Form 36

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Part 4: Use cases and modelling examples

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Introduction

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Date: xx/xx/20xx	Document: ISO/DIS xxxx

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex **(e.g. 3.1)**	Paragraph/Figure/ Table/Note	**Type of comment**	**Commend (justification for change) by the MB**	**Proposed change by the MB**	**Secretariat observations on each comment submitted**
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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65/1024/CD

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PROJECT NUMBER: **IEC 63278-4 ED1**	
DATE OF CIRCULATION: **2023-09-15**	CLOSING DATE FOR COMMENTS: **2023-12-08**
SUPERSEDES DOCUMENTS: **65/994/NP, 65/1023/RVN**	

IEC TC 65 : INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION

SECRETARIAT: France	SECRETARY: Mr Didier GIARRATANO
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 121	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

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TITLE:

Asset administration shell for industrial applications – Part 4: Use cases and modelling examples

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Asset administration shell for industrial applications – Part 4: Use cases and modelling examples

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FDIS	Report on voting
65/XX/FDIS	65/XX/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

0.1 General

The Asset Administration Shell (AAS) is seen as one interoperable manifestation of a digital twin in manufacturing industries. Part 1 describes the conceptual framework for the AAS, the structure of the AAS and requirements associated to the AAS and related entities.

This document complements part 1 by describing in a systematic way the usage of the AAS.

0.2 Context of this document

In this document, a usage perspective is always taken. The document considers selected Smart Manufacturing use cases, see [1], and refines these use cases, but other input was also considered. However, the terms and concepts introduced in part 1 are used.

The level of detail in this document is compliant to Figure 4 “Detailed overview of AAS and related entities” in part 1. Should changes to Figure 4 in part 1 be necessary in the future, this document must also be updated accordingly.

This document also lays a basis for further parts of the IEC 63278 series.

0.3 Structure of this document

Clause 4 of this document introduces additional actors in form of humans or organizations and describes how these actors interact with the AAS and the related entities by stating requirements, recommendations, and permissions. Clause 4 also describes examples about possible modelling and procedures using the AAS following the statements. This completes part 1 regarding an application of the AAS. The claim is that these descriptions are complete regarding the level of detail considered.

Clause 5 of this document describes – in addition to clause 4 – selected examples about possible modeling and procedures using the AAS. It is in the responsibility of a user how to apply the concepts provided by the AAS regarding the own objectives. In this respect, these examples neither claim to be complete nor to provide guidance about good practices.

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Asset administration shell for industrial applications –

Part 4: Use cases and modelling examples

1 Scope

The Asset Administration Shell is a standardized digital representation of an asset. The Asset Administration Shell gives uniform access to information of an asset and services of or related to an asset.

The purpose of the Asset Administration Shell is to enable two or more software applications to exchange information and to mutually use the information that has been exchanged in a trusted and secure manner.

This document assumes an application perspective of the Asset Administration Shell to develop a common understanding on how to use an Asset Administration Shell. The document describes the following topics:

- Use cases of the Asset Administration Shell in the form of generic descriptions of how the Asset Administration Shell is used by various actors and entities. Due to the more detailed description of the AAS compared to IEC 63278-1 based on these use cases, additional requirements for the AAS are derived.
- Modeling examples for Asset Administration Shells in the form of specific examples of possible modeling and procedures.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 63278-1: *Asset Administration Shell for industrial applications – Part 1: Asset Administration Shell structure.*

IEC TR 63283-1: *Industrial-process measurement, control and automation – Smart Manufacturing – Part 1: Terms and definitions.*

3 Terms, definitions, abbreviated terms, and conventions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

– IEC Electropedia: available at http://www.electropedia.org/

– ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
asset
physical or non-physical entity that has value to a human or an organization

[SOURCE: IEV 741-01-04 (modified)]

Note 1 to entry: A physical asset can provide asset services.

3.1.2
Asset Administration Shell
AAS
standardized digital representation of an asset

3.1.3
AAS interface
interface of an AAS giving uniform access to information and services

Note 1 to entry: The two entities according to interface are an AAS user application (i.e., a software application) and an AAS (i.e., a representation)

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3.1.4
AAS responsible
human or organization having interest in an asset and governing an Asset Administration Shell

3.1.5
AAS user application
software application which accesses an AAS via its AAS interface(s) for use by humans or for automatic processing

3.1.6
AAS user application operator
human or organization operating an AAS user application

3.1.7
adapter asset service
software service needed to access a specific asset service

3.1.8
asset integration
software service needed to access asset services

3.1.9
asset owner
human or organization owning an asset

3.1.10
asset service
service that is provided by the considered asset

3.1.11
asset related service
service that is not provided by the considered asset, but by software service outside of the considered asset

3.1.12
concept
unit of knowledge created by a unique combination of characteristics

[SOURCE: IEC 61360-1:2016, 3.1.8] 3D/265/CDV

3.1.13
concept repository
collection of entries that allows lookup by concept identifier and where relationships between entries can be described

[SOURCE: IEC 62832-1:2020, 3.1.5, modified – "concept dictionary" deleted]

3.1.14
concept repository entry
description of a concept containing, at a minimum, an unambiguous concept identifier, a preferred name, and a description

[SOURCE: IEC 62832-1:2020, 3.1.6]

3.1.15
concept repository owner
human or organization owning a concept repository

3.1.16
entity
thing (physical or non-physical) having a distinct existence

[SOURCE: ISO/IEC FDIS 20924, 3.1.18]

3.1.17
interface
shared boundary between two entities defined by functional characteristics, signal characteristics, or other characteristics as appropriate

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3.1.18
meta information
information used to describe an entity

3.1.19
service
distinct part of the functionality that is provided by an entity through interfaces

[SOURCE: IEV 741-01-28]

3.1.20
software application
software functional element specific to the solution of a problem in industrial-process measurement and control

[SOURCE: IEC TR 62390:2005-01, 3.1.2; modified: software was added to the term]

Note 1 to entry: A software application requires a computing infrastructure to be deployed and executed.

3.1.21
software service
software functional element that provides the functionality through interfaces

Note 1 to entry: A software service requires a computing infrastructure to be deployed and executed.

3.1.22
Submodel
representation of an aspect of an asset

3.1.23
SubmodelElement
element of a Submodel

3.1.24
Submodel template
template for the representation of an aspect of an asset

3.1.25
Submodel template element
element of a Submodel template

3.1.26
Submodel template owner
human or organization owning a set of Submodel templates

3.2 Abbreviated terms

AAS	Asset Administration Shell
HMI	Human machine interface
IT	Information technology
OPC-UA	Open platforms communications - unified architecture
OT	Operational technology
P&ID	Process and instrumentation diagram
PCF	Product carbon footprint
PLC	Programmable logic controller

3.3 Items in the context of Asset Administration Shell

Table 1 defines the items considered in the context of the Asset Administration Shell including their characteristics with respect to governance, value, and meta information.

NOTE The term value is used in the sense of the value of a technical quantity and not in the commercial sense of a value proposition.

Table 1 – Governance, value, and meta information of items

Item	Governed by	Value	Meta information
AAS	AAS responsible	Submodels	AAS management information

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Submodel	AAS responsible	SubmodelElements	Submodel template (optional)
SubmodelElement			
• Purpose information	AAS responsible	Value of information	Referenced concept repository entry
• Purpose relationship	AAS responsible	Referenced entities	Referenced concept repository entry
• Purpose service	AAS responsible	Referenced service	Referenced concept repository entry
• Purpose structure	AAS responsible	SubmodelElements of structure	Referenced concept repository entry
Submodel template	Submodel template owner	Submodel template elements	Not applicable
Submodel template element			
• Purpose information	Submodel template owner	Not applicable	Referenced concept repository entry
• Purpose relationship	Submodel template owner	Not applicable	Referenced concept repository entry
• Purpose service	Submodel template owner	Not applicable	Referenced concept repository entry
• Purpose structure	Submodel template owner	Submodel templ. elem. of structure	Referenced concept repository entry
Concept repository entry	Concept repository owner	Concept identifier	Preferred name, description

4 Use Cases for the Asset Administration Shell

4.1 General

According to IEC TR 63283-1 use cases specify of a set of actions performed by a system. The use cases described in this clause are based on Figure 1, which shows the Asset Administration Shell and related entities. These use cases specify actions performed by the AAS and the related entities and can include requirements, recommendations, and permissions.

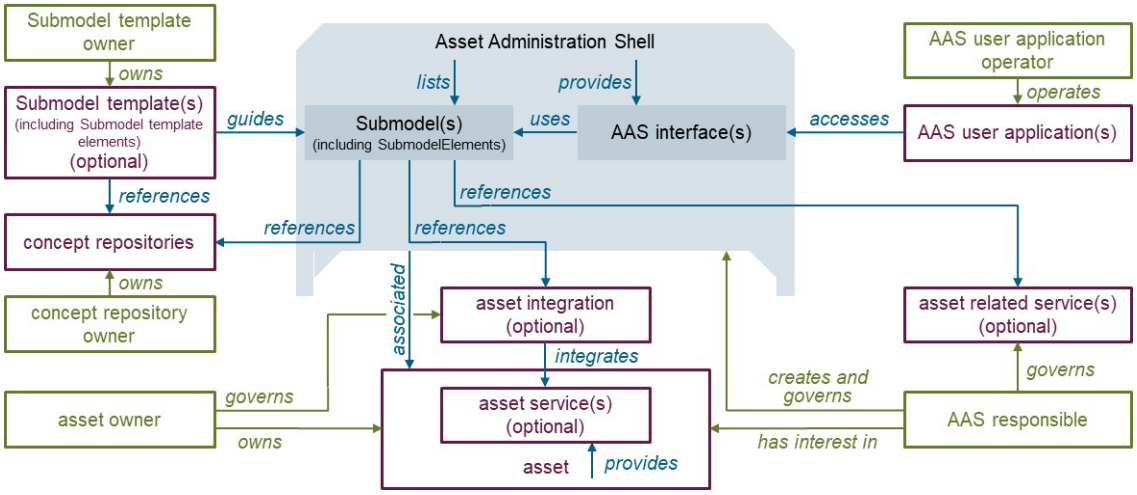


Figure 1 – Asset Administration Shell and related entities

Figure 1 is an extension of Figure 4 “Detailed overview of AAS and related entities” of part 1. A distinction is made between entities assumed by humans or organizations indicated in green and entities assumed by technical systems indicated in purple. To complete Figure 1, further entities were added in addition to the AAS responsible, which are assumed by humans or organizations.

4.2 Governance principles

Governance principles for the AAS delineate the power and options for action of the entities assumed by humans or organizations. They also set rules and guidelines for the interactions, and they define, guide, and provide for enforcement of these interactions.

In detail, this means for the entities assumed by humans or organizations:

- An AAS responsible creates and governs an AAS to be used by AAS user applications but has the interest to govern the usage of the AAS. The concept to support the governance of an AAS responsible is described in 4.5, and is enforced by the AAS interface.

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- A concept repository owner owns concept repository entries of a concept repository to be accessed and explored, but not modified, by other entities, but has the interest to grant and restrict the access and exploration for the entities. In the context of the AAS, the concept to support governance of a concept repository owner is described in 4.5, but the enforcement is not considered in WG24.

NOTE Concept repositories can also be accessed and explored by entities not related to AASs, for example, the usage of concept repositories by traditional procurement systems.

- A Submodel template owner owns Submodel templates to be accessed and explored, but not modified, by AAS user applications, but has the interests to grant and restrict access and exploration for AAS user applications. In the context of the AAS, the concept to support governance of a Submodel template owner is described in 4.5, but the enforcement is not considered in WG24.

- An asset owner owns an asset and governs the asset integration. The asset owner has an interest to grant and restrict the access to and execution of asset services. The asset integration serves that the asset owner can pursue this interest.

- An AAS user application operator operates an AAS user application being of interest in a higher-level context. The AAS user application operator has an interest that AAS user applications may use information and services provided by the AAS and the related entities via the AAS interface. The AAS responsible aligns the own interests regarding to data exposure with the interests of the AAS user application operator. On this basis the AAS responsible defines data exposure regarding the AAS user application. The AAS user application operator – and the developer of the AAS user application – shall be aware that this usage can be restricted by the other entities.

Figure 2 illustrates the governance scopes and subjects.

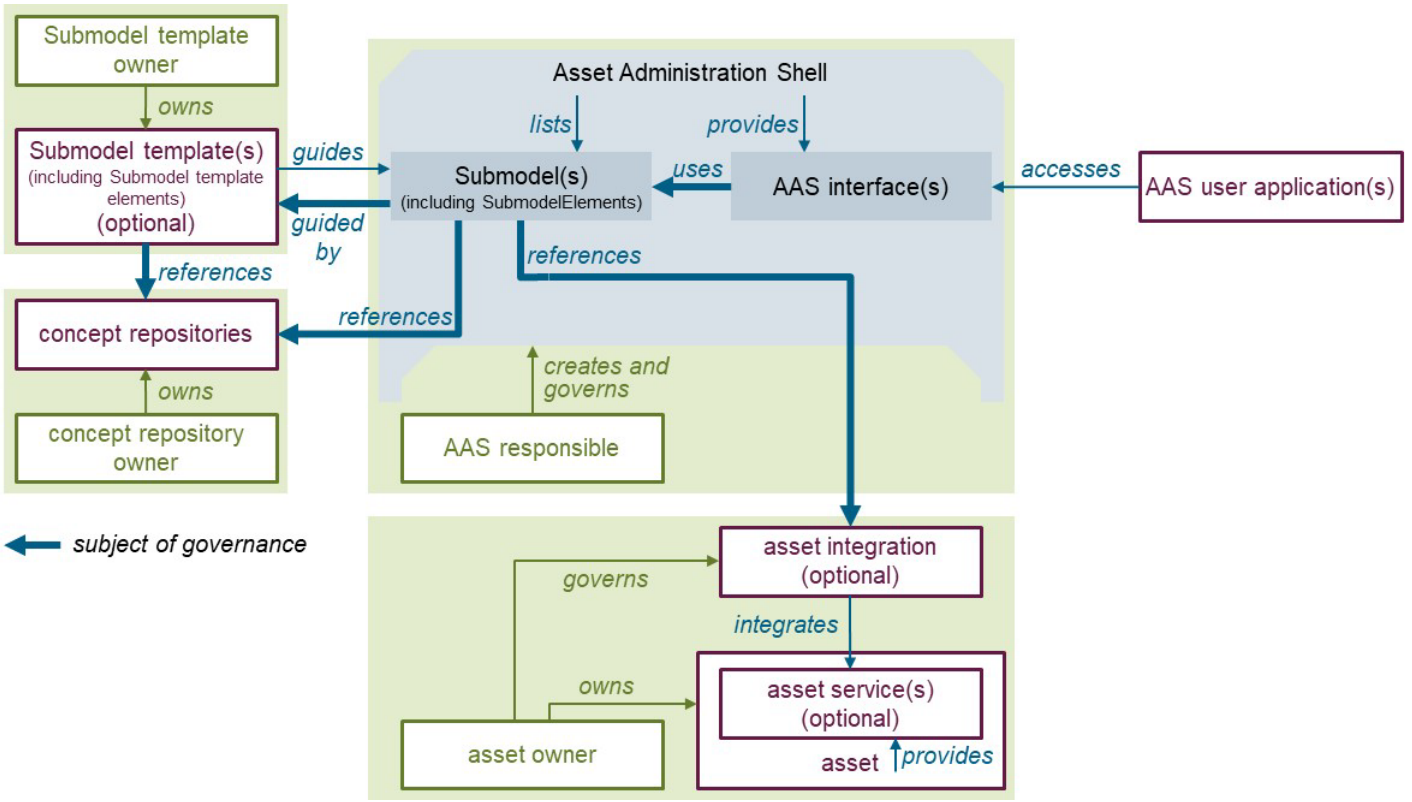


Figure 2 – Illustration of governance scopes and subjects

4.3 Management of assets and Asset Administration Shells

4.3.1 Basic assumptions

The triple of asset, AAS responsible, and AAS form an indivisible unit. Therefore, the relationships that an AAS responsible “creates and governs” an AAS, an AAS responsible “has interest in” an asset, and an AAS is “associated” to an asset shall not change. There is exactly one AAS responsible, who “creates and governs” a specific AAS and there is exactly one asset “associated” to a specific AAS. If an AAS responsible has no longer an interest in an asset, the AAS shall no longer exist. If an asset reaches end of life, an associated AAS also shall no longer exist.

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Assets and AAS have a life cycle. The “start of life” of an AAS is not earlier than the “start of life” of the associated asset and the “end of life” of an AAS is not later than the “end of life” of the associated asset, see Figure 3 for illustration. Start of life and end of life of an asset are defined by the asset owner, start of life and end of life of an AAS are defined by the AAS responsible.

EXAMPLE The start of life of an asset can be defined as the ideation or the definition of the asset. The end of life of an asset can be defined, if all traces of the existence of the asset are destroyed.

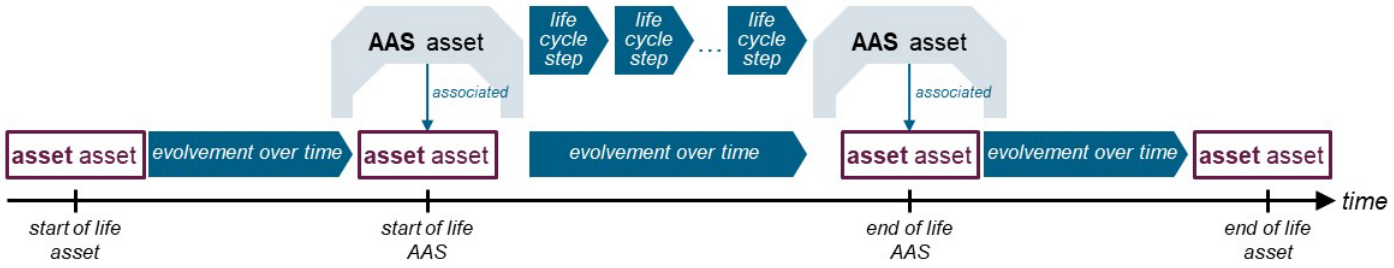


Figure 3 – Illustration of life cycle of assets and AASs

4.3.2 Modification of an asset

Assets can be physical or non-physical.

EXAMPLE Examples for physical entities are equipment, raw material, parts components and pieces, supplies, consumables, physical products, and waste. Examples for non-physical assets are knowledge about an equipment and concepts in mind. Software as the code running on a computing device and the description of software can be seen as physical assets, the function of software can be seen as a non-physical asset.

NOTE There is a clear distinction between the asset and a representation of the asset. An AAS as a digital representation of an asset can itself be seen as an asset.

Physical assets are permanently in an aging process due to their physical presence and are therefore subject to constant modification. In addition, modifications can also be made deliberately from the outside, for example a physical reconfiguration of the asset.

Non-physical assets remain unchanged in themselves. Modifications occur only because of targeted interventions from outside.

4.3.3 Modification of an Asset Administration Shell

4.3.3.1 General

There are two different ways how AASs can be modified: the **value** of an AAS can be modified or the **structure** of an AAS can be modified.

Modification of the AAS management information is not considered within the scope of this document.

4.3.3.2 Modification of the value of an AAS

Modifying the value of an AAS affects SubmodelElements. A SubmodelElement can be an element of a Submodel of an AAS or an element of another SubmodelElement. The modification shall respect the defined value range.

NOTE 1 Part 1 does not make any specifications about the range of value.

Depending on the purpose of the SubmodelElement changing the value means, see also Table 1:

- Purpose information: the value of the information is changed.
- Purpose relationship: the referenced entities are changed.
- Purpose service: the referenced service is changed.
- Purpose structure: the value of the SubmodelElements of the structure are changed.

NOTE 1 The value of a SubmodelElement will always contain the up-to-date information. The AAS user application is responsible to retrieve values of specific versions or revisions if requested.

NOTE 2 The value of a SubmodelElement with purpose information can be a time series.

4.3.3.3 Modification of the structure of an AAS

The following modifications of an AAS are structural changes:

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- Creating or deleting a Submodel of an AAS.
- Creating or deleting a SubmodelElement. A SubmodelElement can be an element of a Submodel of an AAS or an element of another SubmodelElement.
- Replacement of a SubmodelElement of a SubmodelElement with purpose structure of an AAS by another SubmodelElement. An example for such a structural change is explained in 4.3.3.4.
- Modifying the referenced concept repository entry of a SubmodelElement, for details see 4.4.4.5 and 4.4.4.6.
- Modifying the guidance of a Submodel of an AAS by a Submodel template, for details see 4.4.4.5 and 4.4.4.6.

Structural changes shall respect the defined constraints defined by concept repositories and Submodel templates, for details see 4.4.2 and 4.4.3.

EXAMPLE Figure 4 shows an example, where the concept repository entry “CRESMref” postulates a reference to a Submodel. Therefore, Submodel “SM2” is never deleted, because otherwise the reference defined by SubmodelElement “SMref” is not compliant to the definition of “CRESMref”.

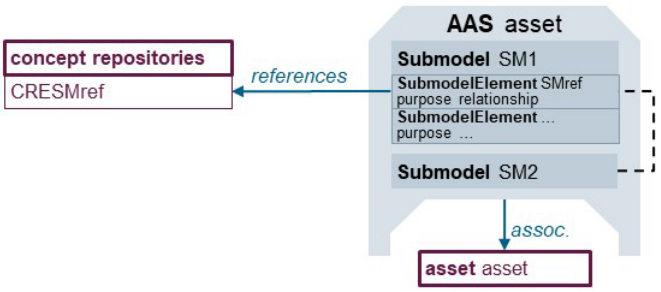


Figure 4 – Illustration of a constraint restricting structural changes

The management of structural changes considering the specified constraints is not within the scope of this document.

4.3.3.4 Modeling example: modification of a SubmodelElement

Figure 5 illustrates the modification of a SubmodelElement with purpose structure, which is an example for a structural change of the associated AAS. The SubmodelElement “req_properties” describes required properties by describing the required material and production process. The required material and production process are described by further attributes. In the example, initially “req_processA” is required as the required production process, but then modified to “req_processB”.

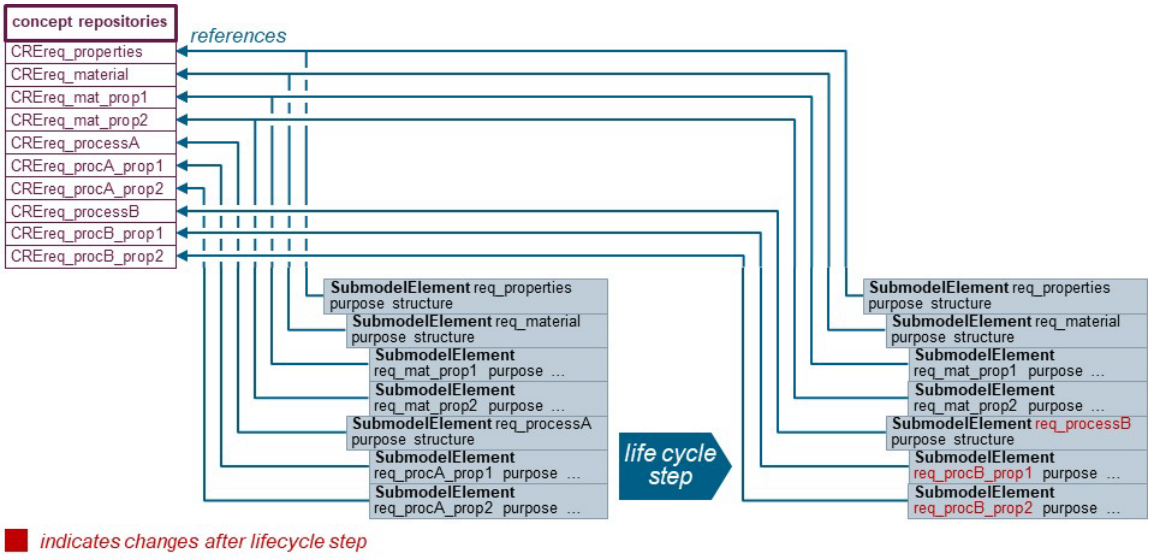


Figure 5 – Modeling example: modification of a SubmodelElement

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4.3.4 Asset integration and asset services

Figure 6 shows the internal structure of the asset integration. For each asset service of the asset, the asset integration includes a corresponding adapter asset service, via which the affected asset service can be accessed from the AAS. The asset services are not subject to any boundary conditions from the perspective of the AAS, but it is the task of the asset owner to implement the “accesses” relationship appropriately. Thereby the asset owner is enabled to determine which asset services are visible from the AAS. An adapter asset service can act in the role of an AAS user application, while an asset service cannot.

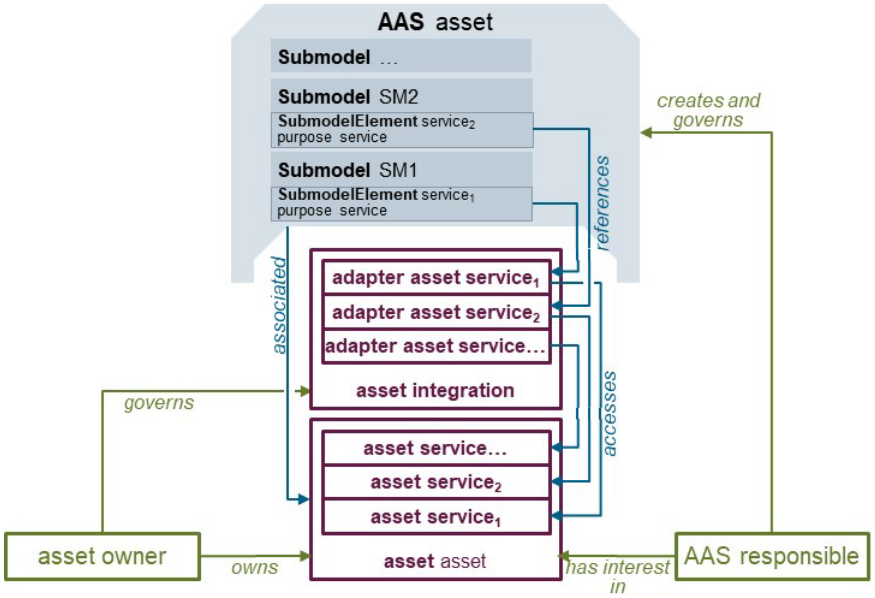


Figure 6 – Internal structure of asset integration

While adapter asset services are software services, asset services are not limited to software services. An example of this is the asset service “start_stop” shown in Figure 8, which can be used to start and stop a physical drive. This functionality goes beyond pure software functionality. However, only services with a software interface are accessible via adapter asset services.

4.3.5 Relationships between an asset and its Asset Administration Shell

4.3.5.1 General

Figure 7 illustrates manual and automatic information flows between a physical and digital object according to [2]:

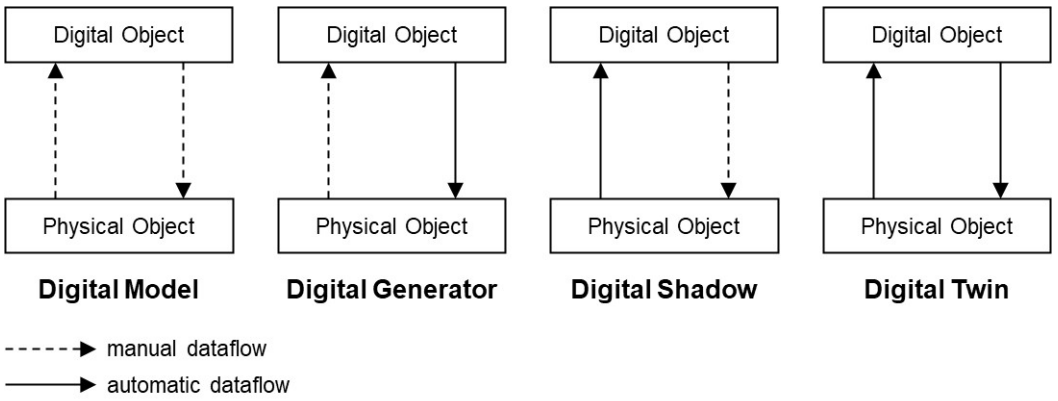


Figure 7 – Relationships between digital object and physical object according to [2]

All relationships according to Figure 7 between physical objects and digital objects are addressed in the context of the AAS. The AAS assumes the role of the digital object according to Figure 7 and the asset assumes the role of the physical object according to Figure 7. However, the AAS goes beyond the scope of Figure 7 and also considers non-physical objects.

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For **non-physical** assets as objects of thought only digital models according to Figure 7 are applicable. Digital generator, digital shadow, and digital twin according to Figure 7 are not applicable, because there cannot be established a dataflow from and to a non-physical entity.

NOTE Possibly external manipulations of the human brain are not considered in this context.

For **physical assets,** all relationships according to Figure 7 are applicable. To establish an automatic dataflow between an asset and an AAS the asset shall provide suitable asset services.

EXAMPLE 1 The asset is a flow chart as concept in mind. If the asset as concept in mind changes the corresponding AAS can be modified manually. For example, if one realizes during the work with the AAS that the asset as concept in mind does not address the purpose adequately, the concept in mind is changed.

EXAMPLE 2 The asset is a rectangular sheet as physical entity. The length, height, and width of the asset can be measured, and the measured values can be manually entered into the AAS. If the width is changed in the AAS then suitable physical operations can be used to change the asset accordingly.

4.3.5.2 Modeling example: relationships between a drive and its AAS

In this example a drive is considered, which provides the asset services “start_stop” and “get_status”. The drive is switched on or off when the asset service “start_stop” is executed. When the asset service “get_status” is executed, it provides the current status of the drive.

The associated AAS includes the SubmodelElement “command” with purpose information representing the value of the switching signal to the drive and the SubmodelElement “status” with purpose information representing the current status of the drive. In addition, the AAS includes the SubmodelElements “start_stop” and “get_status” with purpose service to reference the asset services “start_stop” and “get_status” of the drive via the asset integration.

Figure 8 illustrates for this example the various relationships according to Figure 7 between an asset and its AAS.

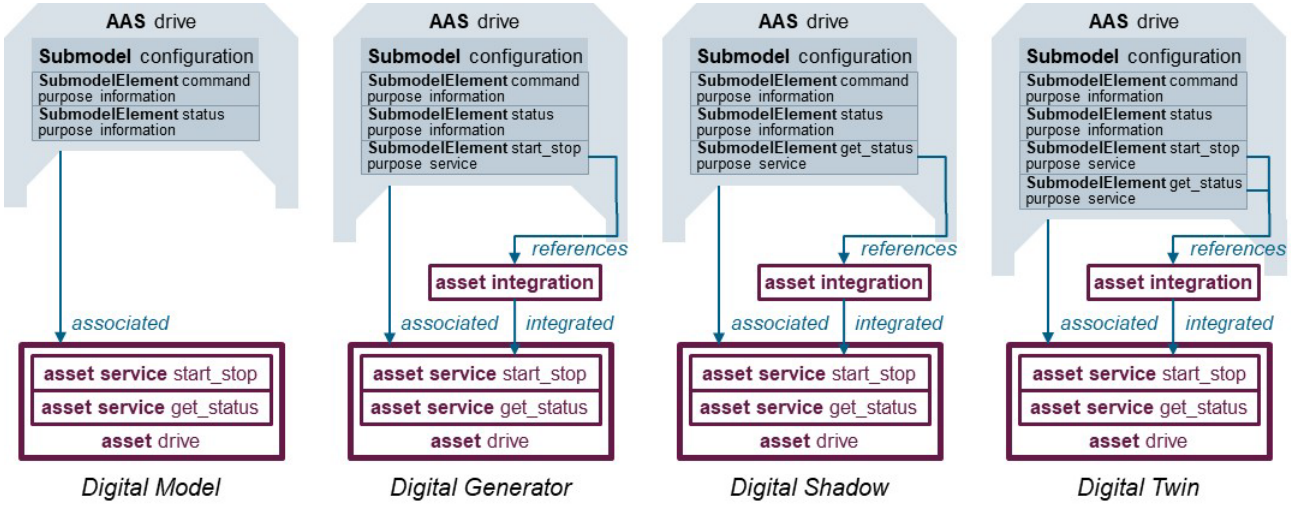


Figure 8 – Relationships between a drive and its AAS according to [2]

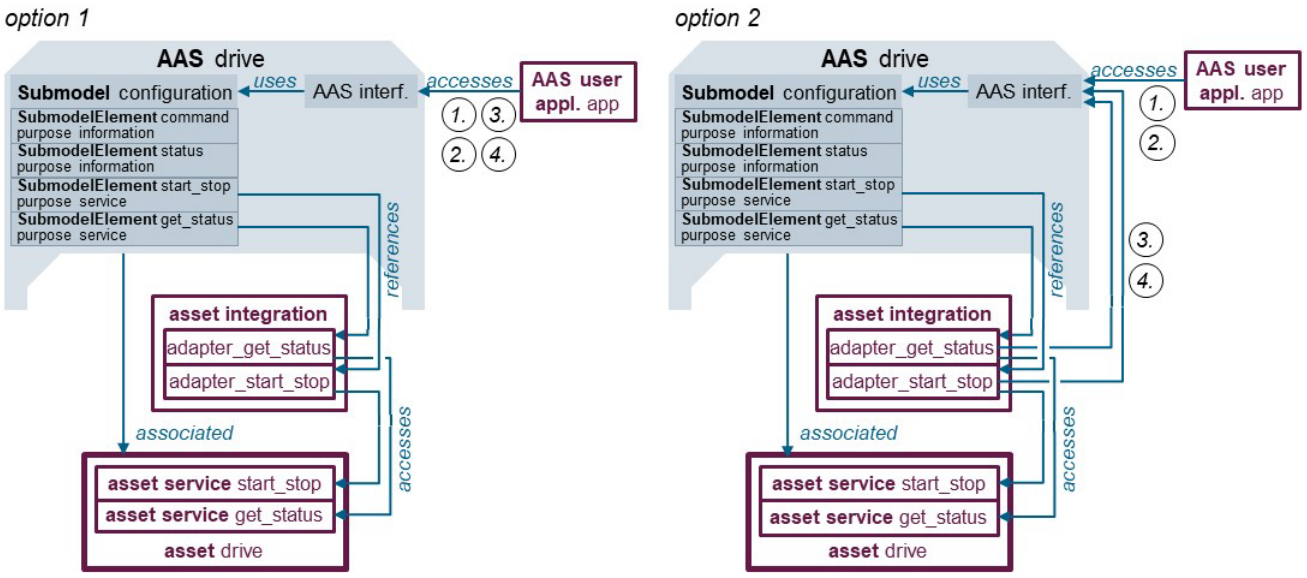
- In the case of a digital model the drive can only be switched on and off manually on site and does not provide any feedback about its status.
- In the case of a digital generator the drive can be switched on and off via a communication interface but does not have a communication interface to provide feedback on its status. An externally monitored fault is manually entered into the AAS.
- In the case of a digital shadow the drive can only be switched on and off manually on site but has a communication interface that provides feedback on its status.
- In the case of a digital twin the drive can be switched on and off via a communication interface and provides its status, for example on, off, faulty, via a communication interface.

The current status provided by the asset service “get_status” can be stored as value of the SubmodelElement “status”. The storage of the value can be done by an AAS user application, which initiates the execution of the asset service “get_status” and receives in turn the provided status, see Figure 9 option 1, or the adapter asset services of the asset service “get_status” assumes the role of an AAS

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user application and accesses the AAS interface to store the provided status in the SubmodelElement "status", see Figure 9 option 2.

The command executed by the asset service "start_stop" can be stored as value of the SubmodelElement "command". The storage of the value can be done by an AAS user application, which initiates the execution of the asset service "start_stop", see Figure 9 option 1, or the adapter asset service of the asset service "start_stop" assumes the role of an AAS user application and accesses the AAS interface to store the command in the SubmodelElement "command", see Figure 9 option 2.



Updating SubmodelElement "status"

1. *"app" requests for discovery and gets reference to "get_status"*
2. *"app" requests for execution of "get_status" and gets current status*
3. *"app" requests for discovery and gets reference to "status"*
4. *"app" updates "status" with current status*

1. *"app" requests for discovery and gets reference to "get_status"*
2. *"app" requests for execution of "get_status"*
3. *adapter asset service of "get_status" requests for discovery and gets reference to "status"*
4. *adapter asset service of "get_status" updates "status"*

Updating SubmodelElement "command"

1. *"app" requests for discovery and gets reference to "start_stop"*
2. *"app" requests for execution of "start_stop"*
3. *"app" requests for discovery and gets reference to "command"*
4. *"app" updates "command" with current command*

1. *"app" requests for discovery and gets reference to "start_stop"*
2. *"app" requests for execution of "get_status"*
3. *adapter asset service of "start_stop" requests for discovery and gets reference to "command"*
4. *adapter asset service of "start_stop" updates "command"*

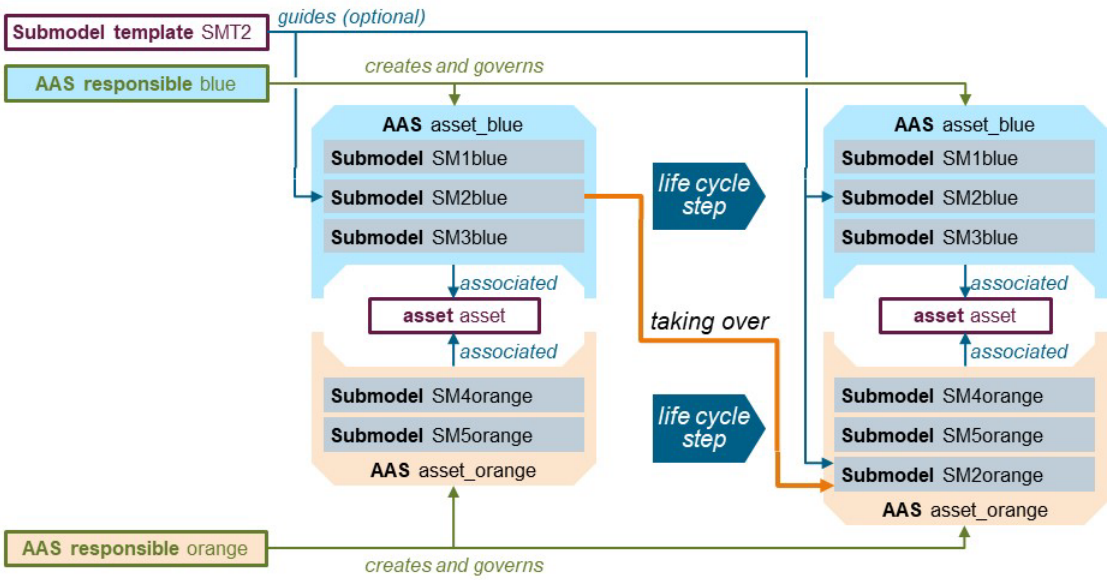
Figure 9 – Updating SubmodelElements "status" and "command"

4.3.6 Taking over information from an Asset Administration Shell

4.3.6.1 General

Figure 15 "Illustration of value exchange in overall scenario" of part 1 introduces the concept of taking over information from one AAS to another AAS associated to the same asset. This means that one or more Submodels of an AAS are added as new Submodels to the other AAS. Such a taking over must be triggered explicitly in the context of an AAS, for example by an AAS user application. Figure 10 illustrates this step.

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NOTE 1 It is possible that the AAS “asset_orange” does not exist before the takeover but is created because of takeover or that the AAS “asset_blue” does not exist after the takeover and is deleted because of takeover.

NOTE 2 Taking over only refers to adding one or more Submodels once. The AAS responsible “blue” and “orange” agree whether and how the Submodels “SM2blue” and “SM2orange” are synchronized over their life cycle after taking over.

Figure 10 – Illustration of taking over information from an AAS

There are two different approaches of taking over information from an AAS: **copying** and **referencing** of Submodels.

4.3.6.2 Modeling example: taking over a Submodel by copying

A new Submodel “SMorange” is created, which can be guided by the same Submodel template. The current values of the SubmodelElements of the Submodel “SMblue” are copied into the SubmodelElements of the newly created Submodel “SMorange” as follows:

- The reference to the concept repository entry is copied.
- If the SubmodelElement has the purpose information, the current value is copied.
- If the SubmodelElement has the purpose relationship, the corresponding reference is copied.
- If the SubmodelElement has the purpose service and the referenced service is an asset related service, the AAS responsible “orange” shall ensure to govern an asset related service that the SubmodelElement can reference. If the referenced service is an adapter service of an asset service, taking over by copying is not possible, because the adapter service is governed by the asset owner, see 4.3.4, and the asset owner has no interest to lose governance because of copying.
- If the SubmodelElement has the purpose structure, the copying process continues recursively for the associated SubmodelElements.

Figure 11 illustrates the result of taking over a Submodel by copying. Typically, “SMblue” and “SMorange” are not synchronized.

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