



IDTA 02059-1-0

Artificial Intelligence

Deployment

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SPECIFICATION

Submodel Template of the
Asset Administration Shell



Submodel Template

IDTA approved

- 100% AAS compliant
- Consistent & interoperable
- Released by the AAS experts

Imprint

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1 General

1.1 About this document

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

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

1.2 Scope of the Submodel

This Submodel template aims at interoperable provision of information describing deployment of Artificial Intelligence (AI) models in regard to the asset of the respective Asset Administration Shell. Central element is the provision of properties [7], ideally interoperable by the means of dictionaries such as ECLASS and IEC CDD (Common Data Dictionary). The purpose of this document is to make selected specifications of Submodels in such manner that information about assets can be exchanged in a meaningful way between partners in a value creation network. It targets the assistance of deployment of AI models in a standardized way. Currently the focus is on an industrial environment.

The intended use-case is the provision of a standardized property structure for deploying AI, which enables an easier usage of AI in an industrial environment. With the assistance of two other AI Submodels (AI Dataset and AI ModelNameplate), it provides an overview of the whole AI lifecycle and allows an easier management of it.

This concept can serve as a basis for standardizing the respective Submodel. The conception is based on existing norms, studies of common practices at enterprises, directives and standards so that a far-reaching acceptance can be achieved.

1.3 Relevant standards for the Submodel template

According to [3], interoperable properties might be defined by standards, consortium specifications or manufacturer specifications. So called property dictionaries are used identify information elements (see Terms and Definitions of [6]). Such property dictionaries include:

- ECLASS, see: <https://www.eclasscontent.com/>
- IEC CDD, see: <https://cdd.iec.ch/cdd/iec61987/iec61987.nsf> and <https://cdd.iec.ch/cdd/iec62683/cdddev.nsf>

In this document, properties are aimed to be described by ECLASS.

2 Submodel AI Deployment

2.1 Approach

While defining Submodels the following three aspects must be considered as suggested in [5]:

2.1.1 Use and economic relevance

The Submodel Artificial Intelligence (AI) Deployment is designed for assisting the deployment of AI models. This helps the growth and usage of AI in all kind of fields, e.g. manufacturing. An usage of AI reduces costs, because it allows to automatize processes.

One use case is the initial collection of all parameters and information needed to integrate an AI model into a usable application. The Submodel contains, among other things, information about the access possibilities to the model in the form of the storage location. In addition, information about the input and output of the AI model is available in the Submodel "AI Deployment". Information on the hardware requirements needed is also provided by the "AI Deployment" Submodel. Alongside passive parameters that describe the configuration and access options, data is also recorded in the Submodel that provides information about active use, e.g. the runtime.

2.1.2 Possible functions and interactions

The Submodel "AI Deployment" provides information for the deployment of AI models. Engineers in the manufacturing environment can use the Submodel to obtain information about the deployment of the AI model. This includes, for example, the storage location of the model. In addition, AI model developers can use the Submodel to provide information about the required hardware and thus actively influence the planning process of a production line, for example. In the operating case, parameters of the model currently in use are displayed in the Submodel. This allows workers on the production line to evaluate the functionality and performance of the model using the observed parameters.

The SMC "Storage" contains the information about the storage location of the deployable model. Due to the design of the SMC, it is possible to save the deployable model directly as a file in the "AI Deployment" Submodel.

The two SMCs "Input" and "Output" serve a similar purpose. Here, the SMC "Input" contains the input variables of the deployable model, while the SMC "Output" contains the output variables. Both SMCs are designed in such a way that the users of the Submodel have the freedom of representation of the input and output variables.

The SMC "Software Requirement" and the SMC "Hardware Requirement" deal with the requirements necessary for the operation of the model. Here, the SMC "SoftwareRequirements" enables the upload of a requirements file, e.g. a requiriement.txt, as used in venv in Python.

The SMC "PerformanceInformation" and its child "InferenceTime" allow inference times to be recorded for specific hardware configurations. This allows the selection of specific hardware whom the deployable model must run with a specific inference time in the application. In order to ensure the monitoring of the running model, there exists the SMC LiveMonitoring. It contains the SMC "HardwareWorkload", which shows the current utilization of the hardware. For detecting changes in the data and in the model, there is the SMC "DriftMetrics".

2.1.3 Property specification

See section 3 Submodel and Collections.

3 Submodel and collections

3.1 Properties of the Submodel "AI Deployment"

The figure below shows the UML-diagram defining the relevant properties which need to be set. Table 1: Properties of Submodel "Deployment" describes the details of the Submodel structure combined with examples.

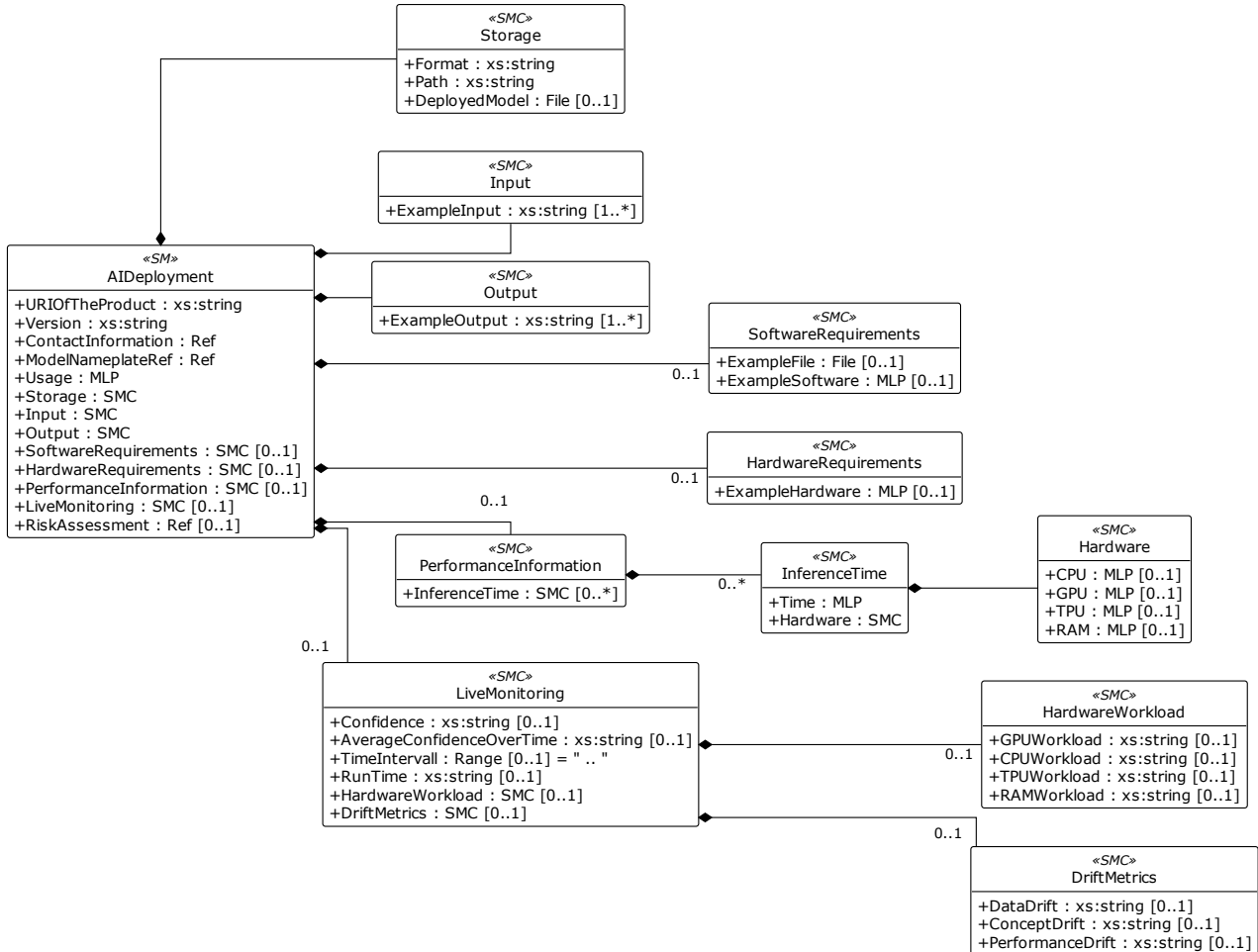


Figure 1: UML Diagram of Properties of Submodel "AI Deployment"

Table 1: Properties of Submodel "AI Deployment"

idShort:	AIDeployment		
Class:	Submodel		
semanticId:	[IRI] https://admin-shell.io/idta/SubmodelTemplate/AIDeployment/1/0		
Parent:	AAS		
Explanation:	Contains the information for AI deployment		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	

[Prop] URIOfTheProduct	[IRDI] 0112/2///61987#ABN590#002 unique global identification of the product instance using an universal resource identifier (URI)	[String] https://www.example.com/search?q=deployment	[1]
[Prop] Version	[IRDI]0173-1#02-AAS354#002 Version of the deployment	[String] 1.0	[1]
[Ref] ContactInformation	https://admin-shell.io/idta/AIDeployment/Contactinformation/1/0 Reference to the Contact Information IDTA Submodel to describe the responsible person for the Submodel	[-]	[1]
[Ref] ModelNameplateRef	[IRI] https://admin-shell.io/idta/AIDeployment/ModelNameplateRef/1/0 Reference to the ModelNameplate-Submodel of the deployed model	[-]	[1]
[SMC] Storage	[IRI] https://admin-shell.io/idta/AIDeployment/Storage/1/0 Collection of storage information about the deployable AI-model	[-] 3 elements	[1]
[SMC] Input	[IRI] https://admin-shell.io/idta/AIDeployment/Input/1/0 Collection of information about the input data for deployment	[-] 1 elements	[1]
[SMC] Output	[IRI] https://admin-shell.io/idta/AIDeployment/Output/1/0 Collection of information about the output data for deployment	[-] 1 elements	[1]
[SMC] SoftwareRequirements	[IRI] https://admin-shell.io/idta/AIDeployment/SoftwareRequirements/1/0 Collection about required software for deployment	[-] 1 elements	[0..1]
[SMC] HardwareRequirements	[IRI] https://admin-shell.io/idta/AIDeployment/HardwareRequirements/1/0 Collection about required hardware for deployment	[-] 1 elements	[0..1]
[SMC] PerformanceInformation	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/1/0 Collection of performance measurements	[-] 1 elements	[0..1]
[SMC] LiveMonitoring	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/1/0 Collection containing live values for monitoring	[-] 6 elements	[0..1]
[Ref] RiskAssessment	[IRI] https://admin-shell.io/idta/AIDeployment/RiskAssessment/1/0 risk assessment based on regulation(EU) 2024/1689 of the european parliament and of the council	[-]	[0..1]

3.2 Properties of the SMC “Storage”

Table 2: Properties of SMC "Storage"

idShort:	Storage		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/Storage/1/0		
Parent:	SM AIDeployment		
Explanation:	Collection of storage information about the deployable AI-model@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[Prop] Format	[IRI] https://admin-shell.io/idta/AIDeployment/Storage/Format/1/0 Data format of the deployable model (e.g. onnx, docker-image ,...) onnx	[String]	[1]
[File] DeployedModel	[IRI] https://admin-shell.io/idta/AIDeployment/Input/1/0 The deployable model	[-]	[0..1]

3.3 Properties of the SMC “Input”

Table 3 Properties of SMC "Input"

idShort:	Input		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/Input/1/0		
Parent:	SM AIDeployment		
Explanation:	Collection of information about the input data for deployment@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[Prop] ExampleInput	[IRI] https://admin-shell.io/idta/AIDeployment/Input/InputProperty/1/0 This is an example input information placeholder	[String]	[1..*]

3.4 Properties of the SMC “Output”

Table 4 Properties of SMC "Output"

idShort:	Output		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/Output/1/0		
Parent:	SM AIDeployment		
Explanation:	Collection of information about the output data for deployment@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[Prop]	[IRI] https://admin-shell.io/idta/AIDeployment/Output/OutputProperty/1/0	[String]	[1..*]
ExampleOutput	This is an example input information placeholder		

3.5 Properties of the SMC “SoftwareRequirements”

Table 5 Properties of SMC "SoftwareRequirements"

idShort:	SoftwareRequirements		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/SoftwareRequirements/1/0		
Parent:	SM AIDeployment		
Explanation:	Collection about required software for deployment@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[File]	[IRI] https://admin-shell.io/idta/AIDeployment/SoftwareRequirements/RequirementsFile/1/0	[-]	[0..1]
ExampleFile	Requirement file for software requirements		

3.6 Properties of the SMC “HardwareRequirements”

Table 6 Properties of SMC "HardwareRequirements"

idShort:	HardwareRequirements		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/HardwareRequirements/1/0		

Parent:	SM AIDeployment		
Explanation:	Collection about required hardware for deployment@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[File]	[IRI] https://admin-shell.io/idta/AIDeployment/HardwareRequirements/HardwareDescription/1/0 This is an example requirement placeholder	[-]	[0..1]

3.7 Properties of the SMC “PerformanceInformation”

Table 7 Properties of SMC "PerformanceInformation"

idShort:	PerformanceInformation		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/1/0		
Parent:	SM AIDeployment		
Explanation:	Collection of performance measurements@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[SMC]	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/InferenceTime/1/0 Collection of information about the measured inference time and the used equipment to achieve it	[-] 2 elements	[0..*]

3.7.1 Properties of SMC “InferenceTime”

Table 8 Properties of SMC "InferenceTime"

idShort:	InferenceTime		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/InferenceTime/1/0		
Parent:	SMC PerformanceInformation		
Explanation:	Collection of information about the measured inference time and the used equipment to achieve it@en		
[SME type]	semanticId	[valueType]	card.

idShort	Description@en	example	
[MLP] Time	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/InferenceTime/Time/1/0 Measured inference time	[-] 0.0708561778068 5424@en	[1]
[SMC] Hardware	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/InferenceTime/Hardware/1/0 Collection of hardware used for the measurement	[-] 4 elements	[1]

3.7.1.1 Properties of SMC “Hardware”

Table 9 Properties of SMC "Hardware"

idShort:	Hardware		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/InferenceTime/Hardware/1/0		
Parent:	SMC InferenceTime		
Explanation:	Collection of hardware used for the measurement@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[MLP] CPU	[IRD]0173-1#01-ACL481#008 Information about the CPU.	[-] Intel(R) Core(TM) i9- 10885H CPU @ 2.40GHz 2. 40 GHz@en	[0..1]
[MLP] GPU	[IRD]0173-1#01-ACL476#008 Information about the GPU.	[-] Nvidia GeForce RTX 3090@en	[0..1]
[MLP] TPU	[IRI] https://admin-shell.io/idta/AIDeployment/PerformanceInformation/InferenceTime/Hardware/TPU/1/0 Information about the TPU.	[-] @en	[0..1]
[MLP] RAM	[IRD]0173-1#01-ACL340#008 Information about the RAM.	[-] 64GB@en	[0..1]

3.8 Properties of the SMC “LiveMonitoring”

Table 10 Properties of SMC "LiveMonitoring"

idShort:	LiveMonitoring		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/1/0		
Parent:	SM AIDeployment		
Explanation:	Collection containing live values for monitoring@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[Prop] Confidence	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/Confidence/1/0 Live confidence	[String]	[0..1]
[Range] TimeIntervall	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/AverageConfidence/1/0 Time intervall for calculating the average confidence	[-] ..	[0..1]
[Prop] AverageConfidenceOverTime	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/TimeIntervall/1/0AverageConfidenceOverTime confidence over a definded time intervall	[String]	[0..1]
[Prop] RunTime	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/RunTime/1/0 Time the deployed model is running without a break or downtime	[String]	[0..1]
[SMC] HardwareWorkload	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/HardwareWorkload/1/0 Collection containing the live hardware workload	[-] 4 elements	[0..1]
[SMC] DriftMetrics	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/DriftMetrics/1/0 Collection of live monitoring of different drift metrics	[-] 3 elements	[0..1]

3.8.1 Properties of SMC “HardwareWorkload”

Table 11 Properties of SMC "HardwareWorkload"

idShort:	HardwareWorkload
Class:	SubmodelElementCollection
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/HardwareWorkload/1/0
Parent:	SMC LiveMonitoring
Explanation:	Collection containing the live hardware workload@en

[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[Prop] GPUWorkload	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/HardwareWorkload/GPUWorkload/1/0 Live GPU workload	[String]	[0..1]
[Prop] CPUWorkload	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/HardwareWorkload/CPUWorkload/1/0 Live CPU workload	[String]	[0..1]
[Prop] TPUWorkload	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/HardwareWorkload/TPUWorkload/1/0 Live TPU workload	[String]	[0..1]
[Prop] RAMWorkload	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/HardwareWorkload/RAMWorkload/1/0 Live RAM workload	[String]	[0..1]

3.8.2 Properties of SMC “DriftMetrics”

Table 12 Properties of SMC "DriftMetrics"

idShort:	DriftMetrics		
Class:	SubmodelElementCollection		
semanticId:	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/DriftMetrics/1/0		
Parent:	SMC LiveMonitoring		
Explanation:	Collection of live monitoring of different drift metrics@en		
[SME type]	semanticId	[valueType]	card.
idShort	Description@en	example	
[Prop] DataDrift	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/DriftMetrics/DataDrift/1/0 Live data drift	[String]	[0..1]
[Prop] ConceptDrift	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/DriftMetrics/ConceptDrift/1/0 Live concept drift	[String]	[0..1]
[Prop] PerformanceDrift	[IRI] https://admin-shell.io/idta/AIDeployment/LiveMonitoring/DriftMetrics/PerformanceDrift/1/0 Live performance drift	[String]	[0..1]

Annex A. Explanations on used table formats

1. General

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

2. Tables on Submodels and SubmodelElements

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

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

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

- If an idShort ends with '__00__', this indicates a suffix of the respective length (here: 2) of decimal digits, in order to make the idShort unique. A different idShort might be chosen, as long as it is unique in the parent's context.
- The Keys of semanticId in the main section feature only idType and value, such as: [IRI]https://admin-shell.io/vdi/2770/1/0/DocumentId/Id. The attributes "type" and "local" (typically "ConceptDescription" and "(local)" or "GlobalReference" and "(no-local)") need to be set accordingly; see [6].
- If a table does not contain a column with "parent" heading, all represented attributes share the same parent. This parent is denoted in the head of the table.
- Multi-language strings are represented by the text value, followed by '@'-character and the ISO 639 language code: example@EN.
- The [valueType] is only given for Properties.

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