Smart Manufacturing, Edge Computing & Standardization

Presenter: Daniel Stock – 11.03.2021
Smart Manufacturing drives the convergence of ICT and OT
System landscape in manufacturing companies inhibits efficient use of new technological possibilities

- ICT & OT are increasingly converging, do not fit together due to different genesis (e.g. reliability vs. flexibility)
- IoT & IIoT approaches are increasingly being used
- New possibilities
  - Better communication technology, computing power and AI tools
- New challenges
  - Efficient use of domain knowledge while maintaining technological sovereignty
  - Use of the flexibility of ICT in OT
  - Widespread use of artificial intelligence for production optimization
Data Governance for Industrial AI Services

Data governance is the basis for the scalable, efficient and reliable use of AI services in industrial production

- **Data quality** - Ensure that the data is accurate, consistent, and free of "interference" that could affect the use and analysis of data-driven algorithms.

- **Data availability** - Ensure that the data is available and easy to use for the appropriate data-driven applications.

- **Data usability and knowledge** - Ensure that the data is structured, documented, and named, enable easy search and query, and are compatible with the data-driven tools users use.

- **Data Integrity and Sovereignty** - Ensure that data retains its essential properties, even when stored, converted, transferred, and viewed on different platforms.

- **Data Security** - Ensure that the data is classified according to its sensitivity and define processes to protect information and prevent data loss and leaks.
RAMI 4.0 (DIN SPEC 91345)
Reference Architecture Model Industrie 4.0

Layers
- Business
- Functional
- Information
- Communication
- Integration
- Asset

Life Cycle & Value Stream
IEC 62890
IEC 62264 // IEC 61512

Hierarchy Levels

Unified virtual representation of assets?
→ Asset Administration Shell

How do components on each level map to each other?

RAMEC (source: Fraunhofer FOKUS)
The Asset Administration Shell is the implementation of the „Digital Twin“ for Industrie 4.0.

The Asset Administration Shell establishes cross-company interoperability.

The Asset Administration Shell is available for non-intelligent and intelligent products.

The Asset Administration Shell covers the complete life cycle of products, devices, machines and facilities.

The Asset Administration Shell enables integrated value chains.

The Asset Administration Shell is the digital basis for autonomous systems and AI.

"Digital Twin" - Virtual representation of a physical asset
Integration of AI in Smart Manufacturing

AI technology needs smart infrastructure and vice versa
Infrastructure for Smart Manufacturing applications

Converged ICT and OT layers allow flexible deployment and delivery of smart services

Deployment based on specific requirements of data driven technologies, available resources and physical capability of machines / CPS to enable self-x.

Example Scenario: Collaborating mobile robots which exchange environmental data for autonomous navigation

Cloud-Servers for scalable services

Edge server for time-sensitive ML services

SG Base Station for RT services: RT

Edge Server for collaborative services

e.g. trajectory planning & safety

Deployment

based on specific requirements of data driven technologies, available resources and physical capability of machines / CPS to enable self-x.

Cloud-Layer

Edge-Cloud-Communication-Layer

OT-Layer

Collaborating Robots with mission critical services:

Collaborating

Robots with

mission
critical

services:

e.g. trajectory
planning &
safety

Knowledge

Definition of relevant and critical process parameters

AAS

Process / functional Requirements Submodel

Formalized process knowledge

Resource Description Submodel

• Technical requirements

Resource Description Submodel

• Technical capabilities

Resource Description Submodel

• Technical requirements

Mapping of technical requirements (technology, latency, bandwidth, ...)

Mapping of compute requirements (technology, storage, volume, bandwidth, ...)

Mapping of process requirements (technical requirements, ...)

Deployment Description Submodel

• Technical Requirements for deployment
Example Introduction of 5G (architectures) in manufacturing environments

New technologies enable new ways to build systems and their architectures

Extreme Mobile Broadband (eMBB)
- 10+ Gbps
- Archiving large amounts of data

Massive Machine-Type Communications (mMTC)
- 1 Million Devices/km²
- >1ms Latency
- Ultra-Reliable and Low-Latency Communications (URLLC)

Building Automation
- AGV control & navigation
- Automation, control

Asset Management
- Augmented/Mixed Reality

Safety Systems
- Sensors and Actuators

Distribution of large amounts of data

Image & Image Recognition

CPPS – Cyber Physical Production Systems
- CPPS (logical composition)
- Global, open network (e.g., Internet)
- Information flow & Interaction

Factory
- Infrastructure - Factory as CPPS

Shop Floor - Equipment as CPPS

Central Office
- BBU (Baseband Unit)
- RRU (5G Remote Radio Unit)

Hybrid Cloud / Edge Cloud
- BBU (Deep Edge Cloud)
- RRU (Deep Edge Cloud)

Physical Process / Environment

CPPS
- Embedded system
- Functions (internal logic)
- External interfaces
- Internal interfaces
- Actuators
- Sensors

Physical Process / Environment

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GAIA-X
European digital ecosystem

- Resource description standards need to be unified and standardized for interoperability.

Integration in GAIA-X ecosystem through AAS submodels.

Representation of resources and assets.
German standardization strategy
Industrie 4.0 - Development and standardization of AAS and submodels

- STRATEGY & MOBILIZATION
  - SME mobilization
  - international cooperation
  - high level strategy

- SUPPORT & COORDINATION
  - ADVISORY BOARD
  - STEERING COMMITTEE
  - EXPERT PANEL
  - cross-sector needs
  - coordination of standards
  - international collaborations

- STANDARDS DEVELOPMENT & IMPLEMENTATION
  - proposals for international standards

AG1 – Working Group „Reference architecture and standardization“
SG Models & Standards
UAG Infrastructure – AAS Registry, Infrastructure and Deployment

Source: Fraunhofer IPA, based on SCI 4.0
Overview of publications on the asset administration shell

Transfer of working documents into standards

- Object of consideration
  - Business view
  - Usage view
  - Functional view
  - Implementation view

- Intended reader
  - Solution architect
  - System architect
  - Application engineer

- Asset administration shell
  - Structure of the administration shell
  - Details of the administration shell (parts 1, 2, 3, x)
  - Examples for the administration shell

- Functional view
  - Compute architecture
  - Service architecture
  - Property value statement

- Industrie 4.0
  - Communication
  - Interaction principles
  - Integration of field devices

- Industry 4.0
  - Service architecture
  - Communication guideline

- Industrie 4.0
  - Language

- Examples for the Asset Administration Shell
  - Software architecture
  - Practitioner
  - System architect

* Currently still under discussion and development (as of 05/2020)
Standardisation at national, European and international level
Industrie 4.0 - Development and standardization of AAS and submodels

The standardization work is carried out in committees and working groups (at national level) and technical committees, sub-committees and working groups (on international and European level).
IEC/TC 65/WG 23 Smart Manufacturing Framework and System Architecture
Topics and Task Forces – Impact of Edge Computing in Smart Manufacturing

- **TF Smart Manufacturing Markets and Innovation Trend Analysis**
  - Where is the market going, what are future requirements?

- **TF Smart Manufacturing and New Technologies**
  - Which technologies (e.g. Edge Computing) are available and what’s their impact?

- **TF Smart Manufacturing Use Cases**
  - What requirements are there for Edge Computing in SM?

- **TF Smart Manufacturing Terms and Definitions**
  - What are we even talking about?

- **TF Smart Manufacturing and Safety**
  - What are the safety impact of Edge Computing in industrial applications?

- **TF Smart Manufacturing and Cybersecurity**
  - What are the security impacts of Edge Computing in industrial applications?
Asset Administration Shell in Research and Development
Placement of development of AAS and submodels in projects (examples)

- FabOS - open, distributed, real-time and secure operating system for production
  - Development of unified AAS submodels to describe ICT & OT resources for data governance for AI services in production
- InterOpera - Digital Interoperability in Industry Collaborative Value-Added Networks 4.0
  - Development of a map of knowledge domains, scenarios and business models, Best Practices for Submodels and Interaction Patterns
- Verwaltungsschale vernetzt
  - What happens when AAS from different initiatives and companies meet with different technologies and implementation variants
- BaSys 4.0, BaSys4.2, BaSys ÜberProduktion - Basissystem Industrie 4.0
  - BaSys 4 defines a reference architecture for production systems that enables the transition to Industrie 4.0. The open source middleware Eclipse BaSyx is a reference implementation of the concepts of BaSys 4.
Thank you for your attention

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