i&gt; must have a String"^^xsd:string ;
sh:minCount 0 ;
sh:datatype xsd:string ;
sh:name "sourceOfDefinition"^^xsd:string ;
];
sh:property [
  a sh:PropertyShape ;
  sh:maxCount 1 ;
  sh:message "A &lt;i&gt;valueList&lt;/i&gt; must have a ValueList"^^xsd:string ;
  sh:minCount 0 ;
  sh:name "valueList"^^xsd:string ;
];
sh:property [
  a sh:PropertyShape ;
  sh:class aas:Reference ;
  sh:maxCount 1 ;
  sh:message "A &lt;i&gt;valueId&lt;/i&gt; must have a Reference"^^xsd:string ;
  sh:minCount 0 ;
  sh:name "valueId"^^xsd:string ;
];
.
aas:DataSpecificationPhysicalUnitShape a sh:NodeShape ;
sh:targetClass aas:DataSpecificationPhysicalUnit ;
sh:property [
  a sh:PropertyShape ;
  sh:path phys_unit:unitName ;
  sh:class aas:SubmodelElement ;
  sh:minCount 1 ;
  sh:maxCount 1 ;
  sh:message "Exactly one &lt;i&gt;unitName&lt;/i&gt; which links to a &lt;i&gt;string&lt;/i&gt; is required."^^xsd:string ;
  sh:name "DataSpecificationPhysicalUnit.unitName"^^xsd:string ;
];
sh:property [
  a sh:PropertyShape ;
  sh:path phys_unit:unitSymbol ;
sh:datatype xsd:string ;
sh:minCount 1 ;
sh:maxCount 1 ;
sh:message "Exactly one <i>unitSymbol</i> which links to a <i>string</i> is required."^^xsd:string ;
sh:name "DataSpecificationPhysicalUnit.unitSymbol"^^xsd:string ;
]

sh:property [
 a sh:PropertyShape ;
 sh:path phys_unit:definition ;
 sh:class rdf:langString ;
 sh:minCount 1 ;
 sh:maxCount 1 ;
 sh:message "Exactly one <i>unitSymbol</i> which links to a <i>langstring</i> is required."^^xsd:string ;
 sh:name "DataSpecificationPhysicalUnit.definition"^^xsd:string ;
]

sh:property [
 a sh:PropertyShape ;
 sh:path phys_unit:siNotation ;
 sh:datatype xsd:string ;
 sh:minCount 0 ;
 sh:maxCount 1 ;
 sh:message "Only one <i>siNotation</i> which links to a <i>string</i> is allowed."^^xsd:string ;
 sh:name "DataSpecificationPhysicalUnit.siNotation"^^xsd:string ;
]

sh:property [
 a sh:PropertyShape ;
 sh:path phys_unit:siName ;
 sh:datatype xsd:string ;
 sh:minCount 0 ;
 sh:maxCount 1 ;
 sh:message "Only one <i>siName</i> which links to a <i>string</i> is allowed."^^xsd:string ;
 sh:name "DataSpecificationPhysicalUnit.siName"^^xsd:string ;
]

sh:property [
 a sh:PropertyShape ;
 sh:path phys_unit:dinNotation ;
 sh:datatype xsd:string ;
 sh:minCount 0 ;
 sh:maxCount 1 ;
 sh:message "Only one <i>dinNotation</i> which links to a <i>string</i> is allowed."^^xsd:string ;
 sh:name "DataSpecificationPhysicalUnit.dinNotation"^^xsd:string ;
]
sh:name "DataSpecificationPhysicalUnit.dinNotation"^^xsd:string ;
]
sh:property [  
a sh:PropertyShape ;  
sh:path phys_unit:eceName ;  
sh:datatype xsd:string ;  
sh:minCount 0 ;  
sh:maxCount 1 ;  
sh:message "Only one <i>eceName</i> which links to a <i>string</i> is allowed."^^xsd:string ;  
sh:name "DataSpecificationPhysicalUnit.eceName"^^xsd:string ;
] ;
sh:property [  
a sh:PropertyShape ;  
sh:path phys_unit:eceCode ;  
sh:datatype xsd:string ;  
sh:minCount 0 ;  
sh:maxCount 1 ;  
sh:message "Only one <i>eceCode</i> which links to a <i>string</i> is allowed."^^xsd:string ;  
sh:name "DataSpecificationPhysicalUnit.eceCode"^^xsd:string ;
] ;
sh:property [  
a sh:PropertyShape ;  
sh:path phys_unit:nistName ;  
sh:datatype xsd:string ;  
sh:minCount 0 ;  
sh:maxCount 1 ;  
sh:message "Only one <i>nistName</i> which links to a <i>string</i> is allowed."^^xsd:string ;  
sh:name "DataSpecificationPhysicalUnit.nistName"^^xsd:string ;
] ;
sh:property [  
a sh:PropertyShape ;  
sh:path aas:sourceOfDefinition ;  
sh:datatype xsd:string ;  
sh:minCount 0 ;  
sh:maxCount 1 ;  
sh:message "Only one <i>sourceOfDefinition</i> which links to a <i>string</i> is allowed."^^xsd:string ;  
sh:name "DataSpecificationPhysicalUnit.sourceOfDefinition"^^xsd:string ;
] ;
sh:property [  
a sh:PropertyShape ;
sh:path phys_unit:conversionFactor ;
sh:datatype xsd:string ;
sh:minCount 0 ;
sh:maxCount 1 ;
sh:message "Only one <i>conversionFactor</i> which links to a <i>string</i> is allowed."^^xsd:string ;
sh:name "DataSpecificationPhysicalUnit.conversionFactor"^^xsd:string ;
]
sh:property [
  a sh:PropertyShape ;
  sh:path phys_unit:registrationAuthorityId ;
  sh:datatype xsd:string ;
  sh:minCount 0 ;
  sh:maxCount 1 ;
  sh:message "Only one <i>registrationAuthorityId</i> which links to a <i>string</i> is allowed."^^xsd:string ;
  sh:name "DataSpecificationPhysicalUnit.registrationAuthorityId"^^xsd:string ;
]
sh:property [
  a sh:PropertyShape ;
  sh:path phys_unit:supplier ;
  sh:datatype xsd:string ;
  sh:minCount 0 ;
  sh:maxCount 1 ;
  sh:message "Only one <i>supplier</i> which links to a <i>string</i> is allowed."^^xsd:string ;
  sh:name "DataSpecificationPhysicalUnit.supplier"^^xsd:string ;
]
]

aas:EntityShape a sh:NodeShape ;
rdfs:subClassOf aas:SubmodelElementShape ;
sh:targetClass aas:Entity ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Entity/statement> ;
  sh:class aas:SubmodelElement ;
  sh:minCount 0 ;
  sh:message "A <i>statement</i> must link to a <i>SubmodelElement</i>"^^xsd:string ;
  sh:name "statement"^^xsd:string ;
]
sh:property [
  a sh:PropertyShape ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

sh:path <https://admin-shell.io/aas/3/0/RC01/Entity/entityType> ;
    sh:class aas:EntityType ;
    sh:maxCount 1 ;
    sh:minCount 1 ;
    sh:message "Exactly one <i>entityType</i> linking to a <i>EntityType</i> is required."^^xsd:string ;
    sh:name "statement"^^xsd:string ;
]
sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Entity/globalAssetId> ;
    sh:class aas:Reference ;
    sh:maxCount 1 ;
    sh:message "Only one <i>globalAssetId</i> attribute linking to a <i>Reference</i> is allowed."^^xsd:string ;
    sh:minCount 0 ;
    sh:name "Entity.globalAssetId"^^xsd:string ;
]
sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Entity/externalAssetId> ;
    sh:class aas:IdentifierKeyValuePair ;
    sh:maxCount 1 ;
    sh:message "Only one <i>externalAssetId</i> attribute linking to an <i>IdentifierKeyValuePair</i> is allowed."^^xsd:string ;
    sh:minCount 0 ;
    sh:name "Entity.externalAssetId"^^xsd:string ;
]

aas:EventShape a sh:NodeShape ;
rdfs:subClassOf aas:SubmodelElementShape ;
sh:targetClass aas:Event ;
skos:note "As of November 2019, Event is not mandatory. This shape serves as a stump for further definitions."@en ;

aas:EventElementShape a sh:NodeShape ;
rdfs:subClassOf aas:SubmodelElementShape ;
sh:targetClass aas:EventElement ;
skos:note "As of November 2019, EventElement is not mandatory. This shape serves as a stump for further definitions."@en ;
aas:EventMessageShape a sh:NodeShape ;
  rdfs:subClassOf aas:SubmodelElementShape ;
  sh:targetClass aas:EventMessage ;
  skos:note "As of November 2019, EventMessage is not mandatory. This shape serves as a stump for further definitions."@en ;
.

aas:FileShape a sh:NodeShape ;
  rdfs:subClassOf aas:DataElementShape ;
  sh:targetClass aas:File ;
  sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/File/mimeType> ;
    sh:maxCount 1 ;
    sh:minCount 1 ;
    sh:datatype xsd:string ;
    sh:message "Exactly on <i>mimeType</i> is required"^^xsd:string ;
    sh:name "mime type"^^xsd:string ;
  ] ;
  sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/File/value> ;
    sh:datatype xsd:string ;
    sh:minCount 0 ;
    sh:maxCount 1 ;
    sh:message "Only one <i>value</i> is allowed"^^xsd:string ;
    sh:name "value"^^xsd:string ;
  ] ;
.

aas:FormulaShape a sh:NodeShape ;
  sh:targetClass aas:Formula ;
  sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Formula/dependsOn> ;
    sh:class aas:Reference ;
    sh:minCount 0 ;
    sh:message "Only References are allowed for <i>dependsOn</i>"^^xsd:string ;
    sh:name "depends on"^^xsd:string ;
  ] ;
.
aas:HasDataSpecificationShape a sh:NodeShape ;  
  sh:targetClass aas:HasDataSpecification ;  
  sh:property [  
    a sh:PropertyShape ;  
    sh:path <https://admin-shell.io/aas/3/0/RC01/HasDataSpecification/dataSpecification> ;  
    sh:class aas:Reference ;  
    sh:minCount 0 ;  
    sh:message "Only References are allowed for <i>dataSpecification</i>."^^xsd:string ;  
    sh:name "data specification"^^xsd:string ;  
] ;  

aas:HasKindShape a sh:NodeShape ;  
  sh:targetClass aas:HasKind ;  
  sh:property [  
    a sh:PropertyShape ;  
    sh:path <https://admin-shell.io/aas/3/0/RC01/HasKind/kind> ;  
    sh:class aas:ModelingKind ;  
    sh:maxCount 1 ;  
    sh:message "Only one value for <i>kind</i> is allowed."^^xsd:string ;  
    sh:minCount 0 ;  
    sh:name "kind"^^xsd:string ;  
] ;  

aas:HasSemanticsShape a sh:NodeShape ;  
  sh:targetClass aas:HasSemantics ;  
  sh:property [  
    a sh:PropertyShape ;  
    sh:path <https://admin-shell.io/aas/3/0/RC01/HasSemantics/semanticId> ;  
    sh:maxCount 1 ;  
    sh:minCount 0 ;  
    sh:class aas:Reference ;  
    sh:message "Only one value for <i>semanticId</i> is allowed."^^xsd:string ;  
    sh:name "semantic id"^^xsd:string ;  
] ;  

aas:IdentifiableShape a sh:NodeShape ;
sh:targetClass aas:Identifiable ;

rdfs:subClassOf aas:ReferableShape ;

sh:property [  
a sh:PropertyShape ;  
sh:path <https://admin-shell.io/aas/3/0/RC01/Identifiable/administration> ;
sh:class aas:AdministrativeInformation ;
sh:maxCount 1 ;
sh:message "Only one value for <i>administration</i> is allowed."^^xsd:string ;
sh:minCount 0 ;
sh:name "administration"^^xsd:string ;
] ;

sh:property [  
a sh:PropertyShape ;  
sh:path <https://admin-shell.io/aas/3/0/RC01/Identifiable/identification> ;
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>identifier</i> is required."^^xsd:string ;
sh:name "identification"^^xsd:string ;
] ;

aas:IdentifierShape a sh:NodeShape ;

sh:targetClass aas:Identifier ;

sh:property [  
a sh:PropertyShape ;  
sh:path <https://admin-shell.io/aas/3/0/RC01/Identifier/idType> ;
sh:class aas:IdentifierType ;
sh:description "identifier id type"^^xsd:string ;
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>idType</i> is required"^^xsd:string ;
sh:name "id type"^^xsd:string ;
] ;

sh:property [  
a sh:PropertyShape ;  
sh:path <https://admin-shell.io/aas/3/0/RC01/Identifier/id> ;
sh:nodeKind sh:Literal ;
sh:description "identifier id"^^xsd:string ;
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>id</i> is required"^^xsd:string ;
sh:name "id"^^xsd:string ;
]
.

aas:KeyShape a sh:NodeShape ;
sh:targetClass aas:Key ;
sh:property [  
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Key/value> ;  
#sh:datatype xsd:string ;  
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>value</i> is required"^^xsd:string ;
sh:name "key.value"^^xsd:string ;
]
sh:property [  
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Key/idType> ;  
sh:class aas:KeyType ;  
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>idType</i> is required"^^xsd:string ;
sh:name "key.idType"^^xsd:string ;
]
sh:property [  
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Key/type> ;  
sh:class aas:KeyElements ;  
sh:maxCount 1 ;
sh:message "Only 1 <i>keyElement</i> can be stated"^^xsd:string ;
sh:minCount 0 ;
sh:name "key.type"^^xsd:string ;
]
.

aas:MultiLanguagePropertyShape a sh:NodeShape ;
sh:targetClass aas:MultiLanguageProperty ;
rdfs:subClassOf aas:SubmodelElementShape ;
rdfs:subClassOf aas:DataElementShape ;
sh:property [
    a sh:PropertyShape ;
    sh:path aas:value ;
    sh:datatype rdf:langString ;
    sh:minCount 0 ;
    sh:message "A language string <i>value</i> must have a language tag"^^xsd:string ;
    sh:name "MultiLanguageProperty.value"^^xsd:string ;
]
sh:property [
    a sh:PropertyShape ;
    sh:path aas:valueId ;
    sh:maxCount 1 ;
    sh:minCount 0 ;
    sh:class aas:Reference ;
    sh:message "Only one <i>valueId</i> attribute having a <i>Reference</i> is allowed"^^xsd:string ;
    sh:name "Property.valueId"^^xsd:string ;
]

aas:ObjectAttributesShape a sh:NodeShape ;
sh:targetClass aas:ObjectAttributes ;
sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3.0/RC01/ObjectAttributes/objectAttribute> ;
    sh:class aas:DataElement ;
    sh:minCount 1 ;
    sh:message "At least one <i>objectAttribute</i> pointing to a <i>DataElement</i> is required."^^xsd:string ;
    sh:name "ObjectAttributes.objectAttribute"^^xsd:string ;
]

aas:OperationShape a sh:NodeShape ;
rdfs:subClassOf aas:SubmodelElementShape ;
sh:targetClass aas:Operation ;
sh:property [
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3.0/RC01/Operation/inputVariable> ;
    sh:class aas:OperationVariable ;
    sh:minCount 0 ;
    sh:message "Only OperationVariables can be accepted as <i>inputVariable</i>"^^xsd:string ;
sh:name "input variable"^^xsd:string ;
]
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Operation/outputVariable> ;
  sh:class aas:OperationVariable ;
  sh:minCount 0 ;
  sh:message "Only OperationVariables can be accepted as <i>outputVariable</i>"^^xsd:string ;
  sh:name "output variable"^^xsd:string ;
]
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Operation/inoutputVariable> ;
  sh:class aas:OperationVariable ;
  sh:minCount 0 ;
  sh:message "Only OperationVariables can be accepted as <i>inoutputVariable</i>"^^xsd:string ;
  sh:name "inoutput variable"^^xsd:string ;
]
.

aas:OperationVariableShape a sh:NodeShape ;
sh:targetClass aas:OperationVariable ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/OperationVariable/value> ;
  sh:class aas:SubmodelElement ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one OperationVariable <i>value</i> pointing to a <i>SubmodelElement</i> is required."^^xsd:string ;
  sh:name "operation variable value"^^xsd:string ;
]
.

aas:PermissionShape a sh:NodeShape ;
sh:targetClass aas:Permission ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Permission/permission> ;
  sh:class aas:Property ;
  sh:minCount 1 ;
sh:maxCount 1 ;
sh:message "Exactly one Permission permission pointing to a Property is required."^^xsd:string ;
sh:name "Permission.permission"^^xsd:string ;
]

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Permission/kindOfPermission> ;
  sh:class aas:PermissionKind ;
  sh:minCount 1 ;
  sh:maxCount 1 ;
  sh:message "Exactly one kindOfPermission pointing to a PermissionKind is required."^^xsd:string ;
  sh:name "Permission.kindOfPermission"^^xsd:string ;
]

aas:PermissionsPerObjectShape a sh:NodeShape ;
sh:targetClass aas:PermissionsPerObject ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/object> ;
  sh:class aas:Referable ;
  sh:minCount 1 ;
  sh:maxCount 1 ;
  sh:message "Exactly one object pointing to a Referable is required."^^xsd:string ;
  sh:name "PermissionsPerObject.object"^^xsd:string ;
]

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/targetObjectAttributes> ;
  sh:class aas:ObjectAttributes ;
  sh:minCount 0 ;
  sh:maxCount 1 ;
  sh:message "Only one targetObjectAttributes pointing to a ObjectAttributes is allowed."^^xsd:string ;
  sh:name "PermissionsPerObject.targetObjectAttributes"^^xsd:string ;
]

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/permission> ;
  sh:class aas:Permission ;
  sh:minCount 0 ;
  sh:maxCount 1 ;
  sh:message "Only one permission pointing to a Property is required."^^xsd:string ;
  sh:name "Permission.permission"^^xsd:string ;
] ;

sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/PermissionsPerObject/targetObjectAttributes> ;
  sh:class aas:ObjectAttributes ;
  sh:minCount 0 ;
  sh:maxCount 1 ;
  sh:message "Only one targetObjectAttributes pointing to a ObjectAttributes is allowed."^^xsd:string ;
  sh:name "PermissionsPerObject.targetObjectAttributes"^^xsd:string ;
] ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

sh:message "A <i>permission</i> must point to a <i>Permission</i>.

sh:name "PermissionsPerObject.permission"

sh:targetClass aas:PolicyAdministrationPoint

sh:property[
    a sh:PropertyShape;
    sh:path <https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint/localAccessControl>;
    sh:class aas:AccessControl;
    sh:maxCount 1;
    sh:minCount 0;
    sh:message "Only one <i>localAccessControl</i> attribute having a <i>AccessControl</i> is allowed."
    sh:name "PolicyAdministrationPoint.localAccessControl"
];

sh:property[
    a sh:PropertyShape;
    sh:path <https://admin-shell.io/aas/3/0/RC01/PolicyAdministrationPoint/externalAccessControl>;
    sh:datatype xsd:boolean;
    sh:maxCount 1;
    sh:minCount 1;
    sh:message "Exactly one <i>externalAccessControl</i> attribute having a <i>boolean</i> is required."
    sh:name "PolicyAdministrationPoint.externalAccessControl"
];

sh:targetClass aas:PolicyDecisionPoint

sh:property[
    a sh:PropertyShape;
    sh:path <https://admin-shell.io/aas/3/0/RC01/PolicyDecisionPoint/externalPolicyDecisionPoints>;
    sh:datatype xsd:boolean;
    sh:maxCount 1;
    sh:minCount 1;
    sh:message "Exactly one <i>externalPolicyDecisionPoints</i> pointing to a <i>boolean</i> is required."
    sh:name "PolicyDecisionPoint.externalPolicyDecisionPoints"
];
aas:PolicyEnforcementPointShape a sh:NodeShape ;
  sh:targetClass aas:PolicyEnforcementPoint ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/PolicyEnforcementPoints/externalPolicyEnforcementPoint> ;
    sh:datatype xsd:boolean ;
    sh:maxCount 1 ;
    sh:minCount 1 ;
    sh:message "Exactly one <i>externalPolicyDecisionPoint</i> attribute having a <i>boolean</i> is required."
    ^xsd:string ;
    sh:name "PolicyEnforcementPoint.externalPolicyDecisionPoint"^^xsd:string ;
  ] ;

aas:PolicyInformationPointsShape a sh:NodeShape ;
  sh:targetClass aas:PolicyInformationPoints ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints/internalInformationPoint> ;
    sh:class aas:Submodel ;
    sh:minCount 0 ;
    sh:message "A <i>internalInformationPoint</i> attribute must point to a <i>Submodel</i>."^^xsd:string ;
    sh:name "PolicyInformationPoints.internalInformationPoint"^^xsd:string ;
  ] ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/PolicyInformationPoints/externalInformationPoints> ;
    sh:datatype xsd:boolean ;
    sh:maxCount 1 ;
    sh:minCount 1 ;
    sh:message "Exactly one <i>externalInformationPoints</i> attribute having a <i>boolean</i> is required."
    ^xsd:string ;
    sh:name "PolicyInformationPoints.externalInformationPoint"^^xsd:string ;
  ] ;

aas:PropertyShape a sh:NodeShape ;
  sh:targetClass aas:Property ;
  rdfs:subClassOf aas:DataElementShape ;
  sh:property [ a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Property/category> ;
sh:property [  
  a sh:PropertyShape ;  
  sh:path <https://admin-shell.io/aas/3/0/RC01/Property/value> ;  
  sh:nodeKind sh:Literal ;  
  sh:maxCount 1 ;  
  sh:minCount 0 ;  
  sh:message "Only one <i>value</i> is allowed."^^xsd:string ;  
  sh:name "Property.value"^^xsd:string ;  
] ;

sh:property [  
  a sh:PropertyShape ;  
  sh:path <https://admin-shell.io/aas/3/0/RC01/Property/valueId> ;  
  sh:maxCount 1 ;  
  sh:minCount 0 ;  
  sh:class aas:Reference ;  
  sh:message "Only one <i>valueId</i> is allowed"^^xsd:string ;  
  sh:name "Property.valueId"^^xsd:string ;  
] ;

aas:QualifiableShape a sh:NodeShape ;  
sh:targetClass aas:Qualifiable ;  
sh:property [  
  a sh:PropertyShape ;  
  sh:path <https://admin-shell.io/aas/3/0/RC01/Qualifiable/qualifier> ;  
  sh:class aas:Constraint ;  
  sh:name "qualifier"^^xsd:string ;  
] ;

aas:QualifierShape a sh:NodeShape ;  
sh:targetClass aas:Qualifier ;  
rdfs:subClassOf aas:HasSemanticsShape ;  
sh:property [
```turtle
a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Qualifier/type> ;
sh:datatype xsd:string ;
sh:maxCount 1 ;
sh:minCount 1 ;
sh:message "Exactly one <i>type</i> linking to a <i>xsd:string</i> is required."^^xsd:string ;
sh:name "qualifier type"^^xsd:string ;
]
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Qualifier/value> ;
sh:nodeKind sh:Literal ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:message "Only one <i>value</i> is allowed."^^xsd:string ;
sh:name "qualifier value"^^xsd:string ;
]
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Qualifier/valueId> ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:class aas:Reference ;
sh:message "Only one <i>valueId</i> having a <i>Reference</i> entity is allowed."^^xsd:string ;
sh:name "qualifier value id"^^xsd:string ;
]
]

aas:RangeShape a sh:NodeShape ;
sh:targetClass aas:Range ;
rdfs:subClassOf aas:DataElementShape ;
sh:property [ a sh:PropertyShape ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Range/min> ;
sh:nodeKind sh:Literal ;
sh:message "A <i>min</i> attribute must link to a <i>Literal</i>."^^xsd:string ;
sh:name "min"^^xsd:string ;
]
sh:property [ a sh:PropertyShape ;
```
sh:path `https://admin-shell.io/aas/3/0/RC01/Range/max`; 
  sh:nodeKind sh:Literal; 
  sh:message "A `<i>max</i>` attribute must link to a `<i>Literal</i>`."^^xsd:string; 
  sh:name "max"^^xsd:string; 
];
.

aas:HasExtensionsShape a sh:NodeShape; 
sh:targetClass aas:HasExtensions; 
sh:property [
  a sh:PropertyShape; 
  sh:path `https://admin-shell.io/aas/3/0/RC01/HasExtensions/extension`; 
  sh:class sh:Extension; 
  sh:minCount 0; 
  sh:message "A `<i>hasExtensions</i>` attribute must point to a `<i>Extension</i>`."^^xsd:string; 
  sh:name "hasExtensions.Extension"^^xsd:string;
];
.

aas:ExtensionShape a sh:NodeShape; 
sh:targetClass aas:Extension; 
rdfs:subClassOf aas:HasSemantics; 
sh:property [
  a sh:PropertyShape; 
  sh:path `https://admin-shell.io/aas/3/0/RC01/Extensions/name`; 
  sh:datatype xsd:string; 
  sh:maxCount 1; 
  sh:minCount 1; 
  sh:message "Exactly one `<i>name</i>` is required."^^xsd:string; 
  sh:name "Extensions.name"^^xsd:string;
];
sh:property [
  a sh:PropertyShape; 
  sh:path `https://admin-shell.io/aas/3/0/RC01/Extensions/valueType`; 
  sh:datatype xsd:string; 
  sh:maxCount 1; 
  sh:minCount 0; 
  sh:message "Only one value for `<i>valueType</i>` is allowed"^^xsd:string; 
  sh:name "Extensions.valueType"^^xsd:string;
];

sh:property {
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Extensions/value> ;
    sh:class sh:ValueDataType ;
    sh:maxCount 1 ;
    sh:minCount 0 ;
    sh:message "Only one <i>value</i> is allowed"^^xsd:string ;
    sh:name "Extensions.value"^^xsd:string ;
} ;

sh:property {
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Extensions/refersTo> ;
    sh:class sh:Reference ;
    sh:maxCount 1 ;
    sh:minCount 0 ;
    sh:message "Only one value for <i>refersTo</i> is allowed"^^xsd:string ;
    sh:name "Extensions.refersTo"^^xsd:string ;
} ;

aas:ReferableShape a sh:NodeShape ;
sh:targetClass aas:Referable ;

sh:property {
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Referable/category> ;
    sh:datatype xsd:string ;
    sh:maxCount 1 ;
    sh:minCount 0 ;
    sh:message "Only one value for <i>category</i> is allowed"^^xsd:string ;
    sh:name "Referable.category"^^xsd:string ;
} ;

sh:property {
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/Referable:description> ;
    sh:datatype rdf:langString ;
    sh:name "Referable.description"^^xsd:string ;
    sh:minCount 0 ;
} ;

sh:property {
    a sh:PropertyShape ;
} ;
sh:path <https://admin-shell.io/aas/3/0/RC01/Referable/displayName> ;
  sh:datatype rdf:langString ;
  sh:name "Referable.displayName"^^xsd:string ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one value for <i>displayName</i> is allowed"^^xsd:string ;
] ;
sh:property [ 
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Referable/idShort> ;
  sh:datatype xsd:string ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one <i>idShort</i> is required."^^xsd:string ;
  sh:name "Referable.idShort"^^xsd:string ;
  sh:pattern "^[a-zA-Z]\w*$"^^xsd:string ;
] ;
sh:property [ 
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Referable/parent> ;
  sh:class aas:Referable ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one value for <i>parent</i> is allowed"^^xsd:string ;
  sh:name "Referable.parent"^^xsd:string ;
  sh:nodeKind sh:IRI ;
] .

aas:ReferenceShape a sh:NodeShape ;
  sh:targetClass aas:Reference ;
sh:property [ 
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Reference/key> ;
  sh:class aas:Key ;
  sh:minCount 1 ;
  sh:name "key"^^xsd:string ;
] ;
aas:ReferenceElementShape a sh:NodeShape ;
  sh:targetClass aas:ReferenceElement ;
  sh:property [ 
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/ReferenceElement/value> ;
    sh:maxCount 0 ;
    sh:minCount 1 ;
    sh:class aas:Reference ;
    sh:message "Only one value for <i>value</i> is allowed"^^xsd:string ;
    sh:name "ReferenceElement.value"^^xsd:string ;
  ] ;

aas:RelationshipElementShape a sh:NodeShape ;
  rdfs:subClassOf aas:SubmodelElementShape ;
  sh:targetClass aas:RelationshipElement ;
  sh:property [ 
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/RelationshipElement/first> ;
    sh:maxCount 1 ;
    sh:minCount 1 ;
    sh:class aas:Referable ;
    sh:message "Exactly one value for <i>first</i> is required"^^xsd:string ;
    sh:name "first"^^xsd:string ;
  ] ;
  sh:property [ 
    a sh:PropertyShape ;
    sh:path <https://admin-shell.io/aas/3/0/RC01/RelationshipElement/second> ;
    sh:maxCount 1 ;
    sh:minCount 1 ;
    sh:class aas:Referable ;
    sh:message "Exactly one value for <i>second</i> is required"^^xsd:string ;
    sh:name "second"^^xsd:string ;
  ] ;

aas:SecurityShape a sh:NodeShape ;
  sh:targetClass aas:Security ;
  sh:property [ 
    a sh:PropertyShape ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

```sh
sh:path <https://admin-shell.io/aas/3/0/RC01/Security/accessControlPolicyPoints> ;
  sh:class aas:AccessControlPolicyPoints ;
  sh:maxCount 1 ;
  sh:minCount 1 ;
  sh:message "Exactly one value for <i>relationshipSecond</i> is required"^^xsd:string ;
  sh:name "accessControlPolicyPoints"^^xsd:string ;
}
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Security/certificate> ;
  sh:class aas:Certificate ;
  sh:message "A <i>certificate</i> must point to a Certificate"^^xsd:string ;
  sh:minCount 0 ;
  sh:name "certificate"^^xsd:string ;
}
sh:property {
  a sh:PropertyShape ;
  sh:class aas:Reference ;
  sh:message "A <i>requiredCertificateExtension</i> must point to a Reference."^^xsd:string ;
  sh:minCount 0 ;
  sh:name "requiredCertificateExtension"^^xsd:string ;
}

aas:SubjectAttributesShape a sh:NodeShape ;
sh:targetClass aas:SubjectAttributes ;
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/SubjectAttributes/subjectAttribute> ;
  sh:class aas:DataElement ;
  sh:minCount 1 ;
  sh:message "At least one <i>subjectAttribute</i> pointing to a <i>DataElement</i> is required."^^xsd:string ;
  sh:name "SubjectAttributes.subjectAttribute"^^xsd:string ;
}

aas:SubmodelShape a sh:NodeShape ;
sh:targetClass aas:Submodel ;
rdfs:subClassOf aas:HasDataSpecificationShape ;
```
rdfs:subClassOf aas:HasKindShape ;
rdfs:subClassOf aas:HasSemanticsShape ;
rdfs:subClassOf aas:IdentifiableShape ;
rdfs:subClassOf aas:QualifiableShape ;
sh:message "Invalid Identification Template (For Submodels with Kind = Type only Ids of Type IRDI or IRI are allowed) / (For Submodels with Kind = Instance only Ids of Type Custom or IRI are allowed)"^^xsd:string ;
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/Submodel/submodelElement> ;
  sh:class aas:SubmodelElement ;
  sh:minCount 0 ;
  sh:message "all submodel elements must be instances of type SubmodelElement"^^xsd:string ;
  sh:name "sub model element"^^xsd:string ;
} ;

aas:SubmodelElementShape a sh:NodeShape ;
sh:targetClass aas:SubmodelElement ;
rdfs:subClassOf aas:HasDataSpecificationShape ;
rdfs:subClassOf aas:HasKindShape ;
rdfs:subClassOf aas:HasSemanticsShape ;
rdfs:subClassOf aas:QualifiableShape ;
rdfs:subClassOf aas:ReferableShape ;

aas:SubmodelElementCollectionShape a sh:NodeShape ;
rdfs:subClassOf aas:SubmodelElementShape ;
sh:targetClass aas:SubmodelElementCollection ;
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/allowDuplicates> ;
  sh:datatype xsd:boolean ;
  sh:defaultValue false ;
  sh:maxCount 1 ;
  sh:minCount 0 ;
  sh:message "Only one boolean value for <i>allowDuplicates</i> is allowed"^^xsd:string ;
  sh:name "allow duplicates"^^xsd:string ;
} ;
sh:property {
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/ordered> ;
sh:datatype xsd:boolean ;
sh:defaultValue false ;
sh:maxCount 1 ;
sh:minCount 0 ;
sh:message "Only one boolean value for <i>ordered</i> is allowed"^^xsd:string ;
sh:name "ordered"^^xsd:string ;
]
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/SubmodelElementCollection/value> ;
  sh:class aas:SubmodelElement ;
  sh:minCount 0 ;
  sh:message "SubmodelElementCollection can contain only SubmodelElements for <i>value</i>."^^xsd:string ;
  sh:name "value"^^xsd:string ;
]
.

aas:ViewShape a sh:NodeShape ;
rdfs:subClassOf aas:HasDataSpecificationShape ;
rdfs:subClassOf aas:HasSemanticsShape ;
rdfs:subClassOf aas:ReferableShape ;
sh:targetClass aas:View ;
sh:property [
  a sh:PropertyShape ;
  sh:path <https://admin-shell.io/aas/3/0/RC01/View/containedElement> ;
  sh:class aas:Reference ;
  sh:name "view contained element"^^xsd:string ;
  sh:message "View can contain only References for <i>containedElement</i>."^^xsd:string ;
]
.

iii. RDF EXAMPLE

```xml
@prefix aas: <http://admin-shell.io/aas/3/0/RC01/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

# Asset Administration Shell
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "ExampleMotor"^^xsd:string ;
  rdfs:label "ExampleMotor"^^xsd:string ;
  <http://admin-shell.io/aas/3/0/RC01/Referable/description> "A very short description of the AAS instance."@en ;
  rdfs:comment "A very short description of the AAS instance."^^xsd:string ;
  <http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/asset> [a aas:Reference] ;
    <http://admin-shell.io/aas/3/0/RC01/Reference/key> [          a aas:Key ;
      <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
      <http://admin-shell.io/aas/3/0/RC01/Key/type> <http://admin-shell.io/aas/3/0/RC01/IdentifiableElements/ASSET> ;
      <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;
      <http://admin-shell.io/aas/3/0/RC01/Key/value> <http://customer.com/assets/KHBVZJSQKIY> ;
      <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
    ];
  ] ;
  <http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel> [a aas:Reference] ;
    <http://admin-shell.io/aas/3/0/RC01/Reference/key> [          a aas:Key ;
      <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
      <http://admin-shell.io/aas/3/0/RC01/Key/type> <http://admin-shell.io/aas/3/0/RC01/IdentifiableElements/SUBMODEL> ;
      <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;
      <http://admin-shell.io/aas/3/0/RC01/Key/value> <http://i40.customer.com/type/F13E8576F6488342> ;
      <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
    ];
```


|
# Asset

<http://customer.com/assets/KHBVZJSQKIY> rdf:type aas:Asset;

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "ServoDCMotor"^^xsd:string;

rdfs:label "ServoDCMotor"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Referable/category> "CONSTANT"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Referable/description> "Hersteller-Identifikation"@en;

rdfs:comment "Hersteller-Identifikation"@de;

<http://admin-shell.io/aas/3/0/RC01/Referable/description> "Identification from Manufacturer"@en;

rdfs:comment "Identification from Manufacturer"@de;

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Identifiable/identification";

<http://customer.com/aas/9175_7013_7091_9168>;


<http://admin-shell.io/aas/3/0/RC01/Asset/assetIdentificationModel> [

rdfs:label "Identification"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Identification"^^xsd:string;


aas:semanticId [

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> 

rdfs:label "Identification"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Referable/category> "CONSTANT"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Referable/description> "Identification from Manufacturer"@en;

<http://admin-shell.io/aas/3/0/RC01/Referable/description> "Hersteller-Identifikation"@de;

rdfs:comment "Identification from Manufacturer"@en;

rdfs:comment "Hersteller-Identifikation"@de;

<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification> 

<http://i40.customer.com/type/F13E8576F6488342>;

aas:semanticId [
DETAILS OF THE ADMINISTRATION SHELL - PART 1

a aas:Reference ;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
    a aas:Key ;
    <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
    <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBALREFERENCEKEYELEMENT ;
    <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
    <http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#01-ADN198#009"^^xsd:string ;
    <http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDIIDENTIFIERTYPE ;
] ;
]

aas:kind aas:INSTANCE ;

<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [ 
    rdf:type aas:Property ;
    rdf:subject <http://i40.customer.com/type/F13E8576F6488342/Manufacturer> ;
    <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Manufacturer"^^xsd:string ;
    rdfs:label "Manufacturer"^^xsd:string ;
    aas:propertyCategory aas:CONSTANT ;
    aas:kind aas:INSTANCE ;
    aas:semanticId [ 
        a aas:Reference ;
        <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
            a aas:Key ;
            <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
            <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBALREFERENCEKEYELEMENT ;
            <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
            <http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#02-AAO677#002"^^xsd:string ;
            <http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDIIDENTIFIERTYPE ;
        ] ;
    ] ;
    <http://admin-shell.io/aas/3/0/RC01/Key/value> "CUSTOMER GmbH"^^xsd:string ;
] ;

<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [ 
    rdf:type aas:Property ;
    rdf:subject <http://i40.customer.com/type/F13E8576F6488342/GLN> ;
    <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "GLN"^^xsd:string ;
    rdfs:label "GLN"^^xsd:string ;
    aas:propertyCategory aas:CONSTANT ;
aas:kind aas:INSTANCE ;
aas:semanticId [  
a aas:Reference ;  
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
a aas:Key ;  
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;  
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;  
<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;  
<http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#02-AAW338#001"^^xsd:string ;  
<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;  
] ;  
];  
<http://admin-shell.io/aas/3/0/RC01/Key/value> "10101010"^^xsd:integer ;  
];  
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [  
rdf:type aas:MultiLanguageProperty ;  
rdf:subject <http://i40.customer.com/type/F13E8576F6488342/ProductDesignation> ;  
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "ProductDesignation"^^xsd:string ;  
rdfs:label "ProductDesignation"^^xsd:string ;  
aas:propertyCategory aas:CONSTANT ;  
aas:semanticId [  
a aas:Reference ;  
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
a aas:Key ;  
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;  
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;  
<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;  
<http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#02-AAW338#001"^^xsd:string ;  
<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;  
] ;  
];  
aas:kind aas:INSTANCE ;  
<http://admin-shell.io/aas/3/0/RC01/Key/value> "I40 Capable Servo Motor"@en ;  
];  
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [  
rdf:type aas:Property ;  
rdf:subject <http://i40.customer.com/type/F13E8576F6488342/SerialNumber> ;
DETAILS OF THE ADMINISTRATION SHELL - PART 1

<aas:propertyCatagory rdf:resource="http://admin-shell.io/aas/3/0/RC01/Referable/idShort">"SerialNumber"^^xsd:string ;
  rdfs:label "SerialNumber"^^xsd:string ;
aas:semanticId [a aas:Reference ;
  rdf:resource="http://admin-shell.io/aas/3/0/RC01/Reference/key" [a aas:Key ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/index" "0"^^xsd:integer ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/type" aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/local" "false"^^xsd:boolean ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/value" "0173-1#02-AAM556#002"^^xsd:string ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/idType" aas:IRDI_IDENTIFIER_TYPE ;
  ] ;
];
aas:kind aas:INSTANCE ;
  rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/value" "P12345678I40"@en ;
] ;
.

# Submodel
  rdfs:label "TechnicalData"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
  rdf:resource="http://admin-shell.io/aas/3/0/RC01/Identifiable/identification" 
  rdf:resource="http://i40.customer.com/type/7A7104BDAB57E184" ;
aas:semanticId [a aas:Reference ;
  rdf:resource="http://admin-shell.io/aas/3/0/RC01/Reference/key" [a aas:Key ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/index" "0"^^xsd:integer ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/type" aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/local" "false"^^xsd:boolean ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/value" "0173-1#01-AFZ615#016"^^xsd:string ;
    rdf:resource="http://admin-shell.io/aas/3/0/RC01/Key/idType" aas:IRDI_IDENTIFIER_TYPE ;
  ] ;
];
aas:kind aas:INSTANCE ;
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element[
  rdf:type aas:Property;
  rdf:subject <http://i40.customer.com/type/7A7104BDAB57E184/MaxRotationSpeed>;
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "MaxRotationSpeed"^^xsd:string;
  rdfs:label "MaxRotationSpeed"^^xsd:string;
  aas:propertyCategory aas:PARAMETER;
  aas:semanticId[
    a aas:Reference;
    <http://admin-shell.io/aas/3/0/RC01/Referable/key>[
      a aas:Key;
      <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer;
      <http://admin-shell.io/aas/3/0/RC01/Key/type>aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT;
      <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean;
      <http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#02-BAA120#008"^^xsd:string;
      <http://admin-shell.io/aas/3/0/RC01/Key/idType>aas:IRD_IDENTIFIER_TYPE;
    ];
  ];
  aas:kind aas:INSTANCE;
  <http://admin-shell.io/aas/3/0/RC01/Key/value> "5000"^^xsd:integer;
];

<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element[
  rdf:type aas:Property;
  rdf:subject <http://i40.customer.com/type/7A7104BDAB57E184/MaxTorque>;
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "MaxTorque"^^xsd:string;
  rdfs:label "MaxTorque"^^xsd:string;
  aas:propertyCategory aas:PARAMETER;
  aas:semanticId[
    a aas:Reference;
    <http://admin-shell.io/aas/3/0/RC01/Referable/key>[
      a aas:Key;
      <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer;
      <http://admin-shell.io/aas/3/0/RC01/Key/type>aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT;
      <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean;
      <http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#02-BAE098#004"^^xsd:string;
      <http://admin-shell.io/aas/3/0/RC01/Key/idType>aas:IRD_IDENTIFIER_TYPE;
    ];
  ];
# Submodel

<http://i40.customer.com/type/1A7B62B529F19152> rdf:type aas:Submodel ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Documentation"^^xsd:string ;
rdfs:label "Documentation"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
<http://i40.customer.com/type/1A7B62B529F19152> ;
aas:kind aas:INSTANCE ;
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>ElementCollection [ rdf:type aas:SubmodelElementCollection ;
rdf:subject <http://i40.customer.com/type/7A7104BDAB57E184/OperatingManual> ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "OperatingManual"^^xsd:string ;
rdfs:label "OperatingManual"^^xsd:string ;
aas:semanticId [ a aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;

<http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
]
];
aas:kind aas:INSTANCE ;
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [ rdf:type aas:Property ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentId"^^xsd:string ;
rdfs:label "DocumentId"^^xsd:string ;
aas:propertyCategory aas:CONSTANT ;
aas:semanticId [ a aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
  a aas:Key ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/type>  
  aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/value>  
  <http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/DocumentId/Val> ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/idType>  
  <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;  
] ;  
];  
aas:kind aas:INSTANCE ;  
<http://admin-shell.io/aas/3/0/RC01/Key/value> "3 608 870 A47"^^xsd:string ;  
] ;  
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [  
rdf:type aas:Property ;  
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentClassId"^^xsd:string ;  
rdfs:label "DocumentClassId"^^xsd:string ;  
aas:propertyCategory aas:CONSTANT ;  
aas:semanticId [  
a aas:Reference ;  
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
  a aas:Key ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/type>  
  aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/value>  
  <http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/DocumentClassification/ClassId> ;  
  <http://admin-shell.io/aas/3/0/RC01/Key/idType>  
  <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;  
] ;  
];  
aas:kind aas:INSTANCE ;  
<http://admin-shell.io/aas/3/0/RC01/Key/value> "03-02"^^xsd:string ;  
] ;  
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [
rdf:type aas:MultiLanguageProperty ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentClassName"^^xsd:string ;
rdfs:label "DocumentClassName"^^xsd:string ;
aas:propertyCategory aas:CONSTANT ;
aas:semanticId [  
a a aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
a a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;
<http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
] ;
];
aas:kind aas:INSTANCE ;
<http://admin-shell.io/aas/3/0/RC01/Key/value> "Operation"@en ;
<http://admin-shell.io/aas/3/0/RC01/Key/value> "Bedienung"@de ;
];
<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [  
rdf:type aas:Property ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentClassificationSystem"^^xsd:string ;
rdfs:label "DocumentClassificationSystem"^^xsd:string ;
aas:semanticId [  
a a aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
a a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;
rdfs:label "Language"^^xsd:string ;
aas:semanticId [ a aas:Reference ;
   <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
      <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
      <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;
      <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;
      <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
   ] ;
]
; aas:kind aas:INSTANCE ;
</http://admin-shell.io/aas/3/0/RC01/Key/value> "en-US"^^xsd:string ;
]
;
</http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [ rdf:type aas:File ;
   <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DigitalFile_PDF"^^xsd:string ;
   rdfs:label "DigitalFile_PDF"^^xsd:string ;
   aas:category "PARAMETER"^^xsd:string ;
   aas:semanticId [ a aas:Reference ;
      <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
         <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
         <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:CONCEPT_DESCRIPTION_IDENTIFIABLE_ELEMENT ;
         <http://admin-shell.io/aas/3/0/RC01/Key/local> "true"^^xsd:boolean ;
         <http://admin-shell.io/aas/3/0/RC01/Key/value> <http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Description/Title> ;
      ] ;
   ] ; aas:kind aas:INSTANCE ;
# Submodel

<http://i40.customer.com/instance/AC69B1CB44F07935> rdf:type aas:Submodel;

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "OperationalData"^^xsd:string;

rdfs:label "OperationalData"^^xsd:string;

aas:category "VARIABLE"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>

<http://i40.customer.com/instance/AC69B1CB44F07935>;

aas:semanticId [a as:Reference;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [a aas:Key;

<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer;

<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT;

<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean;

<http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#01-AFZ615#016"^^xsd:string;

<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE;

];

];

aas:kind aas:INSTANCE;

<http://admin-shell.io/aas/3/0/RC01/AssetAdministrationShell/submodel>Element [rdf:type aas:Property;

rdf:subject <http://i40.customer.com/instance/AC69B1CB44F07935/RotationSpeed>;

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "RotationSpeed"^^xsd:string;

rdfs:label "RotationSpeed"^^xsd:string;

aas:propertyCategory aas:VARIABLE;

aas:kind aas:INSTANCE;

aas:semanticId [a aas:Reference;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [a aas:Key;
# ConceptDescription

"Document"^^xsd:string ;
  rdfs:label "Document"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
aas:hasDataSpecification [ 
  rdf:type aas:Reference ;
  <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
    a aas:Key ;
    <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
    <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
    <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
    <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
  ] ;
] ;
aas:content [ 
  rdf:type aas:DataSpecificationIEC61360 ;
  aas:preferredName "Document"@en ;
  aas:preferredName "Dokument"@de ;
  aas:shortName "Document"@en ;
  aas:sourceOfDefinition "[ISO 15519-1:2010]"^^xsd:string ;
  aas:datatype "ENTITY"^^xsd:string ;
  aas:definition "Feste und geordnete Menge von für die Verwendung durch Personen bestimmte Informationen, die verwaltet und als Einheit zwischen Benutzern und System ausgetauscht werden kann."@de ;
] ;
.

# ConceptDescription
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentIdValue"^^xsd:string ;
rdfs:label "DocumentIdValue"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/DocumentId/Val> ;
aas:hasDataSpecification [ 
  rdf:type aas:Reference ;
  <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
    a aas:Key ;
  ] ;
# ConceptDescription


[http://admin-shell.io/aas/3/0/RC01/Referable/idShort] "DocumentClassId"^^xsd:string ;

rdfs:label "DocumentClassId"^^xsd:string ;

aas:category "CONSTANT"^^xsd:string ;

[http://admin-shell.io/aas/3/0/RC01/Identifiable/identification] 


aas:hasDataSpecification [ 

click here to highlight this statement ;

[http://admin-shell.io/aas/3/0/RC01/Reference/key] [ 

a aas:Key ;

[http://admin-shell.io/aas/3/0/RC01/Key/index] "0"^^xsd:integer ;

[http://admin-shell.io/aas/3/0/RC01/Key/type] aas:GLOBAL_REFERENCE_KEY_ELEMENT ;

[http://admin-shell.io/aas/3/0/RC01/Key/local] "false"^^xsd:boolean ;

[http://admin-shell.io/aas/3/0/RC01/Key/value] 


[http://admin-shell.io/aas/3/0/RC01/Key/idType] <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;

] ;

] ;

aas:content [ 

click here to highlight this statement ;

}
rdf:type aas:DataSpecificationIEC61360 ;
  aas:preferredName "Document Class Id"@en ;
  aas:preferredName "Dokumentenklassen ID"@de ;
  aas:shortName "DocumentClassId"@en ;
  aas:datatype "STRING"^^xsd:string ;
  aas:definition "Eindeutige ID der Klasse in einer Klassifikation."@de ;
]
.

# ConceptDescription
<br:http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/DocumentClassification/ClassName> rdf:type aas:ConceptDescription ;
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentClassName"^^xsd:string ;
  rdfs:label "DocumentClassName"^^xsd:string ;
  aas:category "CONSTANT"^^xsd:string ;
  aas:hasDataSpecification [rdf:type aas:Reference ;
    <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
      a aas:Key ;
      <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
      <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
      <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
      <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
    ] ;
  ] ;
  aas:content [rdf:type aas:DataSpecificationIEC61360 ;
    aas:preferredName "Document Class Name"@en ;
    aas:shortName "DocumentClassName"@en ;
    aas:datatype "STRING_TRANSLATABLE"^^xsd:string ;
    aas:definition "Liste von sprachabhängigen Namen zur ClassId."@de ;
  ] ;
.
# ConceptDescription

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentClassificationSystem"^^xsd:string ;
rdfs:label "DocumentClassificationSystem"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
aas:hasDataSpecification [ rdf:type aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
<http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
] ;
]
],
aas:content [ rdf:type aas:DataSpecificationIEC61360 ;
aas:preferredName "Classification System"@en ;
aas:preferredName "Klassifikationssystem"@de ;
aas:shortName "DocumentClassificationSystem"@en ;
aas:datatype "STRING"^^xsd:string ;
aas:definition "Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss 'VDI2770:2018' verwendet werden."@de ;
]
].

# ConceptDescription

<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Organization/OrganizationName> rdf:type aas:ConceptDescription ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "OrganizationName"^^xsd:string ;
rdfs:label "OrganizationName"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Organization/OrganizationName> ;
aas:hasDataSpecification [ 
  rdf:type aas:Reference ;
  <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
    a aas:Key ;
    <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
    <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
    <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
    <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
  ] ;
] ;

aas:content [ 
  rdf:type aas:DataSpecificationIEC61360 ;
  aas:preferredName "gebräuchliche Bezeichnung für Organisation"@de ;
  aas:preferredName "organization name"@en ;
  aas:shortName "OrganizationName"@en ;
  aas:datatype "STRING"^^xsd:string ;
  aas:definition "Die gebräuchliche Bezeichnung für die Organisation."@de ;
] ;

# ConceptDescription

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "OrganizationOfficialName"^^xsd:string ;
rdfs:label "OrganizationOfficialName"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
aas:hasDataSpecification [ 
  rdf:type aas:Reference ;
  <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 
    a aas:Key ;
    <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
    <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
    <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
    <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
  ] ;
] ;
Zu jedem Dokument muss eine Menge von mindestens einer Dokumentenversion existieren. Es können auch mehrere Dokumentenversionen ausgeliefert werden.

# ConceptDescription

Sprache

Sprache

Sprache
DETAILS OF THE ADMINISTRATION SHELL - PART 1

| aas:shortName "Language"@en ; |
| aas:datatype "STRING"^^xsd:string ; |
| aas:definition "Eine Liste der im Dokument verwendeten Sprachen."@de ; |
|

# ConceptDescription

<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Description/Title> rdf:type aas:ConceptDescription ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Title"^^xsd:string ;
rdfs:label "Title"^^xsd:string ;
aas:category "CONSTANT"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Description/Title> ;
aas:hasDataSpecification [ |

| rdf:type aas:Reference ;
| <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ |
|
| a aas:Key ;
| <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
| <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
| <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
| <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ; |
|
| ] ; |
| ] ; |
| aas:content [ |
| rdf:type aas:DataSpecificationIEC61360 ; |
| aas:preferredName "Titel"@de ; |
| aas:preferredName "Title"@en ; |
| aas:shortName "Title"@en ; |
| aas:datatype "STRING_TRANSLATABLE"^^xsd:string ; |
| aas:definition "Sprachabhängiger Titel des Dokuments."@de ; |
|

# ConceptDescription

<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/LifeCycleStatus/SetDate> rdf:type aas:ConceptDescription ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Date"^^xsd:string ;
rdfs:label "Date"^^xsd:string ;

<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>
<http://www.vdi2770.com/blatt1/Entwurf/Okt18/cd/LifeCycleStatus/SetDate> ;

aas:hasDataSpecification [ 
	rdf:type aas:Reference ;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 

  a aas:Key ; 

  <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;

  <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;

  <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;


  <http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;

] ;
]

aas:content [ 
	rdf:type aas:DataSpecificationIEC61360 ;

  aas:preferredName "Set Date"@en ;

  aas:shortName "SetDate"@en ;

  aas:datatype "DATE"^^xsd:string ;

  aas:definition "Datum und Uhrzeit, an dem der Status festgelegt wurde. Es muss das Datumsformat „YYYY-MM-dd“ verwendet werden (Y = Jahr, M = Monat, d = Tag, siehe ISO 8601)." @de ;

] ;

# ConceptDescription


<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "DocumentVersionIdValue"^^xsd:string ;

rdfs:label "DocumentVersionIdValue"^^xsd:string ;

<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification>

aas:hasDataSpecification [ 
	rdf:type aas:Reference ;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ 

  a aas:Key ; 

  <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;

  <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;

  <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
VERSCHIEDENE VERSIONEN EINES DOKUMENTS MÜSSEN EINDEUTIG IDENTIFIZIERBAR SEIN. DIE DOCUMENTVERSIONID STELLT EINE INNERHALB EINER DOMÄNE EINDEUTIGE VERSIONSIDENTIFIKATIONSNUMMER DARR. @de

# ConceptDescription

Eine Datei, die die DocumentVersion repräsentiert. Neben der obligatorischen PDF/A Datei können weitere Dateien angegeben werden."

# ConceptDescription

```xml
<http://i40.customer.com/type/F13E8576F6488342/MaxRotationSpeed> rdf:type aas:ConceptDescription;
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "MaxRotationSpeed"^^xsd:string;
  rdfs:label "MaxRotationSpeed"^^xsd:string;
  aas:category "PROPERTY"^^xsd:string;
  <http://admin-shell.io/aas/3/0/RC01/Identifiable/identification> [aas:id "0173-1#05-BAA120#008"^^xsd:string;]
  <http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE;
]

aas:administration [rdf:type aas:AdministrativeInformation; aas:revision ""^^xsd:string;]

aas:content [rdf:type aas:DataSpecificationIEC61360; aas:preferredName "max. Drehzahl"@de; aas:preferredName "Max. rotation speed"@en; aas:unit "1/min"^^xsd:string; aas:unitId [rdf:type aas:Reference; <http://admin-shell.io/aas/3/0/RC01/Reference/key> [a aas:Key; <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer; <http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT; <http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean; <http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#05-AAA650#002"^^xsd:string; <http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE;]
]
]

aas:datatype "INTEGER_MEASURE"^^xsd:string;
aas:definition "Höchste zulässige Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben werden darf"@de;
aas:definition "Greatest permissible rotation speed with which the motor or feeding unit may be operated"@en;
```
# ConceptDescription

<http://i40.customer.com/type/F13E8576F6488342/MaxTorque> rdf:type aas:ConceptDescription ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "MaxTorque"^^xsd:string ;
rdfs:label "MaxTorque"^^xsd:string ;
aas:category "PROPERTY"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Identifiable/identification> [  
aas:id "0173-1#02-BAE098#004"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;
] ;
aas:content [  
rdf:type aas:DataSpecificationIEC61360 ;
aas:preferredName "Max. torque"@en ;
aas:preferredName "max. Drehmoment"@de ;
aas:unit "Nm"^^xsd:string ;
aas:unitId [  
rdf:type aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [  
a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
<http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#05-AAA212#003"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;
] ;
] ;
aas:datatype "REAL_MEASURE"^^xsd:string ;
aas:definition "Größtes mechanisch zulässiges Drehmoment, welches der Motor an der Abtriebswelle abgeben kann"@de ;
aas:definition "Greatest permissible mechanical torque which the motor can pass on at the drive shaft"@en ;
] ;
.

# ConceptDescription

<http://customer.com/cd/18EBD56F6B43D895> rdf:type aas:ConceptDescription ;
<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "RotationSpeed"^^xsd:string ;
rdfs:label "RotationSpeed"^^xsd:string ;
aas:category "PROPERTY"^^xsd:string ;
aas:hasDataSpecification [rdf:type aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
<http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;
]
] ;
aas:content [rdf:type aas:DataSpecificationIEC61360 ;
aas:preferredName "Aktuelle Drehzahl"@de ;
aas:preferredName "Actual rotation speed"@en ;
aas:shortName "RotationSpeed"@en ;
aas:unit "1/min"^^xsd:string ;
aas:unitId [rdf:type aas:Reference ;
<http://admin-shell.io/aas/3/0/RC01/Reference/key> [a aas:Key ;
<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;
<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;
<http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#05-AAA650#002"^^xsd:string ;
<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;
]
];
aas:datatype "INTEGER_MEASURE"^^xsd:string ;
aas:definition "Aktuelle Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben wird"@de ;
aas:definition "Actual rotation speed with which the motor or feeding unit is operated"@en ;
] ;
# ConceptDescription

<http://customer.com/cd/18EBD56F6B43D896> rdf:type aas:ConceptDescription ;

<http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "Torque"^^xsd:string ;

rdfs:label "Torque"^^xsd:string ;

aas:category "PROPERTY"^^xsd:string ;


aas:hasDataSpecification [ rdf:type aas:Reference ;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;

<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;

<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;

<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;


<http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/RC01/IdentifierType/IRI> ;

] ;

] ;

aas:content [ rdf:type aas:DataSpecificationIEC61360 ; aas:preferredName "Drehmoment"@de ;

aas:preferredName "Torque"@en ;

aas:shortName "Torque"@en ;
aas:unit "Nm"^^xsd:string ;
aas:unitId [ rdf:type aas:Reference ;

<http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;

<http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;

<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEY_ELEMENT ;

<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean ;

<http://admin-shell.io/aas/3/0/RC01/Key/value> "0173-1#05-AAA212#003"^^xsd:string ;

<http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;

] ;

] ;

aas:datatype "REAL_MEASURE"^^xsd:string ;
aas:definition "Aktuelles Drehmoment, welches der Motor an der Abtriebswelle abgibt"@de ;
aas:definition "Actual mechanical torque which the motor passes on at the drive shaft"@en ;
# ConceptDescription

<http://i40.customer.com/type/F13E8576F6488342/0173-1#0173-1#02-BAE122#006> rdf:type aas:ConceptDescription ;
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "CoolingType"^^xsd:string ;
  rdfs:label "CoolingType"^^xsd:string ;
  aas:category "PROPERTY"^^xsd:string ;
  <http://admin-shell.io/aas/3/0/RC01/Identifiable/identification> [
    aas:id "0173-1#02-BAE122#006"^^xsd:string ;
    <http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;
  ] ;
  aas:hasDataSpecification [ rdf:type aas:DataSpecificationIEC61360 ;
    aas:preferredName "Art der Kühlung"@de ;
    aas:preferredName "Cooling type"@en ;
    aas:datatype "STRING"^^xsd:string ;
    aas:definition "Zusammenfassung verschiedener Kühlarten, um für Suchmerkmale zu einer begrenzten Auswahl zu kommen"@de ;
    aas:definition "Summary of various types of cooling, for use as search criteria that limit a selection"@en ;
  ] ;

# ConceptDescription

<http://i40.customer.com/type/F13E8576F6488342/BAB657> rdf:type aas:ConceptDescription ;
  <http://admin-shell.io/aas/3/0/RC01/Referable/idShort> "BAB657"^^xsd:string ;
  rdfs:label "BAB657"^^xsd:string ;
  aas:category "VALUE"^^xsd:string ;
  <http://admin-shell.io/aas/3/0/RC01/Identifiable/identification> [
    aas:id "0173-1#07-BAB657#003"^^xsd:string ;
    <http://admin-shell.io/aas/3/0/RC01/Key/idType> aas:IRDI_IDENTIFIER_TYPE ;
  ] ;
  aas:hasDataSpecification [ rdf:type aas:Reference ;
    <http://admin-shell.io/aas/3/0/RC01/Reference/key> [ a aas:Key ;
    <http://admin-shell.io/aas/3/0/RC01/Key/index> "0"^^xsd:integer ;
<http://admin-shell.io/aas/3/0/RC01/Key/type> aas:GLOBAL_REFERENCE_KEYELEMENT;

<http://admin-shell.io/aas/3/0/RC01/Key/local> "false"^^xsd:boolean;


<http://admin-shell.io/aas/3/0/RC01/Key/idType> <http://admin-shell.io/aas/3/0/IdentifierType/IRI> ;

[ ] ;
]

aas:content [
	rdf:type aas:DataSpecificationIEC61360 ;

aas:preferredName "offener Kreis, Fremdkühlung"@de ;

aas:preferredName "open circuit, external cooling"@en ;

aas:datatype "STRING"^^xsd:string ;

] ;
ANNEX I. AUTOMATIONML AND COMPLETE EXAMPLE

i. INTRODUCTION

[37] is the AutomationML application recommendation for the asset administration shell (AR AAS). This annex is just for information.

Note: The specification is not yet updated conformant to the version specified in this document. However, the mapping rules as defined in Clause 7.8 still hold.

ii. AUTOMATIONML LIBRARIES FOR ASSET ADMINISTRATION SHELL

[37] is the AutomationML application recommendation for the asset administration shell (AR AAS) and contains the libraries for the asset administration shell roles, interface classes and system unit classes. This annex is just for information.

```xml
<CAEX File Name="AssetAdministrationShellLib.aml" Schema Version="2.15" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespace Schema Location="CAEX_ClassModel_V2.15.xsd">  
  <Additional Information AutomationML Version="2.0"/>  
  <Additional Information Document Versions="Recommendations"/>  
  <Additional Information Document Identifier="AR AAS" Version="1.0.0"/>  
  </Additional Information>  
  <Additional Information Document Versions="Recommendations"/>  
  <Additional Information Document Identifier="BPR EDRef" Version="1.0.0"/>  
  </Additional Information>  
  <Additional Information>  
    <Writer Header>  
      <Writer Name>AutomationML Editor</Writer Name>  
      <Writer ID>916578CA-FE0D-474E-A4FC-9E179892369</Writer ID>  
      <Writer Vendor>AutomationML e.V.</Writer Vendor>  
      <Writer Vendor URL>www.AutomationML.org</Writer Vendor URL>  
      <Writer Version>5.2.7.0</Writer Version>  
      <Writer Release>5.2.7.0</Writer Release>  
      <Last Writing Date Time>2019-11-20T12:02:7871841</Last Writing Date Time>  
      <Writer Project Title>Application Recommendation Asset Administration Shell</Writer Project Title>  
      <Writer Project ID>AR AAS</Writer Project ID>  
    </Writer Header>  
  </Additional Information>  
  <Interface Class Lib Name="AssetAdministrationShellInterfaceClassLib">  
    <Description>Interface Class Library according to Details of the Asset Administration Shell V2.0.</Description>  
    <Version>1.0.0</Version>  
    <Interface Class Name="File Data Reference" Ref Base Class Path="AutomationML BPR Interface Class Lib/External Data Reference">  
      <Description>A File Data Reference represents the address to a File. File Data Reference is derived from the AutomationML Interface Class External Data Reference that is defined in AutomationML BPR_005E_ExternalDataReference_v1.0.0.2. The interface class “External Data Reference” shall be used in order to reference external documents out of the scope of AutomationML.</Description>  
    </Interface Class Name>  
  </Interface Class Lib Name="AssetAdministrationShellInterfaceClassLib">  
</CAEX>
```
DETAILS OF THE ADMINISTRATION SHELL - PART 1

```xml
<InterfaceClass Name="ReferableReference" RefBaseClassPath="AutomationMLInterfaceClassLib/AutomationMLBaseInterface">
  <Description>
    Reference to any other referable element of the same of any other AAS or a reference to an external object or entity. For local references inside the same Asset Administration Shell an InternalLink between two objects with this interface "ReferableReference" shall be set. In this case the attribute value has to be empty. For references between different Asset Administration Shells or external objects or entities the attribute value shall be used and no InternalLink shall be set. </Description>
  <Attribute Name="value" AttributeDataType="xs:string">
    <Description>
      Reference to any other referable element of any other AAS or a reference to an external object or entity. Note: For references to any other referable element of the same AAS InternalLinks are used and this attribute value shall be empty. </Description>
  </Attribute>
</InterfaceClass>

<RoleClassLib Name="AssetAdministrationShellRoleClassLib">
  <Description>
    Role Class Library according to Details of the Asset Administration Shell V2.0. 
  </Description>
  <Version>1.0.0</Version>
  <RoleClass Name="AssetAdministrationShell" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
    <Description>
      An Asset Administration Shell. 
    </Description>
    <Attribute Name="idShort" AttributeDataType="xs:string">
      <Description>
        Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA. 
      </Description>
      <Value></Value>
    </Attribute>
    <Attribute Name="category" AttributeDataType="xs:string">
      <Description>
        The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints. 
      </Description>
      <Value></Value>
    </Attribute>
    <Attribute Name="description" AttributeDataType="xs:string">
      <Description>
        Description or comments on the element. The description can be provided in several languages. 
      </Description>
      <Value></Value>
    </Attribute>
    <Attribute Name="aml-lang=EN" AttributeDataType="xs:string">
      <Value></Value>
    </Attribute>
    <Attribute Name="aml-lang=DE" AttributeDataType="xs:string">
      <Value></Value>
    </Attribute>
    <Attribute Name="identification">
      <Description>
        Abstract attribute class for identification. Has the subattributes id and idType. 
      </Description>
    </Attribute>
  </RoleClass>
</RoleClassLib>
```

<Attribute Name="id" AttributeDataType="xs:string">
    <Description>Identifier of the element. Its type is defined in idType. Id is a subproperty of identification.</Description>
    <Value/>
</Attribute>

<Attribute Name="idType" AttributeDataType="xs:string">
    <Description>Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration "IdentifierType". IdType is a subproperty of identification.</Description>
    <Value/>
</Attribute>

<Attribute Name="administration">
    <Description>Abstract attribute for administration. Has the subattributes revision and version.</Description>
</Attribute>

<Attribute Name="revision" AttributeDataType="xs:string">
    <Description>Revision of the element. Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision neither. Revision is a subproperty of administration.</Description>
    <Value/>
</Attribute>

<Attribute Name="version" AttributeDataType="xs:string">
    <Description>Version of the element. Version is a subproperty of administration.</Description>
    <Value/>
</Attribute>

<Attribute Name="dataSpecification" AttributeDataType="xs:string">
    <Description>Global reference to the data specification template used by the element.</Description>
    <Value/>
</Attribute>

<Attribute Name="derivedFrom" AttributeDataType="xs:string">
    <Description>The derivedFrom attribute is used to establish a relationship between two Asset Administration Shells that are derived from each other.</Description>
    <Value/>
</Attribute>

<Attribute Name="idShort" AttributeDataType="xs:string">
</Attribute>

<RoleClass Name="Asset" RefBaseClassPath="/AutomationMLBaseRoleLib/AutomationMLBaseRole">
    <Description>An Asset describes meta data of an asset that is represented by an AAS. The asset may either represent an asset type or an asset instance. The asset has a globally unique identifier plus – if needed – additional domain specific (proprietary) identifiers.</Description>
</RoleClass>
DETAILS OF THE ADMINISTRATION SHELL - PART 1

 Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA. 

 The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.

 Identifier of the element. Its type is defined in idType. 

 Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration "IdentifierType". 

 Revision of the element. Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision neither. Revision is a subproperty of administration.

 Version of the element. Version is a subproperty of administration.
<RoleClass Name="Submodel" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  <Description>A Submodel defines a specific aspect of the asset represented by the AAS. A submodel is used to structure the virtual representation and technical functionality of an Administration Shell into distinguishable parts. Each submodel refers to a well-defined domain or subject matter. Submodels can become standardized and thus become submodels types. Submodels can have different life-cycles.</Description>
  <Attribute Name="idShort" AttributeDataType="xs:string">
    <Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"), starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.</Description>
  </Attribute>
  <Attribute Name="category" AttributeDataType="xs:string">
    <Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
  </Attribute>
  <Attribute Name="description" AttributeDataType="xs:string">
    <Description>Description or comments on the element. The description can be provided in several languages.</Description>
  </Attribute>
</RoleClass>
<Attribute Name="aml-lang=DE"/>

<Attribute Name="identification">
  <Description>Abstract attribute class for identification. Has the subattributes id and idType.</Description>
  </Attribute>

<Attribute Name="id" AttributeDataType="xs:string">
  <Description>Identifier of the element. Its type is defined in idType. Id is a subproperty of identification.</Description>
  </Attribute>

<Attribute Name="idType">
  <Description>Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration "IdentifierType". IdType is a subproperty of identification.</Description>
  </Attribute>

<Attribute Name="administration">
  <Description>Abstract attribute for administration. Has the subattributes revision and version.</Description>
  </Attribute>

<Attribute Name="revision" AttributeDataType="xs:string">
  <Description>Revision of the element. Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision neither. Revision is a subproperty of administration.</Description>
  </Attribute>

<Attribute Name="version" AttributeDataType="xs:string">
  <Description>Version of the element. Version is a subproperty of administration.</Description>
  </Attribute>

<Attribute Name="dataSpecification" AttributeDataType="xs:string">
  <Description>Global reference to the data specification template used by the element.</Description>
  </Attribute>

<Attribute Name="kind" AttributeDataType="xs:string">
  <DefaultValue>Instance</DefaultValue>
  <Description>Kind of the element: either template or instance.</Description>
  </Attribute>

<Constraint Name=""/>
<NominalScaledType>
  <RequiredValue>Instance</RequiredValue>
  <RequiredValue>Type</RequiredValue>
</NominalScaledType>

</Constraint>

</Attribute>

<Attribute Name="semanticId" AttributeDataType="xs:string">
  <Description>
    Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language. </Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>
</Attribute>

<Attribute Name="qualified:[TYPE]=[VALUE]" AttributeDataType="xs:string">
  <Description>
    A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value. </Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>
</Attribute>

<Attribute Name="type" AttributeDataType="xs:string">
  <Description>
    The type describes the type of the qualifier that is applied to the element. </Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>
</Attribute>

<Attribute Name="value" AttributeDataType="xs:string">
  <Description>
    The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId. </Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/value"/>
</Attribute>

<Attribute Name="valueId" AttributeDataType="xs:string">
  <Description>
    Reference to the global unique id of a coded value. </Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
</Attribute>

</Attribute>

</RoleClass>

<RoleClass Name="SubmodelElementCollection" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  <Description>
    A submodel element collection is a set or list of submodel elements. </Description>
  <Attribute Name="idShort" AttributeDataType="xs:string">
    <Description>
      Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"), starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA. </Description>
  </Attribute>
  <Attribute>
    <Attribute Name="valueId" AttributeDataType="xs:string">
      <Description>
        Reference to the global unique id of a coded value. </Description>
      <Value/>
      <RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
    </Attribute>
    <Attribute>
      <Attribute Name="valueId" AttributeDataType="xs:string">
        <Description>
          Reference to the global unique id of a coded value. </Description>
        <Value/>
        <RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
      </Attribute>
    </Attribute>
  </Attribute>
</RoleClass>
<Attribute Name="category" AttributeDataType="xs:string">
  <Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
</Attribute>

ATTRIBUTE Name="description" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages.</Description>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>
  <Attribute Name="aml-lang=EN"/>
  <Attribute Name="aml-lang=DE"/>
</Attribute>

ATTRIBUTE Name="dataSpecification" AttributeDataType="xs:string">
  <Description>Global reference to the data specification template used by the element.</Description>
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification"/>
</Attribute>

ATTRIBUTE Name="kind" AttributeDataType="xs:string">
  <Description>Kind of the element: either template or instance.</Description>
  <DefaultValue>Instance</DefaultValue>
  <Value>Instance</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>
  <Constraint Name="">
    <NominalScaledType>
      <RequiredValue>Instance</RequiredValue>
    </NominalScaledType>
  </Constraint>
</Attribute>

ATTRIBUTE Name="semanticId" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.</Description>
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>
</Attribute>

ATTRIBUTE Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
  <Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.</Description>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>
</Attribute>

ATTRIBUTE Name="type" AttributeDataType="xs:string">
  <Description>The type describes the type of the qualifier that is applied to the element.</Description>
  <Value></Value>
</Attribute>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>
</Attribute>

ATTRIBUTE Name="value" AttributeDataType="xs:string">
<Description>The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueld are present then the value needs to be identical to the value of the referenced coded value in valueld.</Description>
<Value/>
</Attribute>

ATTRIBUTE Name="valueId" AttributeDataType="xs:string">
<Description>Reference to the global unique id of a coded value.</Description>
<Value/>
<br/>
</Attribute>

ATTRIBUTE Name="allowDuplicates" AttributeDataType="xs:boolean">
<Description>If allowDuplicates=true, then it is allowed that the collection contains the same element several times.</Description>
<DefaultValue>false</DefaultValue>
<br/>
</Attribute>

ATTRIBUTE Name="ordered" AttributeDataType="xs:boolean">
<Description>If ordered=false, then the elements in the property collection are not ordered. If ordered=true then the elements in the collection are ordered. Default = false. Note: An ordered submodel element collection is typically implemented as an indexed array.</Description>
<DefaultValue>false</DefaultValue>
<br/>
</Attribute>

ATTRIBUTE Name="value" AttributeDataType="xs:string">
<Description>Submodel element contained in the collection.</Description>
</Attribute>
<br/>
</RoleClass>

ROLECLASS Name="Blob" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
<Description>A BLOB is a data element that represents a file that is contained with its source code in the value attribute.</Description>
ATTRIBUTE Name="idShort" AttributeDataType="xs:string">
<Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.</Description>
</Attribute>
<br/>
</RoleClass>
<RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

<Attribute Name="description" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages. </Description>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/description" />
  <Attribute Name="aml-lang=EN" />
  <Attribute Name="aml-lang=DE" />
</Attribute>

<Attribute Name="dataSpecification" AttributeDataType="xs:string">
  <Description>Global reference to the data specification template used by the element. </Description>
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification" />
</Attribute>

<Attribute Name="kind" AttributeDataType="xs:string">
  <Description>Kind of the element: either template or instance. </Description>
  <DefaultValue>Instance</DefaultValue>
  <Value>Instance</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
  <Constraint Name="">
    <NominalScaledType>
      <RequiredValue>Instance</RequiredValue>
    </NominalScaledType>
  </Constraint>
</Attribute>

<Attribute Name="semanticId" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language. </Description>
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
</Attribute>

<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
  <Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value. </Description>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier" />
</Attribute>

<Attribute Name="type" AttributeDataType="xs:string">
  <Description>The type describes the type of the qualifier that is applied to the element. </Description>
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/type" />
</Attribute>

<Attribute Name="value" AttributeDataType="xs:string">
  <Description>The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId. </Description>
</Attribute>
<Attribute Name="valueId" AttributeDataType="xs:string">
    <Description>Reference to the global unique id of a coded value.</Description>
    <Value/></Value>
</Attribute>

<Attribute Name="mimeType" AttributeDataType="xs:string">
    <Description>Mime type of the content of the BLOB. The mime type states which file extension the file has. Valid values are e.g. "application/json", "application/xls", "image/jpg". The allowed values are defined as in RFC2046.</Description>
    <Value/></Value>
</Attribute>

<Attribute Name="value" AttributeDataType="xs:string">
    <Description>The value of the BLOB instance of a blob data element. Note: In contrast to the file property the file content is stored directly as value in the Blob data element.</Description>
    <Value/></Value>
</Attribute>

<RoleClass>
    <RoleClassName>Capability</RoleClassName>
    <RefBaseClassPath>"AutomationMLBaseRoleClassLib/AutomationMLBaseRole"</RefBaseClassPath>
    <Description>A capability is the implementation-independent description of the potential of an asset to achieve a certain effect in the physical or virtual world.</Description>
    <Attribute Name="idShort" AttributeDataType="xs:string">
        <Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.</Description>
        <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
    </Attribute>
    <Attribute Name="category" AttributeDataType="xs:string">
        <Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
        <Value/></Value>
    </Attribute>
    <Attribute Name="description" AttributeDataType="xs:string">
        <Description>Description or comments on the element. The description can be provided in several languages.</Description>
        <RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>
    </Attribute>
</RoleClass>
<Attribute Name="dataSpecification" AttributeDataType="xs:string">
    <Description>Global reference to the data specification template used by the element. </Description>
    <Value/></Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification" />
</Attribute>

ATTRIBUTE 

<Attribute Name="kind" AttributeDataType="xs:string">
    <Description>Kind of the element: either template or instance. </Description>
    <DefaultValue>Instance</DefaultValue>
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
</Attribute>

CONSTRAINT

<Attribute Name="" AttributeDataType="">
    <NominalScaledType>
        <RequiredValue>Instance</RequiredValue>
        <RequiredValue>Type</RequiredValue>
    </NominalScaledType>
</Attribute>

ATTRIBUTE 

<Attribute Name="semanticId" AttributeDataType="xs:string">
    <Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language. </Description>
    <Value/></Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
</Attribute>

ATTRIBUTE 

<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
    <Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value. </Description>
    <RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier" />
</Attribute>

ATTRIBUTE 

<Attribute Name="type" AttributeDataType="xs:string">
    <Description>The type describes the type of the qualifier that is applied to the element. </Description>
    <Value/></Value>
    <RefSemantic CorrespondingAttributePath="AAS:Qualifier/type" />
</Attribute>

ATTRIBUTE 

<Attribute Name="valueId" AttributeDataType="xs:string">
    <Description>Reference to the global unique id of a coded value. </Description>
    <Value/></Value>
    <RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId" />
</Attribute>
Annex 435

<RoleClass Name="File" RefBaseClassPath="AutomationMLBPRoleClassLib/ExternalData">
  <Description>A role class for a File that a data element that represents an address to a file. It is derived from the AutomationML role class ExternalData that is an role type for a document type and the base class for all document type roles. It describes different document types. ExternalData is defined in AutomationML BPR_005E_ExternalDataReference_v1.0.0.2.</Description>
  <Attribute Name="idShort" AttributeDataType="xs:string">
    <Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.</Description>
    <Value></Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
  </Attribute>
  <Attribute Name="category" AttributeDataType="xs:string">
    <Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
    <Value></Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
  </Attribute>
  <Attribute Name="description" AttributeDataType="xs:string">
    <Description>Description or comments on the element. The description can be provided in several languages.</Description>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>
  </Attribute>
  <Attribute Name="dataSpecification" AttributeDataType="xs:string">
    <Description>Global reference to the data specification template used by the element.</Description>
    <Value></Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification"/>
  </Attribute>
  <Attribute Name="kind" AttributeDataType="xs:string">
    <Description>Kind of the element: either template or instance.</Description>
    <DefaultValue>Instance</DefaultValue>
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>
  </Attribute>
</RoleClass>
<Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language. </Description>

<Attribute Name="qualifier:TYPE:VALUE" AttributeDataType="xs:string"/>
<Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value. </Description>

<Attribute Name="type" AttributeDataType="xs:string"/>
<Description>The type describes the type of the qualifier that is applied to the element. </Description>

<Attribute Name="valueId" AttributeDataType="xs:string"/>
<Description>Reference to the global unique id of a coded value. </Description>

<ExternalInterface Name="FileDataReference" ID="c7a2932e-7f90-46d3-be64-0408a927c89d" RefBaseClassPath="AssetAdministrationShellInterfaceClassLib/FileDataReference">
  <Attribute Name="refURI" AttributeDataType="xs:anyURI"/>
  <Description>The attribute refURI is an IRI that can represent an absolute or relative path to an L document. An added fragment (with #) references inside the document. </Description>

  <Attribute Name="MIMEType" AttributeDataType="xs:string"/>
  <Description>Mime type of the content of the File. </Description>
</ExternalInterface>
</RoleClass>

<RoleClass Name="Property" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  <Attribute Name="idShort" AttributeDataType="xs:string"/>
  <Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name
</RoleClass>
space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.<Description>
</Description>
</Attribute>
</Attribute>
<Attribute Name="category" AttributeDataType="xs:string">
<Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
<Value></Value>
</Attribute>
<Attribute Name="description" AttributeDataType="xs:string">
<Description>Description or comments on the element. The description can be provided in several languages.</Description>
</Attribute>
</Attribute>
<Attribute Name="dataSpecification" AttributeDataType="xs:string">
<Description>Global reference to the data specification template used by the element.</Description>
</Attribute>
</Attribute>
<Attribute Name="kind" AttributeDataType="xs:string">
<Description>Kind of the element: either template or instance.</Description>
<DefaultValue>Instance</DefaultValue>
</Attribute>
</Attribute>
<Attribute Name="semanticId" AttributeDataType="xs:string">
<Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.</Description>
</Attribute>
</Attribute>
</Attribute>
<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
<Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.</Description>
</Attribute>
</Attribute>
DETAILS OF THE ADMINISTRATION SHELL - PART 1

ATTRIBUTE Name="type" AttributeDataType="xs:string">
  <Description>The type describes the type of the qualifier that is applied to the element. </Description>
  <Value></Value>
</Attribute>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>
</Attribute>

ATTRIBUTE Name="value" AttributeDataType="xs:string">
  <Description>The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId. </Description>
  <Value></Value>
</Attribute>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/value"/>
</Attribute>

ATTRIBUTE Name="valueId" AttributeDataType="xs:string">
  <Description>Reference to the global unique id of a coded value. </Description>
  <Value></Value>
</Attribute>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
</Attribute>
</RoleClass>

ROLECLASS Name="ReferencElement" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  <Description>A reference element is a data element that defines a logical reference to another element within the same or another AAS or a reference to an external object or entity. </Description>
  <Attribute Name="idShort" AttributeDataType="xs:string">
    <Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA. </Description>
    <Value></Value>
  </Attribute>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
</Attribute>

ATTRIBUTE Name="category" AttributeDataType="xs:string">
  <Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints. </Description>
  <Value></Value>
</Attribute>
<RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
</Attribute>

ATTRIBUTE Name="description" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages. </Description>
</Attribute>
<RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>
<Attribute Name="aml-lang=EN"/>
<Attribute Name="aml-lang=DE"/>
</Attribute>
<Attribute Name="dataSpecification" AttributeDataType="xs:string">
<Description>Global reference to the data specification template used by the element.</Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification"/>
</Attribute>
<Attribute Name="kind" AttributeDataType="xs:string">
<Description>Kind of the element: either template or instance.</Description>
<DefaultValue>Instance</DefaultValue>
<Value>Instance</Value>
<RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>
</Attribute>
<Constraint Name="">
<NominalScaledType>
<RequiredValue>Instance</RequiredValue>
<RequiredValue>Type</RequiredValue>
</NominalScaledType>
</Constraint>
</Attribute>
<Attribute Name="semanticId" AttributeDataType="xs:string">
<Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.</Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>
</Attribute>
<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
<Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.</Description>
<RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>
</Attribute>
<Attribute Name="type" AttributeDataType="xs:string">
<Description>The type describes the type of the qualifier that is applied to the element.</Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>
</Attribute>
<Attribute Name="valueId" AttributeDataType="xs:string">
<Description>The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId.</Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
</Attribute>
<Description>Reference to the global unique id of a coded value. </Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>

</Attribute>

</ExternalInterface>

</RoleClass>

<RoleClass Name="RelationshipElement" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">

<Description>A relationship element is used to define a relationship between two referable elements. </Description>

<Attribute Name="idShort" AttributeDataType="xs:string">

<Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA. </Description>

<RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>

</Attribute>

<Attribute Name="category" AttributeDataType="xs:string">

<Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints. </Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>

</Attribute>

<Attribute Name="description" AttributeDataType="xs:string">

<Description>Description or comments on the element. The description can be provided in several languages. </Description>

<RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>

</Attribute>

<Attribute Name="aml-lang=EN"/>

<Attribute Name="aml-lang=DE"/>

</Attribute>

<Attribute Name="dataSpecification" AttributeDataType="xs:string">

<Description>Global reference to the data specification template used by the element. </Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification"/>

</Attribute>

<Attribute Name="kind" AttributeDataType="xs:string">

<Description>Kind of the element: either template or instance. </Description>

<DefaultValue>Instance</DefaultValue>

<Value>Instance</Value>
<RefSemantic CorrespondingAttributePath="AAS:HasKind(kind)" />

<Constraint Name=""/>

<NominalScaledType>
  <RequiredValue>Instance</RequiredValue>
  <RequiredValue>Type</RequiredValue>
</NominalScaledType>
</Constraint>
</Attribute>

<Attribute Name="semanticId" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.</Description>
  <Value/>

  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>
</Attribute>

<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
  <Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.</Description>
  <Value/>

  <RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>
</Attribute>

<Attribute Name="type" AttributeDataType="xs:string">
  <Description>The type describes the type of the qualifier that is applied to the element.</Description>
  <Value/>

  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>
</Attribute>

<Attribute Name="valueId" AttributeDataType="xs:string">
  <Description>Reference to the global unique id of a coded value.</Description>
  <Value/>

  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
</Attribute>

<ExternalInterface Name="first" ID="6382c562-f165-488c-94c6-52fe0b27bb6a" RefBaseClassPath="AssetAdministrationShellInterfaceClassLib/ReferableReferableReference">
  <Attribute Name="value" AttributeDataType="xs:string">
    <Description>Reference to any other referable element of any other AAS or a reference to an external object or entity. Note: For references to any other referable element of the same AAS InternalLinks are used and this attribute value shall be empty.</Description>
    <Value/>

  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/value"/>
</Attribute>
</ExternalInterface>

<ExternalInterface Name="second" ID="f05eccaf-f1f7-4c0c-8502-ba5372640814" RefBaseClassPath="AssetAdministrationShellInterfaceClassLib/ReferableReferableReference">
  <Attribute Name="valueId" AttributeDataType="xs:string">
    <Description>Reference to the global unique id of a coded value.</Description>
    <Value/>

  <RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
</Attribute>
</ExternalInterface>
DETAILS OF THE ADMINISTRATION SHELL - PART 1

_Attribute Name_="value" _AttributeDataType_="xs:string"

_Description_ Reference to any other referable element of any other AAS or a reference to an external object or entity. Note: For references to any other referable element of the same AAS InternalLinks are used and this attribute value shall be empty. </Description>

</Attribute>
</ExternalInterface>
</RoleClass>

<RoleClass _Name_="AnnotatedRelationshipElement" _RefBaseClassPath_="AssetAdministrationShellRoleClassLib/RelationshipElement">
  
  <Description> An annotated relationship element is an relationship element that can be annotated with additional data elements. </Description>

  <Attribute _Name_="annotation" _AttributeDataType_="xs:string"/>

  <RefSemantic _CorrespondingAttributePath_="AAS:AnnotatedRelationshipElement/annotation"/>

</RoleClass>

<RoleClass _Name_="Operation" _RefBaseClassPath_="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  
  <Description> An operation is a submodel element with input and output variables. </Description>

  <Attribute _Name_="idShort" _AttributeDataType_="xs:string"/>

  <RefSemantic _CorrespondingAttributePath_="AAS:Referable/idShort"/>

  <Attribute _Name_="category" _AttributeDataType_="xs:string"/>

  <RefSemantic _CorrespondingAttributePath_="AAS:Referable/category"/>

  <Attribute _Name_="description" _AttributeDataType_="xs:string"/>

  <RefSemantic _CorrespondingAttributePath_="AAS:Referable/description"/>

</RoleClass>

_Attribute Name_="aml-lang=EN"/>

_Attribute Name_="aml-lang=DE"/>

</RoleClass>

_Attribute Name_="dataSpecification" _AttributeDataType_="xs:string"

_Description_ Global reference to the data specification template used by the element. </Description>

_Value_</Value>

<RefSemantic _CorrespondingAttributePath_="AAS:HasDataSpecification/dataSpecification"/>

</Attribute>

_Attribute Name_="kind" _AttributeDataType_="xs:string"

_Description_ Kind of the element: either template or instance. </Description>

_DefaultValue>Instance</DefaultValue>
<Value>Instance</Value>
<RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>
<Constraint Name=""></Constraint>
<NominalScaledType>
<RequiredValue>Instance</RequiredValue>
<RequiredValue>Type</RequiredValue>
</NominalScaledType>
</Constraint>
</Attribute>
<Attribute Name="semanticId" AttributeDataType="xs:string">
<Description> Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>
</Attribute>
<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
<Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>
</Attribute>
<Attribute Name="type" AttributeDataType="xs:string">
<Description>The type describes the type of the qualifier that is applied to the element. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>
</Attribute>
<Attribute Name="valueId" AttributeDataType="xs:string">
<Description>Reference to the global unique id of a coded value. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>
</Attribute>
</RoleClass>
<RoleClass Name="OperationInputVariables" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
<Description>The list of AAS OperationVariableIn entities. In AML, the corresponding InternalElement with this role is a child of the InternalElement with the Operation role. </Description>
</RoleClass>
<RoleClass Name="OperationOutputVariables" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
The list of AAS OperationVariableOut entities. In AML, the corresponding InternalElement with this role is a child of the InternalElement with the Operation role.

A view is a collection of referable elements w.r.t. to a specific viewpoint of one or more stakeholders.

Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.

The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.

Global reference to the data specification template used by the element.

Description or comments on the element. The description can be provided in several languages.

Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.

Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.
Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive.

Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.

The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.

Description or comments on the element. The description can be provided in several languages.
<Attribute Name="aml-lang=DE" AttributeDataType="xs:string"/>
</Attribute>
<Attribute Name="identification">
<Description>Abstract attribute class for identification. Has the subattributes id and idType. </Description>
<RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification"/>
<Attribute Name="id" AttributeDataType="xs:string">
<Description>Identifier of the element. Its type is defined in idType. Id is a subproperty of identification. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Identifier/id"/>
</Attribute>
</Attribute>
<Attribute Name="idType" AttributeDataType="xs:string">
<Description>Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration “IdentifierType”. IdType is a subproperty of identification. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:Identifier/idType"/>
</Attribute>
</Attribute>
<Attribute Name="administration">
<Description>Abstract attribute for administration. Has the subattributes revision and version. </Description>
<RefSemantic CorrespondingAttributePath="AAS:Identifiable/administration"/>
<Attribute Name="revision" AttributeDataType="xs:string">
<Description>Revision of the element. Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision neither. Revision is a subproperty of administration. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:AdministrativeInformation/revision"/>
</Attribute>
</Attribute>
<Attribute Name="version" AttributeDataType="xs:string">
<Description>Version of the element. Version is a subproperty of administration. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:AdministrativeInformation/version"/>
</Attribute>
</Attribute>
</Attribute>
<Attribute Name="dataSpecification" AttributeDataType="xs:string">
<Description>Global reference to the data specification template used by the element. </Description>
<RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification"/>
</Attribute>
</Attribute>
<Attribute Name="isCaseOf" AttributeDataType="xs:string">
<Description>Global reference to an external definition the concept is compatible to or was derived from. </Description>
<Value></Value>
<RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/isCaseOf"/>
</Attribute>
</Attribute>
</RoleClass>
<RoleClass Name="DataSpecification" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
<Description>Description Role class of an element that has a data specification template. A template defines the additional attributes an element may or shall have.</Description>

<Attribute Name="idShort" AttributeDataType="xs:string">
  <Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"), starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the “BrowserPath” in OPC UA.</Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
</Attribute>

<Attribute Name="category" AttributeDataType="xs:string">
  <Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
</Attribute>

<Attribute Name="description" AttributeDataType="xs:string">
  <Description>Description or comments on the element. The description can be provided in several languages.</Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>
</Attribute>

<Attribute Name="aml-lang=EN" AttributeDataType="xs:string">
  <Value/>
</Attribute>

<Attribute Name="aml-lang=DE" AttributeDataType="xs:string">
  <Value/>
</Attribute>

<Attribute Name="identification">
  <Description>Abstract attribute class for identification. Has the subattributes id and idType.</Description>
  <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification"/>
</Attribute>

<Attribute Name="id" AttributeDataType="xs:string">
  <Description>Identifier of the element. Its type is defined in idType. Id is a subproperty of identification.</Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Identifier/id"/>
</Attribute>

<Attribute Name="idType" AttributeDataType="xs:string">
  <Description>Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration "IdentifierType". IdType is a subproperty of identification.</Description>
  <Value/>
  <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType"/>
</Attribute>

<Attribute Name="administration">
  <Description>Abstract attribute for administration. Has the subattributes revision and version.</Description>
  <RefSemantic CorrespondingAttributePath="AAS:Identifiable/administration"/>
</Attribute>
<Attribute Name="revision" AttributeDataType="xs:string">
  <Description>
  Revision of the element. Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision neither. Revision is a subproperty of administration.
  </Description>
</Attribute>

<Attribute Name="version" AttributeDataType="xs:string">
  <Description>
  Version of the element. Version is a subproperty of administration.
  </Description>
</Attribute>

<RoleClass Name="DataSpecificationContent" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  <Description>
  Content of the data specification template.
  </Description>
</RoleClass>

<SystemUnitClassLib Name="AssetAdministrationShellDataSpecificationTemplates">
  <Version>0</Version>
  <SystemUnitClass Name="DataSpecificationIEC61360Template" ID="572c0568-4019-40ec-a3a82dc6ee4">
    <Description>
    An AAS Data Specification template for IEC61369. A template consists of the DataSpecificationContent containing the additional attributes to be added to the element instance that references the data specification template and meta information about the template itself (this is why DataSpecification inherits from Identifiable). In UML these are two separated classes.
    </Description>
    <Attribute Name="idShort" AttributeDataType="xs:string">
      <Description>
      Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"), starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.
      </Description>
    </Attribute>
    <Attribute Name="category" AttributeDataType="xs:string">
      <Description>
      The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.
      </Description>
    </Attribute>
    <Attribute Name="description" AttributeDataType="xs:string">
      <Description>
      Description or comments on the element. The description can be provided in several languages.
      </Description>
    </Attribute>
    <Attribute Name="aml-lang=EN" AttributeDataType="xs:string">
    </Attribute>
    <Attribute Name="aml-lang=DE" AttributeDataType="xs:string">
    </Attribute>
  </SystemUnitClass>
</SystemUnitClassLib>
<Attribute Name="identification">
  <Description>Abstract attribute class for identification. Has the subattributes id and idType. </Description>
  <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification"/>
  <Attribute Name="id" AttributeDataType="xs:string">
    <Description>Identifier of the element. Its type is defined in idType. Id is a subproperty of identification. </Description>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id"/>
  </Attribute>
  <Attribute Name="idType" AttributeDataType="xs:string">
    <Description>Type of the Identifier, e.g. IRI, IRDI etc. The supported Identifier types are defined in the enumeration “IdentifierType”. IdType is a subproperty of identification. </Description>
    <Value>IRI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType"/>
  </Attribute>
</Attribute>

<Attribute Name="administration">
  <Description>Abstract attribute for administration. Has the subattributes revision and version. </Description>
  <RefSemantic CorrespondingAttributePath="AAS:Identifiable/administration"/>
  <Attribute Name="revision" AttributeDataType="xs:string">
    <Description>Revision of the element. Constraint AASd-005: A revision requires a version. This means, if there is no version there is no revision neither. Revision is a subproperty of administration. </Description>
    <Value></Value>
    <RefSemantic CorrespondingAttributePath="AAS:AdministrativeInformation/revision"/>
  </Attribute>
  <Attribute Name="version" AttributeDataType="xs:string">
    <Description>Version of the element. Version is a subproperty of administration. </Description>
    <Value></Value>
    <RefSemantic CorrespondingAttributePath="AAS:AdministrativeInformation/version"/>
  </Attribute>
</Attribute>

<SupportedRoleClass RefRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecification"/>
<SystemUnitClass Name="DataSpecificationIEC61360" ID="8c019d8e-7ddd-4283-aa63-1747021c3d1b">
  <Description>The content of an AAS Data Specification template for IEC61360.</Description>
  <Attribute Name="preferredName" AttributeDataType="xs:string">
    <Description>Identifies the attribute hierarchy for preferredName in above attribute hierarchy. Subordinate attributes are designated by the country code information (see aml-lang literal). </Description>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName"/>
  </Attribute>
  <Attribute Name="shortName" AttributeDataType="xs:string">
    <Description>Identifies the attribute for shortName in above attribute hierarchy. </Description>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName"/>
  </Attribute>
</SystemUnitClass>
<Attribute Name="unit" AttributeDataType="xs:string">
  <Description>Identifies the attribute for unit in above attribute hierarchy.</Description>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit"/>
</Attribute>

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE

ATTRIBUTE
iii. **REF SEMANTIC VALUES AND ROLES FOR AAS**

The following symbolic identifications (literals) are used by the AutomationML mapping. Without loss of generality, these literals are recommended to be used also by other functionalities, unless not otherwise stated by this specification.

<table>
<thead>
<tr>
<th>Literals to be used in names in namespace “AAS:”</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>aml-lang=</td>
<td>When serializing AAS langString types to AML, this literal with respective country code (e.g. &quot;aml-lang=EN&quot;) is used to identify the language specific value of the langString.</td>
</tr>
<tr>
<td>qualifier:</td>
<td>For the serialization of qualifiers, this literal is used to give name to the root of the hierarchy of attributes for the qualifier (e.g. &quot;qualifier:PredicateRelation=GREATER_THAN_0&quot;)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literals to be used in names in namespace “AAS:”</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AssetAdministrationShellRoleClassLib</td>
<td>Name of the root node element for the AAS role classes in the AML RoleClassLib.</td>
</tr>
<tr>
<td>AssetAdministrationShellInterfaceClassLib</td>
<td>Name of the root node element for the AAS information in the AML InterfaceClassLib.</td>
</tr>
<tr>
<td>AssetAdministrationShellDataSpecifications</td>
<td>Name of the root node element for the predefined AAS data specification templates in the AML SystemUnitClassLib.</td>
</tr>
</tbody>
</table>

The following symbolic identifications (literals) are used by the AutomationML mapping in case no other names or existing libraries are selected for export.

<table>
<thead>
<tr>
<th>Literals to be used in names in namespace “AAS:”</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AssetAdministrationShell-InstanceHierarchy</td>
<td>Default name of the root node element for the AAS information in the AML InstanceHierarchy.</td>
</tr>
<tr>
<td>AssetAdministrationShell-SystemUnitClasses</td>
<td>Default name of the root node element for the AAS information in the AML SystemUnitClassLib.</td>
</tr>
<tr>
<td>AssetAdministrationShell-ConceptDescriptions</td>
<td>Default name of the root node element for the AAS concept descriptions in the AML InstanceHierarchy.</td>
</tr>
</tbody>
</table>
The following literals are used to identify attributes of AAS metamodel elements. In AutomationML, this is done via the "RefSemantic" mechanism and the literal is proceeded by the string "AAS:" (e.g. "AAS:Asset"). The rules for creating these values are described in Clause 7.2.4.

<table>
<thead>
<tr>
<th>Literals to identify attributes(^{42}) in namespace “AAS:” (value of RefSemantic)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAS:Referable/ idShort</td>
<td>Identifies the idShort attribute within an AAS Referable, such as Property.</td>
</tr>
<tr>
<td>AAS:Referable/ category</td>
<td>As above for category</td>
</tr>
<tr>
<td>AAS:Referable/ description</td>
<td>As above for description</td>
</tr>
<tr>
<td>AAS:HasKind/ kind</td>
<td>Identifies the kind attribute of submodel and submodel element entities.</td>
</tr>
<tr>
<td>AAS:HasSemantics/ semanticId</td>
<td>Identifies the semanticId attribute within various AAS entities.</td>
</tr>
<tr>
<td>AAS:Identifiable/ identification</td>
<td>Identifies the attribute hierarchy for identification information within AAS Identifiables.</td>
</tr>
<tr>
<td>AAS:Identifier/ idType</td>
<td>Identifies the attribute for idType in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:Identifier/ id</td>
<td>Identifies the attribute for id in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:Identifiable/ administration</td>
<td>Identifies the attribute hierarchy for administrative information within AAS Identifiables.</td>
</tr>
<tr>
<td>AAS:AdministrativeInformation/ version</td>
<td>Identifies the attribute for version in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:AdministrativeInformation/ revision</td>
<td>Identifies the attribute for revision in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:HasDataSpecification/ dataSpecification</td>
<td>Identifies an attribute containing the dataSpecification reference in its string serialization.</td>
</tr>
<tr>
<td>AAS:Qualifiable/ qualifier</td>
<td>Identifies the attribute hierarchy for an AAS Qualifiable in total.</td>
</tr>
<tr>
<td>AAS:Qualifier/ type</td>
<td>Identifies the attribute for qualifier type in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:Qualifier/ value</td>
<td>Identifies the attribute for qualifier value in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:Qualifier/ valueId</td>
<td>Identifies the attribute for qualifier valueId in above attribute hierarchy.</td>
</tr>
<tr>
<td>AAS:AssetAdministrationShell/ derivedFrom</td>
<td>Identifies the attribute containing the derivedFrom reference in its string serialization</td>
</tr>
<tr>
<td>AAS:Asset/ kind</td>
<td>Identifies the attribute containing the information about the kind of the asset</td>
</tr>
<tr>
<td>AAS:Asset/ assetIdentificationModel</td>
<td>Identifies the attribute containing the assetIdentificationModel reference for AAS Asset in its string serialization</td>
</tr>
</tbody>
</table>

\(^{42}\) Note: the blank within the path is to be ignored, it is just used for better formatting of the table. I.e. AAS:Referable/ idShort needs to be AAS:Referable/idShort as value of the RefSemantics attribute.
| AAS:Property/ value | Identifies the value attribute in various AAS SubmodelElements. |
| AAS:MultiLanguageProperty/ value |  |
| AAS:Blob/ value |  |
| AAS:File/ value |  |
| AAS:ReferenceElement/ value |  |
| AAS:Property/ valueId | Identifies the valueId attribute in the property element. |
| AAS:Blob/ mimeType | Identifies the mimeType attribute in various AAS SubmodelElements. For SubmodelElement File the MIMEType attribute of the predefined FileDataReference interface is used. That has the same semantics as AAS:File/ mimeType |
| AAS:AnnotationRelationshipElement/ annotations | Annotation of the AAS SubmodelElement Annotated Relationship. |
| AAS:ConceptDescription/ isCaseOf | Identifies the attribute containing the isCaseOf reference within AAS ConceptDescription in its string serialization. |
| AAS:ConceptDescription/ dataSpecification | Identifies the attribute containing the dataSpecification reference within AAS EmbeddedDataSpecification in its string serialization. |

The following literals are used to identify the predefined templates as defined in Clause 4.8. So far only the IEC61360 Template for concept descriptions is supported.

| Literals to identify system unit classes in AssetAdministrationShellDataSpecificationTemplates | Description |
| DataSpecificationIEC61360Template | System Unit class for the predefined data specification template representing IEC61360 attributes for properties etc. It has the role DataSpecification. |
| DataSpecificationIEC61360 | System Unit class for the content of the predefined data specification template DataSpecificationIEC61360Template. It has the role DataSpecificationContent. |

The AutomationML mapping supports the template “DataSpecificationIEC61360”. The attribute literals are defined in the following table. The name space qualifier in this case is “IEC”. Example: “IEC:DataSpecificationIEC61360/preferredName”

| Literals to identify attributes n namespace “IEC:” (value of RefSemantic) | Description |
| |  |
The following literals are used to identify AAS entities. In AutomationML, this is done via the "Role" mechanism and the role name is preceeded by "AssetAdministrationShellRoleClassLib/" in order to identify the accoding role class lib (e.g. "AssetAdministrationShellRoleClassLib/Asset").

<table>
<thead>
<tr>
<th>Literals to identify AAS entities</th>
<th>Inherits from</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset</td>
<td>AutomationMLBaseRole</td>
<td>The AAS Asset entity. In AML, the corresponding InternalElement with this role is a child of the InternalElement with the AssetAdministrationShell role.</td>
</tr>
<tr>
<td>View</td>
<td>Group</td>
<td>The AAS View entity. In AML, the corresponding InternalElement with this role is a child of the InternalElement with the AssetAdministrationShell role.</td>
</tr>
<tr>
<td>AssetAdministrationShell</td>
<td>AutomationMLBaseRole</td>
<td>The AssetAdministrationShell entity. In AML, the corresponding InternalElement is child of the instance hierarchy named AssetAdministrationShellInstanceHierarchy.</td>
</tr>
<tr>
<td>Submodel</td>
<td>AutomationMLBaseRole</td>
<td>The AAS Submodel entity. In AML, the corresponding InternalElement with this role is a child of the InternalElement with the AssetAdministrationShell role.</td>
</tr>
</tbody>
</table>
### Annex 455

<table>
<thead>
<tr>
<th>SubmodelElementCollection, Operation</th>
<th>AutomationMLBaseRole</th>
<th>One of the AAS SubmodelElement entities. In AML, the corresponding element is always an InternalElement with this role and is a child of the InternalElement with the Submodel role.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property, Blob, Capability</td>
<td>AutomationMLBaseRole</td>
<td>One of the AAS SubmodelElement entities. In AML, the corresponding element is always an InternalElement with this role and is a child of the InternalElement with the Submodel role.</td>
</tr>
<tr>
<td>ReferenceElement</td>
<td>AutomationMLBaseRole</td>
<td>The value of an ReferenceElement is realized as an interface ReferableReference.</td>
</tr>
<tr>
<td>RelationshipElement, AnnotatedRelationshipElement</td>
<td>AutomationMLBaseRole</td>
<td>The attributes first and second of a relationship element are realized with interface ReferableReference.</td>
</tr>
<tr>
<td>File</td>
<td>ExternalData</td>
<td>The AAS File SubmodelElement is realized as ExternalData with interface FileDataReference.</td>
</tr>
<tr>
<td>OperationInputVariables, OperationOutputVariables, OperationInputoutputVariables</td>
<td>AutomationMLBaseRole</td>
<td>The list of AAS OperationVariable entities. In AML, the corresponding InternalElement with this role is a child of the InternalElement with the Operation role.</td>
</tr>
<tr>
<td>ConceptDescription</td>
<td>AutomationMLBaseRole</td>
<td>The AAS ConceptDescription entity. In AML, the corresponding InternalElement is child of the instance hierarchy library named Asset-AdministrationShellConceptDescriptions.</td>
</tr>
</tbody>
</table>

#### iv. AUTOMATIONML EXAMPLE

The following AutomationML Example is a realization of the example as explained in Clause 7.37.3. The used role, interfaces and system unit classes are not included, They can be found in previous Clauses.

```xml
<?xml version=“1.0” encoding=“utf-8”?>
  <AdditionalInformation AutomationMLVersion=“2.0” />
  <InstanceHierarchy Name=“AssetAdministrationShellInstanceHierarchy”>
    <Version>0</Version>
    <InternalElement Name=“ExampleMotor” ID=“6b5bb2c7-ebea-4f5b-a0ea-e70536f44b24”>
      <Attribute Name=“identification”>
        <RefSemantic CorrespondingAttributePath=“AAS:Identifiable/identification” />
      </Attribute>
      <Attribute Name=“idType”>
        <Value>IRI</Value>
        <RefSemantic CorrespondingAttributePath=“AAS:Identifier/idType” />
      </Attribute>
      <Attribute Name=“id”>
        <Value>http://example.com/aas/9175_7013_7091_9168</Value>
        <RefSemantic CorrespondingAttributePath=“AAS:Identifier/id” />
      </Attribute>
    </InternalElement>
  </InstanceHierarchy>
</CAEXFile>
```
<Attribute Name="id">
  <Value>http://i40.example.com/type/1/1/F13E8576F6488342</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
</Attribute>
</Attribute>
</Attribute Name="idShort">
  <Value>Identification</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>
</Attribute Name="category">
  <Value>CONSTANT</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>
</Attribute Name="description">
  <Value>Identification from Manufacturer</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/description" />
  <Attribute Name="aml-lang=EN">
    <Value>Identification from Manufacturer</Value>
  </Attribute>
  <Attribute Name="aml-lang=DE">
    <Value>Herseller-Identifikation</Value>
  </Attribute>
</Attribute>
</Attribute Name="kind">
  <Value>Instance</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
</Attribute>
</Attribute Name="semanticId">
  <Value>(GlobalReference) (no-local) [IRDI]0173-1#01-ADN198#009</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
</Attribute>
</InternalElement Name="Manufacturer" ID="d6964099-e1fa-4157-b9b6-68068d4024c4">
  <Attribute Name="idShort">
    <Value>Manufacturer</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
  </Attribute>
  <Attribute Name="category">
    <Value>CONSTANT</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
  </Attribute>
  <Attribute Name="kind">
    <Value>Instance</Value>
  </Attribute>
</InternalElement Name="Manufacturer" ID="d6964099-e1fa-4157-b9b6-68068d4024c4"/>
<Attribute Name="kind">
  <Value>Instance</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
</Attribute>

<Attribute Name="semanticId">
  <Value>(GlobalReference) (no-local) [IRDI]0173-1#02-AAM556#002</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
</Attribute>

<Attribute Name="value" AttributeDataType="xs:string">
  <Value>P12345678I40</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Property/value" />
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Property" />
</InternalElement>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Submodel" />
</InternalElement>

<InternalElement Name="TechnicalData" ID="7c75c54e-f414-4282-863c-798a8858349b">
  <Attribute Name="identification">
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
  </Attribute>
  <Attribute Name="idType">
    <Value>IRI</Value>
  </Attribute>
</InternalElement>
<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Property"/>
</InternalElement>

<InternalElement Name="MaxTorque" ID="cdb9f75b-da92-484d-a6dd-c024c46d58c8">
  <Attribute Name="idShort">
    <Value>MaxTorque</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
  </Attribute>
  <Attribute Name="category">
    <Value>PARAMETER</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
  </Attribute>
  <Attribute Name="kind">
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>
  </Attribute>
  <Attribute Name="semanticId">
    <Value>(ConceptDescription)(local)[IRDI]0173-1#02-BAE098#004</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>
  </Attribute>
  <Attribute Name="value" AttributeDataType="xs:float">
    <Value>200</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Property/value"/>
  </Attribute>
</InternalElement>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Property"/>
</InternalElement>

<InternalElement Name="CoolingType" ID="92153ec4-89db-4f31-ae67-57dd1ce963c">
  <Attribute Name="idShort">
    <Value>CoolingType</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
  </Attribute>
  <Attribute Name="category">
    <Value>PARAMETER</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
  </Attribute>
  <Attribute Name="description">
    <Value>open circuit, external cooling</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>
  </Attribute>
  <Attribute Name="aml-lang=EN">
    <Value>open circuit, external cooling</Value>
  </Attribute>
  <Attribute Name="kind">
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>
  </Attribute>
</InternalElement>
<Attribute Name="semanticId">
  <Value>(ConceptDescription) (local) [IRDI]0173-1#02-BAE122#006</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
</Attribute>

<Attribute Name="value" AttributeDataType="xs:string">
  <Value>BAB657</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Property/value" />
</Attribute>

<Attribute Name="valueId">
  <Value>(ConceptDescription) (local) [IRDI]0173-1#07-BAB657#003</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Property/valueId" />
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Property" />

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Submodel" />

<InternalElement Name="OperationalData" ID="e2bcafde-ccac-4c73-8df3-9afe6b6b328">
  <Attribute Name="identification">
    <Value>http://i40.example.com/instance/1/1/AC69B1CB44F07935</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
  </Attribute>

  <Attribute Name="idType">
    <Value>IRI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
  </Attribute>

  <Attribute Name="id">
    <Value>OperationalData</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/id" />
  </Attribute>

  <Attribute Name="idShort">
    <Value>OperationalData</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
  </Attribute>

  <Attribute Name="category">
    <Value>VARIABLE</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
  </Attribute>

  <Attribute Name="kind">
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
  </Attribute>

  <Attribute Name="semanticId">
    <Value>(GlobalReference) (no-local) [IRDI]0173-1#01-AFZ615#016</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
  </Attribute>
</InternalElement>
</Attribute>
</InternalElement>

<InternalElement Name="RotationSpeed" ID="5baac73-517c-46ab-949d-02111e1322f8">
  <Attribute Name="idShort">
    <Value>RotationSpeed</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
  </Attribute>
  <Attribute Name="category">
    <Value>VARIABLE</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
  </Attribute>
  <Attribute Name="kind">
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
  </Attribute>
  <Attribute Name="semanticId">
    <Value>(ConceptDescription)(local)[IRI]http://example.com/cd/1/1/18EBD56F6B43D895</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
  </Attribute>
  <Attribute Name="value" AttributeDataType="xs:integer">
    <Value>4370</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Property/value" />
  </Attribute>
</InternalElement>

<InternalElement Name="Torque" ID="3d5d996e-e90b-4e7c-8ade-906f91daad87">
  <Attribute Name="idShort">
    <Value>Torque</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
  </Attribute>
  <Attribute Name="category">
    <Value>VARIABLE</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
  </Attribute>
  <Attribute Name="kind">
    <Value>Instance</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
  </Attribute>
  <Attribute Name="semanticId">
    <Value>(ConceptDescription)(local)[IRI]http://example.com/cd/1/1/18EBD56F6B43D896</Value>
    <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
  </Attribute>
  <Attribute Name="value" AttributeDataType="xs:float">
    <Value>117.4</Value>
  </Attribute>
</InternalElement>
DETAILS OF THE ADMINISTRATION SHELL - PART 1

CUSTOMER GmbH

OPERATING MANUAL

LANGUAGE
<Value>en-US</Value>
</RoleRequirements>
<Attribute Name="id">
  <Value>http://i40.example.com/instance/1/1/AC69B1CB44F07935</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
</Attribute>

<Attribute Name="idShort">
  <Value>OperationalData</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>

<Attribute Name="category">
  <Value>VARIABLE</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

<Attribute Name="kind">
  <Value>Instance</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasKind/kind" />
</Attribute>

<Attribute Name="semanticId">
  <Value>(GlobalReference)(no-local)[IRDI]0173-1#01-0FZ615#016</Value>
  <RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId" />
</Attribute>

<Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"), starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.</Description>

<RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />

<Attribute Name="category" AttributeDataType="xs:string">
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

<Attribute Name="description" AttributeDataType="xs:string">
  <Value></Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/description" />
</Attribute>

<Attribute Name="aml-lang=EN" />

<Attribute Name="aml-lang=DE" />

<Attribute Name="dataSpecification" AttributeDataType="xs:string">
  <Value></Value>
</Attribute>
<Description>Global reference to the data specification template used by the element.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:HasDataSpecification/dataSpecification"/>

</Attribute>

<Attribute Name="kind" AttributeDataType="xs:string">

<Description>Kind of the element: either template or instance.</Description>

<DefaultValue>Instance</DefaultValue>

<Value>Instance</Value>

<RefSemantic CorrespondingAttributePath="AAS:HasKind/kind"/>

</Attribute>

<Attribute Name="semanticId" AttributeDataType="xs:string">

<Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:HasSemantics/semanticId"/>

</Attribute>

<Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">

<Description>A qualifier is a type-value-pair that makes addition statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.</Description>

<RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>

<Attribute Name="type" AttributeDataType="xs:string">

<Description>The type describes the type of the qualifier that is applied to the element.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>

</Attribute>

<Attribute Name="value" AttributeDataType="xs:string">

<Description>The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Qualifier/value"/>

</Attribute>

<Attribute Name="valueId" AttributeDataType="xs:string">

<Description>Reference to the global unqiue id of a coded value.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Qualifier/valueId"/>

</Attribute>

</Attribute>
<Description>The value of the property instance.  </Description>
</Attribute><Attribute Name="valueId" AttributeDataType="xs:string" />
<Description>Reference to the global unique id if a coded value.</Description>
</Attribute></RefSemantic>
<AttributeRefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/OperationInputVariables"/>
<InternalElement Name="OutputVariables" ID="c10d327e-c393-4a76-8738-658b70ae883a" />
<Attribute Name="idShort" AttributeDataType="xs:string">
<Description>Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.</Description>
</Value>
</Attribute><AttributeRefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/Property"/>
<Attribute Name="short" AttributeDataType="xs:string">
<Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>
</Value>
</Attribute><AttributeRefBaseRoleClassPath="AAS:Referable/category" />
</Attribute><Attribute Name="description" AttributeDataType="xs:string">
<Description>Description or comments on the element. The description can be provided in several languages.</Description>
</Value>
</Attribute><AttributeRefBaseRoleClassPath="AAS:Referable/description" />
</Attribute><Attribute Name="dataSpecification" AttributeDataType="xs:string">
<Description>Global reference to the data specification template used by the element.</Description>
</Value>
</Attribute><AttributeRefBaseRoleClassPath="AAS:HasDataSpecification/dataSpecification" />
</Attribute><Attribute Name="kind" AttributeDataType="xs:string">
<Description>Kind of the element: either template or instance.</Description>
</Value>
</Attribute><AttributeRefBaseRoleClassPath="AAS:HasKind/kind" />
</Attribute>
Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.

A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.

The type describes the type of the qualifier that is applied to the element.

The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId.

Reference to the global unique id of a coded value.

The value of the property instance.

Reference to the global unique id if a coded value.

Identifying string of the element within its name space. Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. Constraint AASd-002: idShort shall only feature letters, digits, underscore ("_"); starting mandatory with a letter. Constraint AASd-003: idShort shall be matched case-insensitive. Note: In case of an identifiable element idShort is optional but recommended to be defined. It can be used for unique reference in its name space and thus allows better usability and a more performant implementation. In this case it is similar to the "BrowserPath" in OPC UA.

Reference to the global unique id of a coded value.
<Description>The category is a value that gives further meta information w.r.t. to the class of the element. It affects the expected existence of attributes and the applicability of constraints.</Description>

<RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>

</Attribute><Attribute Name="description" AttributeDataType="xs:string">
<Description>Description or comments on the element. The description can be provided in several languages.</Description>

<RefSemantic CorrespondingAttributePath="AAS:Referable/description"/>

</Attribute><Attribute Name="aml-lang=EN"/>

</Attribute><Attribute Name="aml-lang=DE"/>

</Attribute><Attribute Name="dataSpecification" AttributeDataType="xs:string">
<Description>Global reference to the data specification template used by the element.</Description>

<RefSemantic CorrespondingAttributePath="AAS:Referable/dataSpecification"/>

</Attribute><Attribute Name="kind" AttributeDataType="xs:string">
<Description>Kind of the element: either template or instance.</Description>

<DefaultValue>Instance</DefaultValue>

</Attribute><Attribute Name="kind">
<Constraint Name="">
<NominalScaledType>
<RequiredValue>Instance</RequiredValue>
<RequiredValue>Type</RequiredValue>

</NominalScaledType>
</Constraint>

</Attribute><Attribute Name="semanticId" AttributeDataType="xs:string">
<Description>Description or comments on the element. The description can be provided in several languages. This attribute has the name of the label and has a value with the label written in the default language. The individual languages are modelled as child attributes. The names of the child attributes are the prefix "aml-lang=" with the expression of the language in compliance with RFC5646. At it, the values of the child attributes are the labels within the respective language.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Referable/semanticId"/>

</Attribute><Attribute Name="qualifier:[TYPE]=[VALUE]" AttributeDataType="xs:string">
<Description>A qualifier is a type-value-pair that makes additional statements w.r.t. the value of the element. [TYPE] is the value of the attribute type and [VALUE] is the value of the attribute value.</Description>

<RefSemantic CorrespondingAttributePath="AAS:Qualifiable/qualifier"/>

</Attribute><Attribute Name="type" AttributeDataType="xs:string">
<Description>The type describes the type of the qualifier that is applied to the element.</Description>

<Value></Value>

<RefSemantic CorrespondingAttributePath="AAS:Qualifier/type"/>

</Attribute>

<Attribute Name="value" AttributeDataType="xs:string"/>
The qualifier value is the value of the qualifier. Constraint AASd-006: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId.
<Attribute Name="shortName">
  <Value>Document</Value>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName"/>
</Attribute>

<Attribute Name="unit">
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit"/>
</Attribute>

<Attribute Name="sourceOfDefinition">
  <Value>[ISO 15519-1:2010]</Value>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/sourceOfDefinition"/>
</Attribute>

<Attribute Name="aml-lang=DE">
  <Value>[ISO 15519-1:2010]</Value>
</Attribute>

<Attribute Name="dataType">
  <Value>ENTITY</Value>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType"/>
</Attribute>

<Attribute Name="definition">
  <Value>Feste und geordnete Menge von für die Verwendung durch Personen bestimmte Informationen, die verwaltet und als Einheit zwischen Benutzern und System ausgetauscht werden kann.</Value>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>
  <Attribute Name="aml-lang=DE">
    <Value>Feste und geordnete Menge von für die Verwendung durch Personen bestimmte Informationen, die verwaltet und als Einheit zwischen Benutzern und System ausgetauscht werden kann.</Value>
  </Attribute>
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent"/>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription"/>

<InternalElement Name="DocumentId__URI_www_vdi2770_com_blatt1_Entwurf_Okt18_cd_DocumentId_Val">
  <Attribute Name="identification">
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification"/>
  </Attribute>

  <Attribute Name="idType">
    <Value>IRI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType"/>
  </Attribute>

  <Attribute Name="id">
    <Value>www.vdi2770.com/blatt1/Entwurf/Okt18/cd/DocumentId/Val</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id"/>
  </Attribute>
</InternalElement>
DETAILS OF THE ADMINISTRATION SHELL - PART 1

<InternalElement Name="DocumentClassId__URI_wdi2770_com_bbltt1_Entwurf_Okt18_cd_DocumentClassification_ClassId" ID="bdb52663-52b7-4442-bb55-a6232b849b2e">
  <Attribute Name="identification">
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
  </Attribute>
  <Attribute Name="idType">
    <Value>IRI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
  </Attribute>
  <Attribute Name="id">
    <Value>www.wdi2770.com/blatt1/Entwurf/Okt18/cd/DocumentClassification/ClassId</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
  </Attribute>
  <Attribute Name="idShort">
    <Value>DocumentClassId</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
  </Attribute>
  <Attribute Name="unit">
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
  </Attribute>
  <Attribute Name="dataType">
    <Value>STRING</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
  </Attribute>
  <Attribute Name="definition">
    <Value>Eindeutige ID der Klasse in einer Klassifikation.</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" />
  </Attribute>
  <Attribute Name="aml-lang=DE">
    <Value>Eindeutige ID der Klasse in einer Klassifikation.</Value>
  </Attribute>
</InternalElement>

<InternalElement Name="EmbeddedDataSpecification" ID="489218e7-4cb6-4ef3-916d-d6ee3dd75a78" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
  <Attribute Name="shortName">
    <Value>DocumentClassId</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
  </Attribute>
</InternalElement>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType"/>
</Attribute>

<Attribute Name="definition">
</Value>Liste von sprachabhängigen Namen zur ClassId. </Value>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>
</Attribute>
</Attribute>
</RoleRequirements>
RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" />
</InternalElement>
</RoleRequirements>
RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" />
</InternalElement>
</InternalElement>
Name="DocumentClassificationSystem__URI www.vdi2770.com_blatt1_Entwurf_Okt18_cd_DocumentClassification/ClassificationSystem" ID="ef224659-8efb-485c-b549-c0638d2e69b4">

<Attribute Name="identification">
</Value><RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification"/>
</Attribute>

<Attribute Name="idType">
</Value>IRI </Value>
</RefSemantic CorrespondingAttributePath="AAS:Identifier/idType"/>
</Attribute>
</Attribute>
</Attribute>
</Attribute>
<Attribute Name="hasDataSpecification">
</Value>
</RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification"/>

</Attribute>
</InternalElement>
InternalElement Name="EmbeddedDataSpecification" ID="d304accd-8658-4433-a59e-b3a138635142" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">

<Attribute Name="preferredName">
</Value>
<Value>Classification System</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName"/>
</Attribute>
</Value>Klassifikationssystem</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Klassifikationssystem</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName"/>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Classification System</Value>
</Attribute>
</Value>Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss "VDI2770:2018" verwenden werden.</Value>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>
</Attribute>
</Value>Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss "VDI2770:2018" verwenden werden.</Value>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>  
</Attribute>
</Value>Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss "VDI2770:2018" verwenden werden.</Value>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>
</Attribute>
</Value>Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss "VDI2770:2018" verwenden werden.</Value>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>
</Attribute>
</Value>Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss "VDI2770:2018" verwenden werden.</Value>
</RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition"/>
</Attribute>
</Value>Eindeutige Kennung für ein Klassifikationssystem. Für Klassifikationen nach VDI 2770 muss "VDI2770:2018" verwenden werden.</Value>
</Attribute>
</Attribute>

<Attribute Name="idShort">
  <Value>OrganizationName</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>

<Attribute Name="category">
  <Value>CONSTANT</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

<Attribute Name="hasDataSpecification">
  <RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification" />
</Attribute>

<InternalElement Name="EmbeddedDataSpecification" ID="ae724f57-cf34-42c6-ae7b-247e44d4f16" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
  <Attribute Name="preferredName">
    <Value>gebräuchliche Bezeichnung für Organisation</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName" />
  </Attribute>
  <Attribute Name="aml-lang=DE">
    <Value>gebräuchliche Bezeichnung für Organisation</Value>
  </Attribute>
  <Attribute Name="aml-lang=EN">
    <Value>organization name</Value>
  </Attribute>
  <Attribute Name="shortName">
    <Value>OrganizationName</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
  </Attribute>
  <Attribute Name="unit">
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
  </Attribute>
  <Attribute Name="dataType">
    <Value>STRING</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
  </Attribute>
  <Attribute Name="definition">
    <Value>Die gebräuchliche Bezeichnung für die Organisation.</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" />
  </Attribute>
  <Attribute Name="aml-lang=DE">
    <Value>Die gebräuchliche Bezeichnung für die Organisation.</Value>
  </Attribute>
</InternalElement>
<RoleRequirements
RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" />
</InternalElement>
<RoleRequirements
RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" />
</InternalElement>
<InternalElement
Name="OrganizationOfficialName_URI www_vdi2770_com_blatt1_Entwurf_Okt18_cd_Organization_OrganizationOfficialName" ID="3c1163bc-6b30-41e1-beeb-8882d8716513">
  <Attribute
Name="identification">
    <RefSemantic
CorrespondingAttributePath="AAS:Identifiable/identification" />
  </Attribute>
  <Attribute
Name="idType">
    <Value>IRI</Value>
    <RefSemantic
CorrespondingAttributePath="AAS:Identifier/idType" />
  </Attribute>
  <Attribute
Name="id">
    <Value>www.vdi2770.com/blatt1/Entwurf/Okt18/cd/Organization/OrganizationOfficialName</Value>
    <RefSemantic
CorrespondingAttributePath="AAS:Identifier/id" />
  </Attribute>
  <Attribute
Name="idShort">
    <Value>OrganizationOfficialName</Value>
    <RefSemantic
CorrespondingAttributePath="AAS:Referable/idShort" />
  </Attribute>
  <Attribute
Name="category">
    <Value>CONSTANT</Value>
    <RefSemantic
CorrespondingAttributePath="AAS:Referable/category" />
  </Attribute>
  <Attribute
Name="isCaseOf">
    <Value>(ConceptDescription)(local)[IRDI]0173-1#02-AAO677#002</Value>
    <RefSemantic
CorrespondingAttributePath="AAS:ConceptDescription/isCaseOf" />
  </Attribute>
  <Attribute
Name="hasDataSpecification">
    <RefSemantic
CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification" />
  </Attribute>
  <InternalElement
Name="EmbeddedDataSpecification" ID="3a4abc63-f4fe-4a68-87fc-c4ffac7eeff76"
RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
    <Attribute
Name="preferredName">
      <Value>offizieller Name der Organisation</Value>
      <RefSemantic
CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName" />
    </Attribute>
  </InternalElement>
</InternalElement>
<Attribute Name="aml-lang=EN">
   <Value>official name of the organization</Value>
</Attribute>

<!-- Attribute Name="shortName" -->
<!-- Value=OrganizationOfficialName -->
<!-- RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" / -->

<!-- Attribute Name="unit" -->
<!-- RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" / -->

<!-- Attribute Name="dataType" -->
<!-- Value=STRING -->
<!-- RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" / -->

<!-- Attribute Name="definition" -->
<!-- Value=Der offizielle Namen der Organisation. -->
<!-- RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" / -->

<!-- Attribute Name="aml-lang=DE" -->
<!-- Value=Der offizielle Namen der Organisation. -->
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" />

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" />

  <Attribute Name="identification">
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
  </Attribute>
  <Attribute Name="idType">
    <Value>IRI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
  </Attribute>
  <Attribute Name="id">
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
  </Attribute>
</InternalElement>
Zu jedem Dokument muss eine Menge von mindestens einer Dokumentenversion existieren. Es können auch mehrere Dokumentenversionen ausgeliefert werden.
Eine Liste der im Dokument verwendeten Sprachen.
Eine Liste der im Dokument verwendeten Sprachen.

Tittel
DETAILS OF THE ADMINISTRATION SHELL - PART 1
Datum und Uhrzeit, an dem der Status festgelegt wurde. Es muss das Datumsformat „YYYY-MM-dd“ verwendet werden (Y = Jahr, M = Monat, d = Tag, siehe ISO 8601).
<Attribute Name="id">www.vdi2770.com/blatt1/Entwurf/Okt18/cd/StoredDocumentRepresentation/DigitalFile</Value>
</Attribute>

<Attribute Name="idShort">DigitalFile</Value>
</Attribute>

<Attribute Name="hasDataSpecification">
</Attribute>

<InternalElement Name="EmbeddedDataSpecification" ID="4e500b50-bdaa-450f-81f6-0ba77b8b199a" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
  <Attribute Name="shortName">
    <Value>DigitalFile</Value>
  </Attribute>
  <Attribute Name="unit">
    <Value>FILE</Value>
  </Attribute>
  <Attribute Name="dataType">
    <Value>FILE</Value>
  </Attribute>
  <Attribute Name="definition">
    <Value>Eine Datei, die die DocumentVersion repräsentiert. Neben der obligatorischen PDF/A Datei können weitere Dateien angegeben werden.</Value>
  </Attribute>
  <Attribute Name="aml-lang=DE">
    <Value>Eine Datei, die die DocumentVersion repräsentiert. Neben der obligatorischen PDF/A Datei können weitere Dateien angegeben werden.</Value>
  </Attribute>
</InternalElement>

<InternalElement Name="MaxRotationSpeed__IRDI_0173-1_02-BAA120_008" ID="cbdc9f25-7e81-4d23-8561-5350b35f6d5e">
  <Attribute Name="identification">
    <Value>Eine Datei, die die DocumentVersion repräsentiert. Neben der obligatorischen PDF/A Datei können weitere Dateien angegeben werden.</Value>
  </Attribute>
</InternalElement>
<Attribute Name="idType">
  <Value>IRDI</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
</Attribute>

<Attribute Name="id">
  <Value>0173-1#02-BAA120#008</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
</Attribute>

<Attribute Name="administration">
  <RefSemantic CorrespondingAttributePath="AAS:Identifiable/administration" />
</Attribute>

<Attribute Name="version">
  <RefSemantic CorrespondingAttributePath="AAS:AdministrativeInformation/version" />
</Attribute>

<Attribute Name="revision">
  <Value>2</Value>
  <RefSemantic CorrespondingAttributePath="AAS:AdministrativeInformation/revision" />
</Attribute>

<Attribute Name="idShort">
  <Value>MaxRotationSpeed</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>

<Attribute Name="category">
  <Value>PROPERTY</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

<Attribute Name="isCaseOf">
  <RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/isCaseOf" />
</Attribute>

<Attribute Name="hasDataSpecification">
  <RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification" />
</Attribute>

<InternalElement Name="EmbeddedDataSpecification" ID="81b88f57-8b23-4529-ad12-ffe481881c28" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
  <Attribute Name="preferredName">
    <Value>max. Drehzahl</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName" />
  </Attribute>
  <Attribute Name="aml-lang=de">
    <Value>max. Drehzahl</Value>
  </Attribute>
  <Attribute Name="aml-lang=en">
    <Value>Max. rotation speed</Value>
  </Attribute>
</InternalElement>
Annex 493

ATTRIBUTE

<Attribute Name="shortName">
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
</Attribute>

ATTRIBUTE

<Attribute Name="unit">
    <Value>1/min</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
</Attribute>

ATTRIBUTE

<Attribute Name="unitId">
    <Value>(GlobalReference)(no-local)[IRDI]0173-1#05-AAA650#002</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unitId" />
</Attribute>

ATTRIBUTE

<Attribute Name="dataType">
    <Value>INTEGER_MEASURE</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
</Attribute>

ATTRIBUTE

<Attribute Name="definition">
    <Value>Höchste zulässige Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben werden darf</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" />
</Attribute>

ATTRIBUTE

<Attribute Name="aml-lang=de">
    <Value>Höchste zulässige Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben werden darf</Value>
</Attribute>

ATTRIBUTE

<Attribute Name="aml-lang=en">
    <Value>Greatest permissible rotation speed with which the motor or feeding unit may be operated</Value>
</Attribute>

ROLE REQUIREMENTS

RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" /

<InternalElement>

ROLE REQUIREMENTS

RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" /

<InternalElement Name="MaxTorque__IRDI_0173-1_02-BAE098_004" ID="7b8a5bf5-09ce-4228-9079-49586d7a81c2">

ATTRIBUTE

<Attribute Name="identification">
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
</Attribute>

ATTRIBUTE

<Attribute Name="idType">
    <Value>IRDI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
</Attribute>

ATTRIBUTE

<Attribute Name="id">
    <Value>0173-1#02-BAE098#004</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
</Attribute>
<Attribute Name="idShort">
  <Value>MaxTorque</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>

ATTRIBUTE
<Attribute Name="category">
  <Value>PROPERTY</Value>
  <RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

ATTRIBUTE
<Attribute Name="hasDataSpecification">
  <RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification" />
</Attribute>

INTERNAL ELEMENT
<InternalElement Name="EmbeddedDataSpecification" ID="1cf999e8-8b86-41a6-8aae-256e1b6612b"
                     RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
  <Attribute Name="preferredName">
    <Value>Max. torque</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName" />
  </Attribute>
  <Attribute Name="aml-lang=EN">
    <Value>Max. torque</Value>
  </Attribute>
  <Attribute Name="shortName">
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
  </Attribute>
  <Attribute Name="unit">
    <Value>Nm</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
  </Attribute>
  <Attribute Name="unitId">
    <Value>(GlobalReference) (no-local) [IRDI] 0173-1#05-AAA212#003</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unitId" />
  </Attribute>
  <Attribute Name="dataType">
    <Value>REAL_MEASURE</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
  </Attribute>
  <Attribute Name="definition">
    <Value>Greatest permissible mechanical torque which the motor can pass on at the drive shaft</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" />
    <Attribute Name="aml-lang=EN">
      <Value>Greatest permissible mechanical torque which the motor can pass on at the drive shaft</Value>
    </Attribute>
    <Attribute Name="aml-lang=DE">
    </Attribute>
  </Attribute>
</InternalElement>
Größtes mechanisch zulässiges Drehmoment, welches der Motor an der Abtriebswelle abgeben kann.

Attribute Name="identification"
Attribute Name="idType">
    <Value>IRI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType"/>
</Attribute>
Attribute Name="id">
    <Value>http://example.com/cd/1/1/18EBD566B43D895</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id"/>
</Attribute>
Attribute Name="idShort">
    <Value>RotationSpeed</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/idShort"/>
</Attribute>
Attribute Name="category">
    <Value>PROPERTY</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Referable/category"/>
</Attribute>
Attribute Name="hasDataSpecification">
    <RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification"/>
</Attribute>
Attribute Name="preferredName">
    <Value>Aktuelle Drehzahl</Value>
    <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName"/>
    <Attribute Name="aml-lang=DE">
        <Value>Aktuelle Drehzahl</Value>
    </Attribute>
    <Attribute Name="aml-lang=EN">
        <Value>Actual rotation speed</Value>
    </Attribute>
</Attribute>

<Attribute Name="shortName">
   <Value>RotationSpeed</Value>
   <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
</Attribute>

<Attribute Name="unit">
   <Value>1/min</Value>
   <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
</Attribute>

<Attribute Name="unitId">
   <Value>(GlobalReference)(no-local)[IRDI]0173-1#05-AAA650#002</Value>
   <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unitId" />
</Attribute>

<Attribute Name="dataType">
   <Value>INTEGER_MEASURE</Value>
   <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
</Attribute>

<Attribute Name="definition">
   <Value>Aktuelle Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben wird</Value>
   <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" />
</Attribute>

<Attribute Name="aml-lang=DE">
   <Value>Aktuelle Drehzahl, mit welcher der Motor oder die Speiseinheit betrieben wird</Value>
</Attribute>

<Attribute Name="aml-lang=EN">
   <Value>Actual rotation speed with which the motor or feeding unit is operated</Value>
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" />
</InternalElement>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" />
</InternalElement>

<InternalElement Name="Torque_URI_http_customer_com_cd_1_1_18EBD56F6B43D896" ID="f72c1826-0b8e-45be-9afe-ff3c043bb602">
   <Attribute Name="identification">
      <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
   </Attribute>

   <Attribute Name="idType">
      <Value>IRI</Value>
      <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
   </Attribute>

   <Attribute Name="id">
      <Value>http://example.com/cd/1/1/18EBD56F6B43D896</Value>
   </Attribute>
</InternalElement>
<RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
</Attribute>
</Attribute>
<Attribute Name="idShort">
<Value>Torque</Value>
<RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>
<Attribute Name="category">
<Value>PROPERTY</Value>
<RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>
<Attribute Name="hasDataSpecification">
<RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification" />
</Attribute>

<InternalElement Name="EmbeddedDataSpecification" ID="e9e5f4d-cddf-4542-8934-aee5fbe76cc" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">
<Attribute Name="preferredName">
<Value>Drehmoment</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName" />
</Attribute>
<Attribute Name="aml-lang=DE">
<Value>Drehmoment</Value>
</Attribute>
<Attribute Name="aml-lang=EN">
<Value>Torque</Value>
</Attribute>
</InternalElement>

<Attribute Name="shortName">
<Value>Torque</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
</Attribute>
<Attribute Name="unit">
<Value>Nm</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
</Attribute>
<Attribute Name="unitId">
<Value>{GlobalReference} (no-local) [IRDI]0173-1#05-AAA212#003</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unitId" />
</Attribute>
<Attribute Name="dataType">
<Value>REAL_MEASURE</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
</Attribute>
<Attribute Name="definition">
Actual mechanical torque which the motor passes on at the drive shaft

**aml-lang=EN**

Actual mechanical torque which the motor passes on at the drive shaft

**aml-lang=DE**

Aktuelles Drehmoment, welches der Motor an der Abtriebswelle abgibt

**identification**

IRDI

**idType**

0173-1#02-BAE122#006

**idShort**

CoolingType

**category**

PROPERTY


**preferredName**

Art der Kühlung

**preferredName**

Die Art der Kühlung
<Attribute Name="aml-lang=DE">
  <Value>Art der Kühlung</Value>
</Attribute>

<Attribute Name="aml-lang=EN">
  <Value>Cooling type</Value>
</Attribute>

<Attribute Name="shortName">
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
</Attribute>

<Attribute Name="unit">
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
</Attribute>

<Attribute Name="dataType">
  <Value>STRING</Value>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
</Attribute>

<Attribute Name="definition">
  <Value>Zusammenfassung verschiedener Kühlarten, um für Suchmerkmale zu einer begrenzten Auswahl zu kommen</Value>
  <RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/definition" />
</Attribute>

<Attribute Name="aml-lang=DE">
  <Value>Zusammenfassung verschiedener Kühlarten, um für Suchmerkmale zu einer begrenzten Auswahl zu kommen</Value>
</Attribute>

<Attribute Name="aml-lang=EN">
  <Value>Summary of various types of cooling, for use as search criteria that limit a selection</Value>
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" />

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" />

<InternalElement Name="BAB657__IRDI_0173-1_07-BAB657_003" ID="1319f7a2-eef9-4d93-8563-3158d1d5b159">
  <Attribute Name="identification">
    <RefSemantic CorrespondingAttributePath="AAS:Identifiable/identification" />
  </Attribute>
  <Attribute Name="idType">
    <Value>IRDI</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/idType" />
  </Attribute>
  <Attribute Name="id">
    <Value>0173-1#07-BAB657#003</Value>
    <RefSemantic CorrespondingAttributePath="AAS:Identifier/id" />
  </Attribute>
</InternalElement>
<Attribute Name="idShort">
<Value>BAB657</Value>
<RefSemantic CorrespondingAttributePath="AAS:Referable/idShort" />
</Attribute>

<Attribute Name="category">
<Value>VALUE</Value>
<RefSemantic CorrespondingAttributePath="AAS:Referable/category" />
</Attribute>

<Attribute Name="hasDataSpecification">
<RefSemantic CorrespondingAttributePath="AAS:ConceptDescription/dataSpecification" />
</Attribute>

<InternalElement Name="EmbeddedDataSpecification" ID="f5a3cfcf-2f4b-4450-acc3-af5bac47af66" RefBaseSystemUnitPath="AssetAdministrationShellDataSpecificationTemplates/DataSpecificationIEC61360Template/DataSpecificationIEC61360">

<Attribute Name="preferredName">
<Value>open circuit, external cooling</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/preferredName" />
</Attribute>

<Attribute Name="aml-lang=EN">
<Value>open circuit, external cooling</Value>
</Attribute>

<Attribute Name="aml-lang=DE">
<Value>offener Kreis, Fremdkühlung</Value>
</Attribute>

<Attribute Name="shortName">
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/shortName" />
</Attribute>

<Attribute Name="unit">
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/unit" />
</Attribute>

<Attribute Name="dataType">
<Value>STRING</Value>
<RefSemantic CorrespondingAttributePath="IEC:DataSpecificationIEC61360/dataType" />
</Attribute>

<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/DataSpecificationContent" />
</InternalElement>
</InternalElement>
<RoleRequirements RefBaseRoleClassPath="AssetAdministrationShellRoleClassLib/ConceptDescription" />
</CAEXFile>
The OPC UA nodeset for the OPC UA Companion Specification of the Asset Administration Shell will be published as an OPC UA Companion Specification. In Figure 167 an extract of the Servo DC Motor example is shown.

The specification is not yet updated conformant to the version specified in this document. However, the mapping rules as defined in Clause 0 still hold.
Figure 167 Example Servo Motor in OPC UA (Extract)
ANNEX K. METAMODEL CHANGES

i. METAMODEL CHANGES V3.0RC01 W/O SECURITY PART

Major changes:

- idShort of Submodels etc. do not need to be unique in the context of an AssetAdministrationShell any longer
- Constraints implicitly contained in text were formalized and numbered
- Revised concept on handling of Asset and assetIdentificationModel (assetInformation)
- ConceptDictionaries not supported any longer
- semanticId not mandatory any longer for SubmodelElement
- More than one bill of material for assetInformation in Asset Administration Shell
- Local attribute in Referables removed
- Parent attribute in Referables removed

Table 28 Changes w.r.t. V2.0 w/o Security

<table>
<thead>
<tr>
<th>nc43</th>
<th>V3.0RC01 Change w.r.t. V2.0.1</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>anySimpleTypeDef</td>
<td>Type removed, was not used in any class definition any longer, was mentioned in Text only.</td>
</tr>
<tr>
<td>x</td>
<td>AssetAdministrationShell/asset</td>
<td>Removed, substituted by AssetAdministrationShell/assetInformation (but no reference any longer but an aggregation)</td>
</tr>
<tr>
<td>x</td>
<td>Asset/assetKind</td>
<td>Attribute “assetKind” moved to AssetAdministrationShell/AssetInformation</td>
</tr>
<tr>
<td>x</td>
<td>Asset/assetIdentificationModel</td>
<td>Attribute “assetIdentificationModel” Removed, substituted by AssetInformation/IdentifierKeyValuePairs</td>
</tr>
<tr>
<td>x</td>
<td>Asset/billOfMaterial</td>
<td>Attribute “billOfMaterial” moved to AssetAdministrationShell/AssetInformation</td>
</tr>
<tr>
<td>x</td>
<td>AssetAdministrationShell/conceptDictionaries</td>
<td>Removed</td>
</tr>
<tr>
<td></td>
<td>ConceptDescription/isCaseOf</td>
<td>Text changed, no global reference requested, just reference.</td>
</tr>
<tr>
<td>x</td>
<td>ConceptDictionary</td>
<td>Removed</td>
</tr>
<tr>
<td>x</td>
<td>Entity/asset</td>
<td>Removed, substituted by Entity/globalAssetId and Entity/specificAssetId</td>
</tr>
<tr>
<td>x</td>
<td>Key/local</td>
<td>Local attribute removed.</td>
</tr>
<tr>
<td>x</td>
<td>Referable/parent</td>
<td>Parent attribute removed.</td>
</tr>
</tbody>
</table>

43 “nc=x” means not backward compatible
### Table 29 New Elements in Metamodel V3.0RC01 w/o Security

<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>AssetAdministrationShell/assetInformation</td>
<td>substitute for AssetAdministrationShell/asset but no reference any longer but an aggregation</td>
</tr>
<tr>
<td></td>
<td>AssetInformation</td>
<td>with attributes/functionality from former class Asset because not specific to Asset but AAS</td>
</tr>
<tr>
<td></td>
<td>AssetInformation/thumbnail</td>
<td>Optional Attribute of new class AssetInformation that was not available in Asset class before</td>
</tr>
<tr>
<td>x</td>
<td>Entity/globalAssetId</td>
<td>Substitute for Entity/asset (together with Entity/specificAssetId)</td>
</tr>
<tr>
<td>x</td>
<td>Entity/specificAssetId</td>
<td>Substitute for Entity/asset (together with Entity/globalAssetId)</td>
</tr>
<tr>
<td></td>
<td>Extension</td>
<td>New class, part of new abstract class HasExtensions</td>
</tr>
<tr>
<td></td>
<td>HasExtensions</td>
<td>New abstract class, inherited by Referable</td>
</tr>
<tr>
<td></td>
<td>IdentifierKeyValuePair</td>
<td>New class for AssetInformation/specificAssetId</td>
</tr>
<tr>
<td></td>
<td>Referable/displayName</td>
<td>New optional attribute for all referables</td>
</tr>
</tbody>
</table>

### Table 30 New, Changed or Removed Constraints w/o Security

<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>New, Update, Removed, Reformulated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AASd-001</td>
<td>Removed</td>
<td>Constraint AASd-001: In case of a referable element not being an identifiable element this id is mandatory and used for referring to the element in its name space. For namespace part see AASd-022</td>
</tr>
</tbody>
</table>
| x   | AASd-002 | Update                            | reformulated, formula added
idShort of Referables shall only feature letters, digits, underscore (\_\_\_); starting mandatory with a letter. I.e. [a-zA-Z][a-zA-Z0-9_]+ |
|     | AASd-010 | Reformulated                      | Constraint AASd-010: The property has the category “CONSTANT”. Reformulated to Constraint AASd-010: The property referenced in Permission/permission shall have the category “CONSTANT”. |
|     | AASd-011 | Reformulated                      | Constraint AASd-011: The property referenced in Permission/permission shall be part of the submodel that is referenced within the “selectablePermissions” attribute of “AccessControl”. |

---

44 “nc=x” means not backward compatible
45 “nc=x” means not backward compatible. nc=(x) means although it is a new constraint it is considered to be a more precise definition and not an additional constraint that was not in the focus of the previous version.
<table>
<thead>
<tr>
<th>nc45</th>
<th>V3.0RC01</th>
<th>New, Update, Removed, Reformulated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AASd-012</td>
<td>Reformulated</td>
<td>Constraint AASd-012: If both, the MultiLanguageProperty/value and the MultiLanguageProperty/valueId are present then for each string in a specific language the meaning must be the same as specified in MultiLanguageProperty/valueId.</td>
</tr>
<tr>
<td></td>
<td>AASd-014</td>
<td>Reformulated</td>
<td>Entity was changed</td>
</tr>
<tr>
<td></td>
<td>AASd-020</td>
<td>New</td>
<td>Constraint AASd-020: The value of Property/value shall be consistent to the data type as defined in Property/valueType.</td>
</tr>
<tr>
<td>(x)</td>
<td>AASd-021</td>
<td>New</td>
<td>Constraint AASd-021: Every qualifiable can only have one qualifier with the same Qualifier/type.</td>
</tr>
<tr>
<td></td>
<td>AASd-022</td>
<td>New46</td>
<td>Splitted part from AASd-001</td>
</tr>
<tr>
<td></td>
<td>AASd-026</td>
<td>New47</td>
<td>Constraint AASd-026: If allowDuplicates==false then it is not allowed that the collection contains several elements with the same semantics (i.e. the same semanticId).</td>
</tr>
<tr>
<td></td>
<td>AASd-050</td>
<td>New48</td>
<td>Constraint AASd-050: If the DataSpecificationContent DataSpecificationIEC61360 is used for an element then the value of hasDataSpecification/dataSpecification shall contain the global reference to the IRI of the corresponding data specification template <a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>.</td>
</tr>
<tr>
<td></td>
<td>AASd-050</td>
<td>New49</td>
<td>Constraint AASd-050: A ConceptDescription shall have one of the following categories: VALUE, PROPERTY, REFERENCE, DOCUMENT, CAPABILITY, RELATIONSHIP, COLLECTION, FUNCTION, EVENT, ENTITY, APPLICATION_CLASS, QUALIFIER, VIEW. Default: PROPERTY.</td>
</tr>
<tr>
<td></td>
<td>AASd-052a</td>
<td>New50</td>
<td>Constraint AASd-052a: If the semanticId of a Property references a ConceptDescription then the ConceptDescription/category shall be one of following values: VALUE, PROPERTY.</td>
</tr>
<tr>
<td></td>
<td>AASd-052b</td>
<td>New51</td>
<td>Constraint AASd-052b: If the semanticId of a MultiLanguageProperty references a ConceptDescription then the ConceptDescription/category shall be one of following values: PROPERTY.</td>
</tr>
</tbody>
</table>

46 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
47 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
48 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
49 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
50 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
51 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>New, Update, Removed, Reformulated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASd-053</td>
<td>New&lt;sup&gt;52&lt;/sup&gt;</td>
<td>Constraint AASd-053: If the semanticId of a Range submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: PROPERTY.</td>
<td></td>
</tr>
<tr>
<td>AASd-054</td>
<td>New&lt;sup&gt;53&lt;/sup&gt;</td>
<td>Constraint AASd-054: If the semanticId of a ReferenceElement submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: REFERENCE.</td>
<td></td>
</tr>
<tr>
<td>AASd-055</td>
<td>New&lt;sup&gt;54&lt;/sup&gt;</td>
<td>Constraint AASd-055: If the semanticId of a RelationshipElement or an AnnotatedRelationshipElement submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: RELATIONSHIP.</td>
<td></td>
</tr>
<tr>
<td>AASd-056</td>
<td>New&lt;sup&gt;55&lt;/sup&gt;</td>
<td>Constraint AASd-056: If the semanticId of an Entity submodel element references a ConceptDescription then the ConceptDescription/category shall be one of following values: ENTITY. The ConceptDescription describes the elements assigned to the entity via Entity/statement.</td>
<td></td>
</tr>
<tr>
<td>AASd-057</td>
<td>New&lt;sup&gt;56&lt;/sup&gt;</td>
<td>Constraint AASd-057: The semanticId of a File or Blob submodel element shall only reference a ConceptDescription with the category DOCUMENT.</td>
<td></td>
</tr>
<tr>
<td>AASd-058</td>
<td>New&lt;sup&gt;57&lt;/sup&gt;</td>
<td>Constraint AASd-058: The semanticId of a Capability submodel element shall only reference a ConceptDescription with the category CAPABILITY.</td>
<td></td>
</tr>
<tr>
<td>AASd-059</td>
<td>New&lt;sup&gt;58&lt;/sup&gt;</td>
<td>Constraint AASd-059: The semanticId of a SubmodelElementCollection submodel element shall only reference a ConceptDescription with the category COLLECTION or ENTITY.</td>
<td></td>
</tr>
<tr>
<td>AASd-060</td>
<td>New&lt;sup&gt;59&lt;/sup&gt;</td>
<td>Constraint AASd-060: If the semanticId of an Operation submodel element references a ConceptDescription then the category of the ConceptDescription shall be one of the following values: FUNCTION.</td>
<td></td>
</tr>
<tr>
<td>AASd-061</td>
<td>New&lt;sup&gt;60&lt;/sup&gt;</td>
<td>Constraint AASd-061: If the semanticId of a Event submodel element references a ConceptDescription then the category of the ConceptDescription shall be one of the following values: EVENT.</td>
<td></td>
</tr>
</tbody>
</table>

<sup>52</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>53</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>54</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>55</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>56</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>57</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>58</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>59</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.<br /><sup>60</sup> Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
<table>
<thead>
<tr>
<th>Constraint</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASd-062</td>
<td>New: If the semanticId of a Property references a ConceptDescription then the ConceptDescription/category shall be one of following values: APPLICATION_CLASS.</td>
</tr>
<tr>
<td>AASd-063</td>
<td>New: If the semanticId of a Qualifier references a ConceptDescription and the ConceptDescription/category shall be one of following values: QUALIFIER.</td>
</tr>
<tr>
<td>AASd-064</td>
<td>New: If the semanticId of a View references a ConceptDescription then the category of the ConceptDescription shall be VIEW.</td>
</tr>
<tr>
<td>AASd-065</td>
<td>New: If the semanticId of a Property or MultiLanguageProperty references a ConceptDescription with the category VALUE then the value of the property is identical to DataSpecificationIEC61360/value and the valueId of the property is identical to DataSpecificationIEC61360/valueId.</td>
</tr>
<tr>
<td>AASd-066</td>
<td>New: If the semanticId of a Property or MultiLanguageProperty references a ConceptDescription with the category PROPERTY and DataSpecificationIEC61360/valueList is defined the value and valueId of the property is identical to one of the value reference pair types references in the value list, i.e. ValueReferencePairType/value or ValueReferencePairType/valueId, resp.</td>
</tr>
<tr>
<td>AASd-067</td>
<td>New: If the semanticId of a MultiLanguageProperty references a ConceptDescription then DataSpecificationIEC61360/dataType shall be STRING_TRANSLATABLE.</td>
</tr>
</tbody>
</table>
| AASd-068   | New: If the semanticId of a Range submodel element references a ConceptDescription then DataSpecificationIEC61360/dataType shall be a numerical one, i.e. REAL_* or RATIONAL_*.

61 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

62 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

63 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

64 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

65 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

66 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

67 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

68 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

69 Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.
<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>New, Update, Removed, Reformulated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0) - DataSpecificationIEC61360/dataType is mandatory and shall be defined.</td>
<td></td>
</tr>
<tr>
<td>AASd-071</td>
<td>New⁷⁰</td>
<td>Constraint AASd-071: For a ConceptDescription with category REFERENCE using data specification template IEC61360 (<a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>) - DataSpecificationIEC61360/dataType is STRING by default.</td>
<td></td>
</tr>
<tr>
<td>AASd-072</td>
<td>New⁷¹</td>
<td>Constraint AASd-072: For a ConceptDescription with category DOCUMENT using data specification template IEC61360 (<a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>) - DataSpecificationIEC61360/dataType shall be one of the following values: STRING or URL.</td>
<td></td>
</tr>
<tr>
<td>AASd-073</td>
<td>New⁷²</td>
<td>Constraint AASd-073: For a ConceptDescription with category QUALIFIER using data specification template IEC61360 (<a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>) - DataSpecificationIEC61360/dataType is mandatory and shall be defined.</td>
<td></td>
</tr>
<tr>
<td>AASd-074</td>
<td>New⁷³</td>
<td>Constraint AASd-074: For all ConceptDescriptions except for ConceptDescriptions of category VALUE using data specification template IEC61360 (<a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>) - DataSpecificationIEC61360/definition is mandatory and shall be defined at least in English.</td>
<td></td>
</tr>
<tr>
<td>AASd-075</td>
<td>New⁷⁴</td>
<td>Constraint AASd-075: For all ConceptDescriptions using data specification template IEC61360 (<a href="http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0">http://admin-shell.io/DataSpecificationTemplates/DataSpecificationIEC61360/2/0</a>) values for the attributes not being marked as mandatory or optional in tables Table 6, Table 7, Table 8 and Table 9 depending on its category are ignored and handled as undefined.</td>
<td></td>
</tr>
<tr>
<td>AASd-077</td>
<td>New</td>
<td>Constraint AASd-077: The name of an extension within HasExtensions needs to be unique.</td>
<td></td>
</tr>
<tr>
<td>AASd-080</td>
<td>New⁷⁵</td>
<td>Constraint AASd-080: In case Key/type == GlobalReference idType shall not be any LocalKeyType (IdShort, FragmentId).</td>
<td></td>
</tr>
<tr>
<td>AASd-081</td>
<td>New⁷⁶</td>
<td>Constraint AASd-081: In case Key/type==AssetAdministrationShell Key/idType shall not be any LocalKeyType (IdShort, FragmentId).</td>
<td></td>
</tr>
</tbody>
</table>

⁷⁰ Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
⁷¹ Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
⁷² Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
⁷³ Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
⁷⁴ Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
⁷⁵ Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
⁷⁶ Constraints was implicity contained in former release, therefore it is considered to be backward compatible.
### DETAILS OF THE ADMINISTRATION SHELL - PART 1

<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>New, Update, Removed, Reformulated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASd-092</td>
<td>New[^77]</td>
<td>Constraint AASd-092: If the semanticId of a SubmodelElementCollection with SubmodelElementCollection/allowDuplicates == false references a ConceptDescription then the ConceptDescription/category shall be ENTITY.</td>
<td></td>
</tr>
<tr>
<td>AASd-093</td>
<td>New[^78]</td>
<td>Constraint AASd-093: If the semanticId of a SubmodelElementCollection with SubmodelElementCollection/allowDuplicates == true references a ConceptDescription then the ConceptDescription/category shall be COLLECTION.</td>
<td></td>
</tr>
<tr>
<td>AASd-100</td>
<td>New</td>
<td>Constraint AASd-100: An attribute with data type &quot;string&quot; is not allowed to be empty.</td>
<td></td>
</tr>
</tbody>
</table>

### ii. METAMODEL CHANGES V3.0RC01 – SECURITY PART

#### Table 31 Changes Metamodel w.r.t. V2.0 Security

<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01 Change w.r.t. V2.0.1</th>
<th>Comment</th>
</tr>
</thead>
</table>

#### Table 32 New Elements in Metamodel V2.1 w.r.t. V2.0 Security

<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>Comment</th>
</tr>
</thead>
</table>

#### Table 33 New, Changed or Removed Constraints w/o Security

<table>
<thead>
<tr>
<th>nc</th>
<th>V3.0RC01</th>
<th>New, Update, Removed, Reformulated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASd-010</td>
<td>Removed</td>
<td>Renamed to AASs-010 (see NEW)</td>
<td></td>
</tr>
<tr>
<td>AASs-010</td>
<td>NEW</td>
<td>Reformulation of AASd-010</td>
<td></td>
</tr>
<tr>
<td>Constraint AASs-010: The property referenced in Permission/permission shall have the category “CONSTANT”.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AASd-011</td>
<td>Removed</td>
<td>Renamed to AASs-011 (see NEW)</td>
<td></td>
</tr>
<tr>
<td>AASs-011</td>
<td>NEW</td>
<td>Reformulation of AASd-011</td>
<td></td>
</tr>
<tr>
<td>Constraint AASs-011: The property referenced in Permission/permission shall be part of the submodel that is referenced within the “selectablePermissions” attribute of “AccessControl”.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[^77]: Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

[^78]: Constraints was implicitly contained in former release, therefore it is considered to be backward compatible.

[^79]: "nc=x" means not backward compatible

[^80]: "nc=x" means not backward compatible

[^81]: "nc=x" means not backward compatible. nc=(x) means although it is a new constraint it is considered to be a more precise definition and not an additional constraint that was not in the focus of the previous version.
### iii. METAMODEL CHANGES V2.0.1 W/O SECURITY PART

Major changes:

- Only bugfixes

**Table 34 Changes w.r.t. V2.0.1 w/o Security**

<table>
<thead>
<tr>
<th>nc</th>
<th>V2.0.1 Change w.r.t. V2.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>nc</td>
<td>V2.0.1 Change w.r.t. V2.0</td>
<td>Comment</td>
</tr>
<tr>
<td>nc</td>
<td>DataTypeIEC61360/INTEGER_COUNT</td>
<td>Bugfix, was missing</td>
</tr>
<tr>
<td>nc</td>
<td>DataTypeIEC61360/INTEGER_MEASURE</td>
<td>Bugfix, was missing</td>
</tr>
<tr>
<td>nc</td>
<td>DataTypeIEC61360/INTEGER_CURRENCY</td>
<td>Bugfix, was missing</td>
</tr>
<tr>
<td>nc</td>
<td>hasDataSpecification</td>
<td>Bugfix, ist abstract class</td>
</tr>
</tbody>
</table>

**Table 35 New Elements in Metamodel V2.0.1 w/o Security**

<table>
<thead>
<tr>
<th>V2.0.1</th>
<th>Comment</th>
</tr>
</thead>
</table>

**Table 36 New, Changed or Removed Constraints w/o Security**

<table>
<thead>
<tr>
<th>nc</th>
<th>V2.0.1</th>
<th>New, Update, Removed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>nc</td>
<td>V2.0.1</td>
<td>New, Update, Removed</td>
<td>Comment</td>
</tr>
<tr>
<td>nc</td>
<td>AASd-013</td>
<td>Removed</td>
<td>Constraint AASd-013: Min and Max of a Property Range can be empty, denoting a range with open upper and lower boundary</td>
</tr>
</tbody>
</table>

### iv. METAMODEL CHANGES V2.0.1 – SECURITY PART

**Table 37 Changes Metamodel w.r.t. V2.0 Security**

<table>
<thead>
<tr>
<th>nc</th>
<th>V2.1 Change w.r.t. V2.0</th>
<th>Comment</th>
</tr>
</thead>
</table>

---

82 “nc=x” means not backward compatible

83 “nc=x” means not backward compatible. nc=(x) means although it is a new constraint it is considered to be a more precise definition and not an additional constraint that was not in the focus of the previous version.

84 “nc=x” means not backward compatible
Table 38 New Elements in Metamodel V2.1 w.r.t. V2.0 Security

<table>
<thead>
<tr>
<th>V2.1</th>
<th>Comment</th>
</tr>
</thead>
</table>

Table 39 New, Changed or Removed Constraints w/o Security

<table>
<thead>
<tr>
<th>nc&lt;sup&gt;85&lt;/sup&gt;</th>
<th>V2.0.1</th>
<th>New, Update, Removed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASd-001</td>
<td>update</td>
<td>idShort now mandatory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constraint AASd-001: an identifiable element this id is mandatory and used for referring to the element in its name space.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>➔ Constraint AASd-001: In case of a referable element not being an identifiable element this id is used for referring to the element in its name space.</td>
<td></td>
</tr>
<tr>
<td>AASd-013</td>
<td>removed</td>
<td>Constraint AASd-013: In case of a range with kind=Instance either the min or the max value or both need to be defined.</td>
<td></td>
</tr>
</tbody>
</table>

v. **METAMODEL CHANGES V2.0 W/O SECURITY PART**

Major changes:
- Composite I4.0 Components supported via new Entity submodel element and billOfMaterial
- Event submodel element introduced
- Capability submodel element introduced
- Annotatable relationship submodel element introduced
- MultiLanguageProperty submodel element introduced
- Range submodel element introduced
- Data Specification Template IEC61360 extended for Values, ValueLists and Ranges
- Also referencing of fragments within a file etc. now supported

Table 40 Changes w.r.t. V1.0 w/o Security

<table>
<thead>
<tr>
<th>nc&lt;sup&gt;86&lt;/sup&gt;</th>
<th>V2.0 Change w.r.t. V1.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x)&lt;sup&gt;87&lt;/sup&gt;</td>
<td>anySimpleTypeDef</td>
<td>Type starts now with capital letter: AnySimpleTypeDef</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type changed from string to values representing xsd-type anySimpleType</td>
</tr>
<tr>
<td></td>
<td>Asset</td>
<td>Does not inherit from HasKind any longer (but attribute kind remains)</td>
</tr>
<tr>
<td></td>
<td>Asset/kind</td>
<td>Now of type “AssetKind” instead of “Kind”. Instead of value Type and Instance now value Template and Instance</td>
</tr>
</tbody>
</table>

---

<sup>85</sup> “nc=x” means not backward compatible. nc=(x) means although it is a new constraint it is considered to be a more precise definition and not an additional constraint that was not in the focus of the previous version.

<sup>86</sup> “nc=x” means not backward compatible

<sup>87</sup> Implicitly there was a constraint restricting the values to the values in the enumeration. This is now formalized.
<table>
<thead>
<tr>
<th>nc84</th>
<th>V2.0 Change w.r.t. V1.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AssetAdministrationShell/security</td>
<td>Now optional to support passive AAS of type 1</td>
</tr>
<tr>
<td></td>
<td>Code</td>
<td>Data type removed, not used any longer</td>
</tr>
<tr>
<td>x</td>
<td>DataSpecificationIEC61360/shortName</td>
<td>Type changed from string to LangStringSet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardinality changed from mandatory to optional</td>
</tr>
<tr>
<td>x</td>
<td>DataSpecificationIEC61360/sourceOfDefinition</td>
<td>Type changed from langString to string</td>
</tr>
<tr>
<td>(x)38</td>
<td>DataSpecificationIEC61360/dataType</td>
<td>Type changed from string to Enumeration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardinality changed from mandatory to optional</td>
</tr>
<tr>
<td>x</td>
<td>DataSpecificationIEC61360/code</td>
<td>Attribute code removed</td>
</tr>
<tr>
<td></td>
<td>DataSpecificationIEC61360/definition</td>
<td>Cardinality changed from mandatory to optional</td>
</tr>
<tr>
<td></td>
<td>HasDataSpecification</td>
<td>Was abstract before</td>
</tr>
<tr>
<td></td>
<td>HasDataSpecification/hasDataSpecification</td>
<td>Renamed to HasDataSpecification/dataSpecification</td>
</tr>
<tr>
<td>x</td>
<td>HasKind/kind</td>
<td>Now of type “ModelingKind” instead of “Kind”. Values changed: Type now Template; Instance remains</td>
</tr>
<tr>
<td>x</td>
<td>File/value</td>
<td>File name not without but with extension</td>
</tr>
<tr>
<td>x</td>
<td>Identifiable/description</td>
<td>Type changed from langString to LangStringSet</td>
</tr>
<tr>
<td>x</td>
<td>IdentifierType/URI</td>
<td>URI renamed to IRI</td>
</tr>
<tr>
<td></td>
<td>Kind</td>
<td>Type Kind removed and substituted by types AssetKind and ModelingKind</td>
</tr>
<tr>
<td>x</td>
<td>OperationVariable</td>
<td>Does not inherit from SubmodelElement any longer</td>
</tr>
<tr>
<td></td>
<td>Property/value</td>
<td>Type changed from anySimpleTypeDef to ValueDataType</td>
</tr>
<tr>
<td>x</td>
<td>Qualifier/qualifierType</td>
<td>Renamed to Qualifier/type</td>
</tr>
<tr>
<td>x</td>
<td>Qualifier/qualifierValue</td>
<td>Renamed to Qualifier/value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type changed from AnySimpleTypeDef to ValueDataType</td>
</tr>
<tr>
<td>x</td>
<td>Qualifier/qualifierValueId</td>
<td>Renamed to Qualifier/valueId</td>
</tr>
<tr>
<td>x</td>
<td>Referable/idShort</td>
<td>Now mandatory, was optional (but with constraints for defined elements)</td>
</tr>
<tr>
<td>x</td>
<td>Reference/key</td>
<td>Cardinality changed from 0..* to 1..*</td>
</tr>
</tbody>
</table>

Table 41 New Elements in Metamodel V1.0 w/o Security

<table>
<thead>
<tr>
<th>V2.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AnnotatedRelationshipElement</td>
<td>New submodel element, inheriting from RelationshipElement</td>
</tr>
<tr>
<td>Asset/billOfMaterial</td>
<td>New attribute</td>
</tr>
</tbody>
</table>

Implicitly there was the constraint that only IEC61360 data types are allowed to be used. This is now formalized.
<table>
<thead>
<tr>
<th>AssetKind</th>
<th>New enumeration type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BasicEvent</td>
<td>New submodel element, inherits from Event</td>
</tr>
<tr>
<td>Capability</td>
<td>New submodel element</td>
</tr>
<tr>
<td>DataSpecificationIEC61360/valueList</td>
<td>For value lists (string)</td>
</tr>
<tr>
<td>DataSpecificationIEC61360/value</td>
<td>For coded and explicit values</td>
</tr>
<tr>
<td>DataSpecificationIEC61360/valueId</td>
<td>For coded values</td>
</tr>
<tr>
<td>DataSpecificationIEC61360/levelType</td>
<td>For Ranges</td>
</tr>
<tr>
<td>DataSpecificationPhysicalUnit</td>
<td>New data specification template</td>
</tr>
<tr>
<td>DataTypeIEC61360</td>
<td>New enumeration type</td>
</tr>
<tr>
<td>Entity</td>
<td>New submodel Element</td>
</tr>
<tr>
<td>EntityType</td>
<td>New enumeration type</td>
</tr>
<tr>
<td>IdentifierType</td>
<td>Is a subset of KeyType Enumeration</td>
</tr>
<tr>
<td>KeyElements/FragmentReference</td>
<td>New value FragmentReference as part of KeyElements Enumeration</td>
</tr>
<tr>
<td>LocalKeyType</td>
<td>Is a subset of KeyType Enumeration</td>
</tr>
<tr>
<td>LocalKeyType/FragmentId</td>
<td>New value for KeyType Enumeration (via subset LocalKeyType)</td>
</tr>
<tr>
<td>LangStringSet</td>
<td>New type, used for example in MultiLanguageProperty</td>
</tr>
<tr>
<td>levelType</td>
<td>New enumeration type</td>
</tr>
<tr>
<td>ModelingKind</td>
<td>New enumeration type</td>
</tr>
<tr>
<td>MultiLanguageProperty</td>
<td>New submodel element</td>
</tr>
<tr>
<td>Qualifier/valueType</td>
<td>New attribute to be consistent with valueType of Property etc.</td>
</tr>
<tr>
<td>Range</td>
<td>New submodel element</td>
</tr>
<tr>
<td>ReferableElements/BasicEvent</td>
<td>New enumeration value</td>
</tr>
<tr>
<td>ReferableElements/Capability</td>
<td>New enumeration value</td>
</tr>
<tr>
<td>ReferableElements/Event</td>
<td>New enumeration value</td>
</tr>
<tr>
<td>ReferableElements/MultiLanguageProperty</td>
<td>New enumeration value</td>
</tr>
<tr>
<td>ReferableElements/Range</td>
<td>New enumeration value</td>
</tr>
<tr>
<td>ValueDataType</td>
<td>New type, used for example for Property value</td>
</tr>
<tr>
<td>ValueList</td>
<td>New class</td>
</tr>
<tr>
<td>ValueReferencePairType</td>
<td>New class</td>
</tr>
</tbody>
</table>
### Table 42 New, Changed or Removed Constraints w/o Security

<table>
<thead>
<tr>
<th>nc(^{39})</th>
<th>V2.0</th>
<th>New, Update, Removed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASd-007</td>
<td>update</td>
<td>Reformulated</td>
<td>Constraint AASd-007: if both, the value and the valueId are present then the value needs to be identical to the value of the referenced coded value in valueId.</td>
</tr>
<tr>
<td>AASd-008</td>
<td>update</td>
<td>Reformulated</td>
<td>Constraint AASd-008: The submodel element value of an operation variable shall be of kind=Template.</td>
</tr>
<tr>
<td>AASd-025</td>
<td>removed</td>
<td>Redundant to AASd-015</td>
<td>Constraint AASd-025: The data element shall be part of the submodel that is referenced within the “selectableSubjectAttributes” attribute of “AccessControl”.</td>
</tr>
</tbody>
</table>

\(^{39}\) “nc=x” means not backward compatible. nc=(x) means although it is a new constraint it is considered to be a more precise definition and not an additional constraint that was not in the focus of the previous version.
vi. **METAMODEL CHANGES V2.0 – SECURITY PART**

Table 43 Changes Metamodel w.r.t. V1.0 Security

<table>
<thead>
<tr>
<th>nc⁹⁰</th>
<th>V2.0 Change w.r.t. V1.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>AccessControl/selectableEnvironmentAttributes</td>
<td>Type changed from Submodel to Submodel*</td>
</tr>
<tr>
<td></td>
<td>AccessPermissionRule/permissionsPerObject</td>
<td>Cardinality now consistent for figure and table: 0..*</td>
</tr>
<tr>
<td>x</td>
<td>AccessPermissionRule/targetSubjectAttributes</td>
<td>Cardinality changed from 1..* to 1</td>
</tr>
<tr>
<td></td>
<td>Certificate</td>
<td>Was abstract, now not abstract and contains attributes (see in table New)</td>
</tr>
<tr>
<td>x</td>
<td>PermissionKind/allow</td>
<td>Now PermissionKind/Allow start with capital letter for enumeration values</td>
</tr>
<tr>
<td>x</td>
<td>PermissionKind/deny</td>
<td>Now PermissionKind/Deny start with capital letter for enumeration values</td>
</tr>
<tr>
<td>x</td>
<td>PermissionKind/not applicable</td>
<td>Now PermissionKind/NotApplicable start with capital letter for enumeration values</td>
</tr>
<tr>
<td>x</td>
<td>PermissionKind/Undefined</td>
<td>Now PermissionKind/Undefined start with capital letter for enumeration values</td>
</tr>
<tr>
<td></td>
<td>PermissionsPerObject</td>
<td>Name now consistent for figure and table (in table PermissionPerObject, needs to be PermissionsPerObject)</td>
</tr>
<tr>
<td>x</td>
<td>PolicyAdministrationPoint/externalAccessControl</td>
<td>Type changed from Endpoint to Boolean, cardinality 1</td>
</tr>
<tr>
<td>x</td>
<td>PolicyInformationPoints/externalInformationPoint</td>
<td>Type changed from Endpoint to Boolean, cardinality 1 externalInformationPoint renamed to externalInformationPoints</td>
</tr>
<tr>
<td>x</td>
<td>Security/trustAnchor</td>
<td>Renamed to Security/certificate</td>
</tr>
</tbody>
</table>

Table 44 New Elements in Metamodel w.r.t. Security

<table>
<thead>
<tr>
<th>V2.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>BlobCertificate</td>
<td>New class inheriting from Certificate</td>
</tr>
<tr>
<td>Certificate</td>
<td>Abstract class: was foreseen in V1.0 but not yet modelled</td>
</tr>
<tr>
<td>Security/requiredCertificateExtension</td>
<td>New attribute</td>
</tr>
<tr>
<td>PolicyEnforcementPoint</td>
<td>Was foreseen in V1.0 but not yet modelled</td>
</tr>
<tr>
<td>PolicyEnforcementPoint/externalPolicyEnforcementPoint</td>
<td></td>
</tr>
<tr>
<td>PolicyDecisionPoint</td>
<td>Was foreseen in V1.0 but not yet modelled</td>
</tr>
<tr>
<td>PolicyDecisionPoint/externalPolicyDecisionPoint</td>
<td></td>
</tr>
</tbody>
</table>

⁹⁰ "nc≠x" means not backward compatible
<table>
<thead>
<tr>
<th>nc$^{91}$</th>
<th>V2.0</th>
<th>New, Update, Removed</th>
<th>Comment</th>
</tr>
</thead>
</table>

Table 45 New, Changed or Removed Constraints w/o Security

$^{91}$ “nc=x” means not backward compatible. nc=(x) means although it is a new constraint it is considered to be a more precise definition and not an additional constraint that was not in the focus of the previous version.
ANNEX L. BIBLIOGRAPHY


[3] DIN SPEC 91345:2016-04 "Referenzarchitekturmodell Industrie 4.0 (RAMI4.0) / Reference Architecture Model Industrie 4.0 (RAMI4.0) / Modèle de reference de l’architecture de l’industrie 4.0 (RAMI4.0)”, ICS 03.100.01; 25.040.01; 35.240.50, April 2016. [Online]. Available: https://www.beuth.de/en/technical-rule/din-spec-91345-en/250940128


“Smart Manufacturing - Reference Architecture Model Industry 4.0 (RAMI4.0)”, IEC PAS 63088, International Electrotechnical Commission (IEC), 2017


AUTHORS of V1.0, V2.0.x and V3.0RC01

Sebastian Bader, Fraunhofer IAIS
Erich Barnstedt, Microsoft Deutschland GmbH
Dr. Heinz Bedenbender, VDI/VDE-Gesellschaft für Mess- und Automatisierungstechnik (GMA)
Bernd Berres, MPDV Mikrolab GmbH
Meik Billmann, ZVEI – Zentralverband Elektrotechnik- und Elektronikindustrie
Dr. Birgit Boss, Robert Bosch GmbH
Dr. André Braunmandl, BSI
Erich Clauser, SAP SE
Professor Dr. Christian Diedrich, ifak - Institut f. Automation und Kommunikation e.V. Magdeburg
Björn Flubacher, BSI
Wolfgang Fritsche, IABG mbH
Kai Garrels, ABB STOTZ-KONTAKT GmbH
Dr. Andreas Graf Gatterburg, Hilscher Gesellschaft für Systemautomation mbH
Martin Hankel, Bosch Rexroth AG
Oliver Hillermeier, SAP SE
Dr. Michael Hoffmeister, Festo AG & Co. KG
Michael Jochem, Robert Bosch GmbH
Alexander Köpke, Microsoft Deutschland GmbH
Yevgen Kogan, KUKA Deutschland GmbH
Dr. Heiko Koziol, ABB AG
Walter Kuhlbusch, Festo SE & Co. KG
Dr. Christoph Legat, Hekuma GmbH
Professor Dr. Arndt Lüder, Otto-von-Guericke Universität
Dr. Wolfgang Mahnke, ascolab GmbH
Dr. Marco Mendes, Schneider Electric Automation GmbH
Torben Miny, RWTH Aachen
Dr. Jörg Neidig, Siemens AG
Andreas Neubacher, Deutsche Telekom
Andreas Orzelski, Phoenix Contact GmbH & Co. KG
Florian Pethig, Fraunhofer IOSB-INA
Stefan Pollmeier, ESR Pollmeier GmbH Servo-Antriebstechnik

→ Continued next page
AUTHORS of Version 1.0, 2.0.x and 3.0RC01 - continued

Manuel Sauer, SAP SE
Volker Schaber, SICK AG
Daniel Schel, Fraunhofer IPA
Otto Schell, Deutschsprachige SAP Anwender Gruppe e.V. (DSAG)
Marc Schier, Microsoft Deutschland GmbH
Dr. Miriam Schleipen, Siemens AG
Dr. Michael Schmitt, SAP SE
Tizian Schröder, Otto-von-Guericke-Universität Magdeburg
Dr. Ljilijana Stojanovic, Fraunhofer IOSB
Andreas Teuscher, SICK AG
André Uhl, Schneider Electric Automation GmbH
Dr. Thomas Usländer, Fraunhofer IOSB
Jens Vialkowitsch, Robert Bosch GmbH
Friedrich Vollmar
Thomas Walloschke, Industrie KI GmbH
Bernd Waser, Murrelektronik GmbH
Jörg Wende, IBM Deutschland GmbH
Mathias Wiegand, Festo AG & Co. KG
Constantin Ziesche, Robert Bosch GmbH

This working paper has been elaborated in the Working Subgroup “Asset Administration Shell” of the Working Group on “Reference Architectures, Standards and Norms” of Plattform Industrie 4.0 and the working group “Models and Standards” of the ZVEI in cooperation with the Working Groups “Security of networked Systems” (Plattform Industrie 4.0) and “Security” (ZVEI). The OPC UA Mapping has been elaborated in the joint working group “I4AAS” of the OPC Foundation, ZVEI, VDMA and the Plattform Industrie 4.0. The AutomationML Mapping has been elaborated in the joint working group of AutomationML e.V. and the Plattform Industrie 4.0.