Basics of Industrie 4.0

The digital twin in Industrie 4.0
A short introduction to properties, submodels & Asset Administration Shells (AAS)

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Hard shell, soft core?
Asset Administration Shell: The digital twin in Industrie 4.0

- clear form
  clear rules
- flexible content
Industrie 4.0
What’s new, really?

That’s already possible today

- the cloud
- networks
- automation devices with Internet access
- internet-based services

Industrie 4.0: New Ingredients

- **added value** by exchanging information between value chain partners
- from **intranet** to **internet**
- **neutral and common standards** for communication, services and semantics across companies and sectors

A large number of new **applications** and **business models** will emerge.
The current focus of Plattform Industrie 4.0 is the exchange of information...

... along the value chain,

... between partners in the value chain.
Integration of assets into the world of information

Asset = everything that requires a "connection" for an Industrie 4.0 solution

- machines and their components
- supply materials, parts and products
- exchanged documents (e.g. drawings, wiring diagrams)
- contracts
- orders
- ...

The Asset Administration Shell is the implementation of the digital twin for Industrie 4.0.
Overview

- Identifiers
- Submodels and Asset Administration Shells
- Semantics
- Reduction of integration costs
Basis of Industrie 4.0

Identifiers
Identification

Erika Mustermann and an identifier
Identification

Erika Mustermann and her ID card – Context: Federal Republic of Germany
Identification

Erika Mustermann and her identity card

- unique identifier, here: ID number
- identifying properties of Mrs Mustermann
- further properties of Mrs Mustermann
Access to the Asset Administration Shell
Example: product manufacturer

https://ability.abb.com/aas/1SVR560730R3400?SN=1SV11223345566

https://productid.abb.com/1SVR560730r3400?SN=1SV11223345566
Access to the Asset Administration Shell
Example: plant operator

https://ability.abb.com/aas/1SVR560730R34007SNr1SV11223345566

https://productid.abb.com/1SVR560730r34007SNr1SV11223345566

Administration Shell of the Asset

Asset

QR Code on the Asset/Part of the plant

Asset-Management-App of the plant operator

Server at plant operator

Asset Administration Shell at plant operator
Basis of Industrie 4.0

Submodels and Asset Administration Shells
Use-Case and submodel

Erika Mustermann wants to live healthily

- health status 30.12.2019
  - blood values
  - stress ECG
  - body weight

- nourishment situation „actual“
- nourishment situation „target“
- plan for exercise and sport

- health status 15.6.2020
Use-Case and submodel

**Erika Mustermann wants to save money**

- **Income**
  - salary
  - child support from state
  - bitcoin earnings 😊

- **Spendings**
  - shopping
  - rent
  - insurances
  - saving for holidays
Use-Case and submodel

Erika Mustermann visits Berlin

- itinerary
- train ticket
- hotel booking
- packing list
- sightseeing list
- tickets for the opera
- travel budget
Asset Administration Shell
Container for submodels

Content of Submodel

Submodels

Asset Administration Shell = Digital Twin
Submodels

Group of properties

Assets have properties

- weight, price, order number, dimensions

In I4.0, we combine properties into groups, suitable for use cases:

- logistical properties
- order features
- technical data
- properties for documentation
- ...

We call these submodels.

- Submodels are groups of properties for a use case.
Basis of Industrie 4.0

Semantics
“The Jaguar is in the garage.”
Starting point semantics

Exchange symbols with previously defined meaning

- Symbol
  - refers to an object
  - The meaning is known to both sender and receiver.
  - Anyone can look up the meaning of the symbol in a dictionary.
- Symbols in Industrie 4.0 are machine-readable, they are made for communication between machines.

„M8“ „green yellow“
"Ich bin ein Berliner!"

**Dictionary Human <-> Machine**

- **Code:** 0123/4///46789_1#ABC001
- **Version:** 001
- **Revision:** 04
- **Preferred name:** Berliner
- **Synonymous name:** Pfannkuchen, Kreppel
- **Definition:** Traditional German pastry similar to a doughnut with no central hole, made from sweet yeast dough fried in vegetable oil, with a marmalade or jam filling.

© DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE
Dictionary: ECLASS 10.0.1

27-20-02-06 Temperature Transmitter (0173-1#01-AAC063#016)
Basis of Industrie 4.0

Cybersecurity
Establishing a secure connection
Cybersecurity – Overview, example plant operator
Cybersecurity – Overview, example plant operator

Plant operator

Internet

Business partner
Cybersecurity – Overview, example plant operator

Plant operator

Internet

Business partner
Cybersecurity – Overview, example plant operator

Plant operator

Internet

Business partner

Shared authentication service

trusts
Cybersecurity – Overview, example plant operator

Plant operator

trusts

Internet

logs in

Business partner
Cybersecurity – Overview, example plant operator

Plant operator

Internet

Business partner

receives token

trusts

Cybersecurity – Overview, example plant operator
Cybersecurity – Overview, example plant operator

Plant operator

logs in with token

trusts

Internet

Business partner
Cybersecurity – Overview, example plant operator

Plant operator

Internet

Business partner

verifies token
Cybersecurity – Overview, example plant operator

Secure encrypted connection established to identified partner
Cybersecurity – Overview, example plant operator

Secure encrypted connection established to identified partner

Access control for identified business partners to
- Asset Administration Shells
- Submodels
- Submodel elements

Plant operator

Internet

Business partner
Asset Administration Shell

Reduction of integration costs

- Integration of external partners
- Integration of data sources and systems of a company
Reduction of integration costs

External partners

- Standardised AAS reduces number of for interfaces, m:n \(\rightarrow\) 1:n
- AAS can be extended by new use cases at any time, along the entire life cycle of an asset, AAS "grows with" it
- New partners can be integrated at any time
Reduction of integration costs

Integrating data sources

IT landscapes in companies have a huge complexity and diversity:

- user systems
- systems for business processes
- IoT and SaaS
- PLM and ERP systems
- analytics and artificial intelligence
- systems for integration, e.g. in a corporate group
- systems in production
Reduction of integration costs

Integrating data sources

- AAS can integrate information on an asset from a wide range of systems, e.g. PLM, ERP, CRM, MES, etc.
- Active submodel modules realise data access and model transformation for enterprise systems.
- Data access from external sources via AAS standardised.
- There is no "single source of truth".

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Reduction of integration costs

Use case: Integration for power trains

- assets in the example: frequency inverter, motor and complete drive (powertrain)
- automatic identification of assets, automatic communication setup
- integration of information from engineering, devices (online data frequency converter), database for installed base and product information
- external data access by customer via AAS
Hard shell, soft core?
Asset Administration Shell:
The Digital Twin in Industrie 4.0

- clear form
  clear rules:
  - information model and data formats
  - semantics
  - online API and cybersecurity
- flexible content
  - use cases that can grow
  - flexibility for new partners in the value chain
  - throughout the entire life cycle

The digital twin as a flexible "data socket".