Implementing Asset Administration Shell (AAS) Universal Robot UR5e in Digital Factory

Digitalization of ICPS - Group: B

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Agenda

1. Introduction

- Background of the Digital Factory in Technikum
- Business Rationale for Implementing the AAS : Integrator (Stakeholder)
- Defining the Asset

2. Implementation

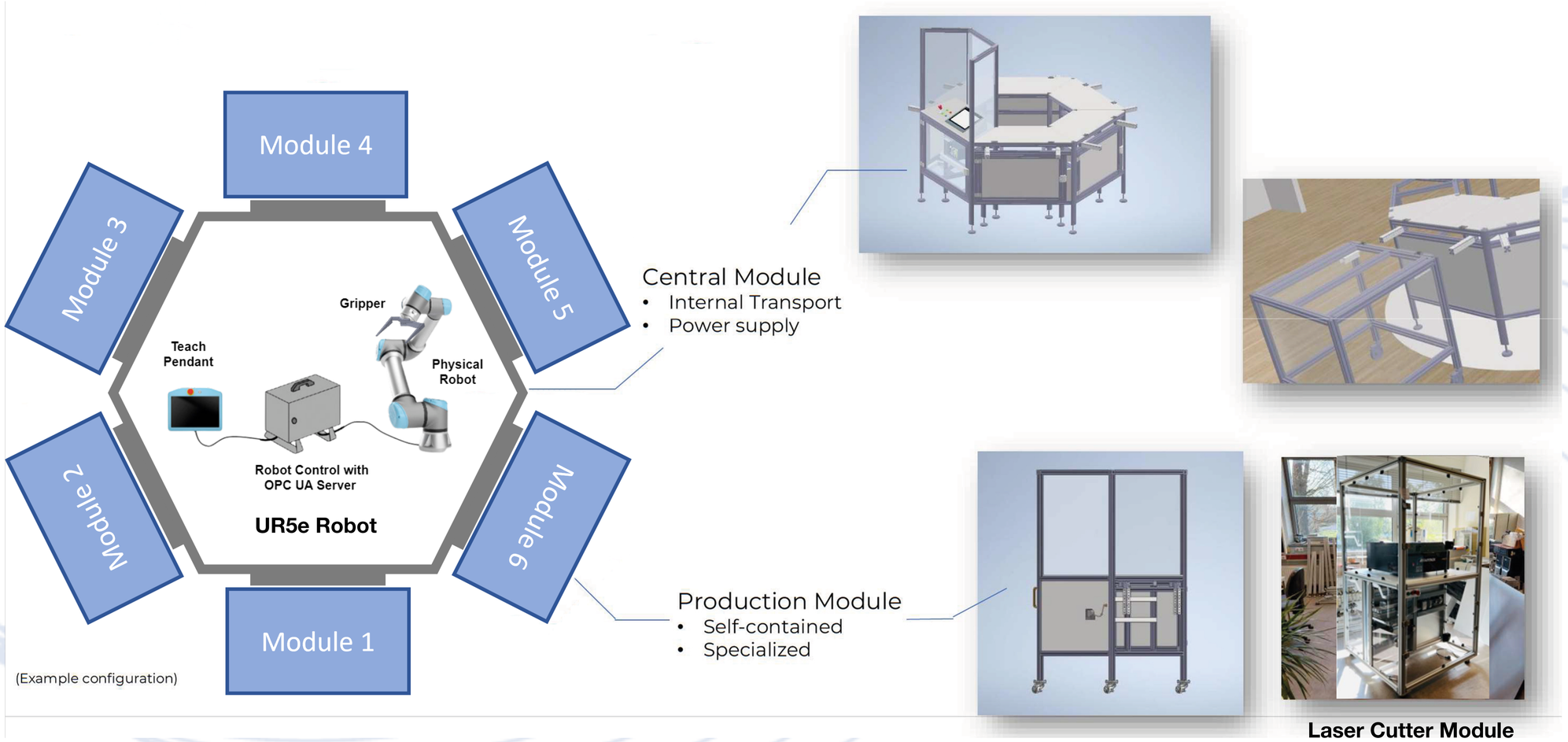
- CP Notation System Specification - From CP43 to CP44
- RAMI 4.0 Specification - Integrator view
- AAS Structure Specification
- Practical Implementation

3. Conclusion & Outlook

4. Bibliography

Introduction

Background of the Digital Factory in Technikum



Concept of digital factory at HS Emden Leer [1]

Introduction

Business Rationale for Implementing the AAS : Integrator (Stakeholder)

I want ...

1. **Reconfiguration**
2. **Seamless Integration**
3. **Interoperability**

Among each modules within Digital Factory

“To optimise the production”

“To allow scheduling”

Digital Factory Integrator’s requirement

1. Enhanced Modularity and Adaptability

With the AAS framework, the digital factory can conform to industry 4.0 standards, facilitating consistent integration and reconfiguration of modules

2. Improved Interconnectivity and Data Exchange

The AAS framework allow UR5e to showcase its capabilities and offer operational data, (e.g. queue state, occupancy and maintenance status) and allow operator to utilise the operation function (e.g. pick and place, and service).

3. Streamlined Production Management and Decision-making

The AAS framework allow integrator to access the constant information of UR5e, including user manuals, technical specifications, and other crucial data.

With AAS Implementation, it will provide above capabilities to the UR5e

Introduction

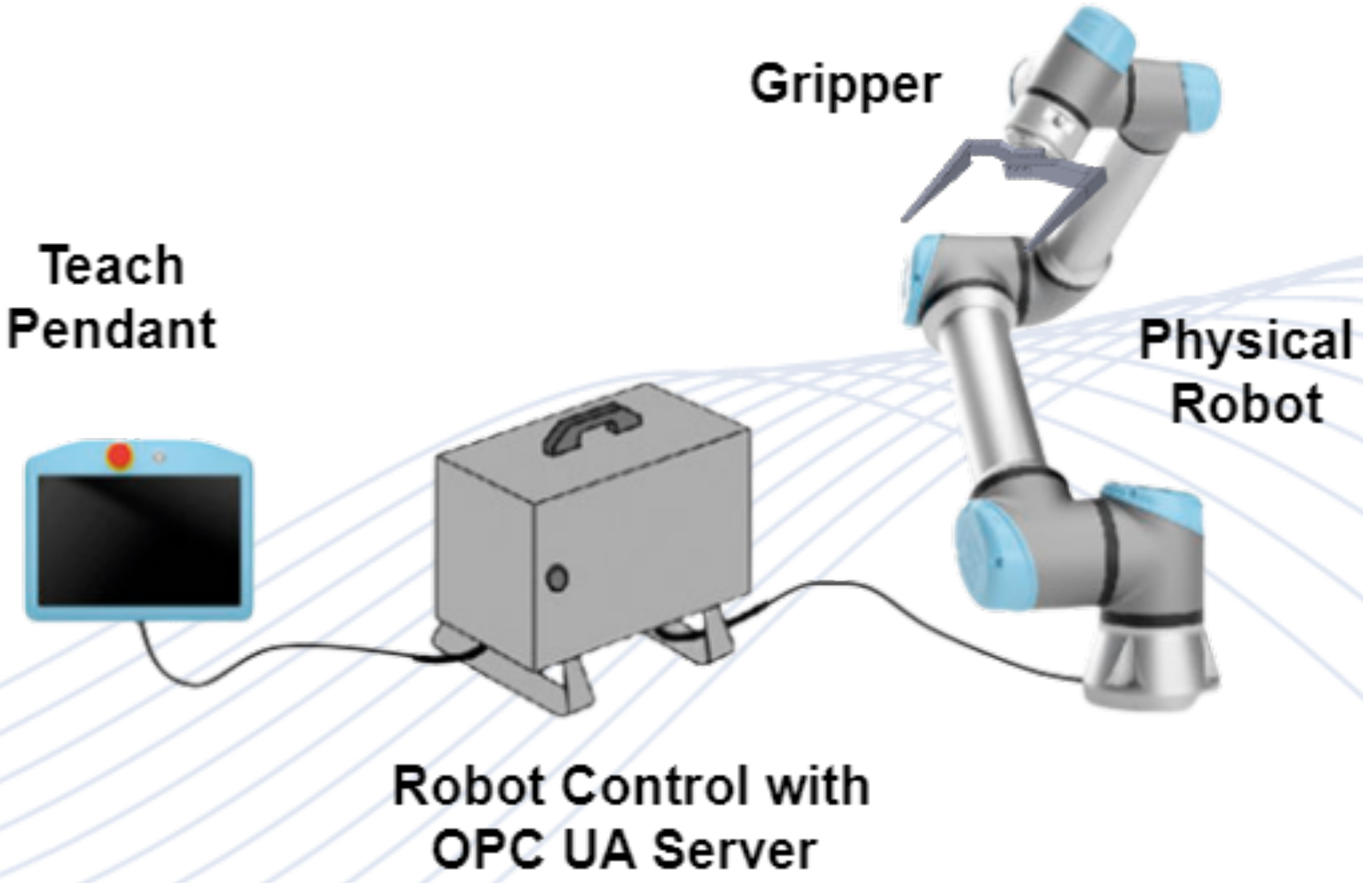
Defining the Asset

Hardware Components

- Physical Robot
- Robot Control
- Teach Pendant
- 3D Printed Gripper

Software Component

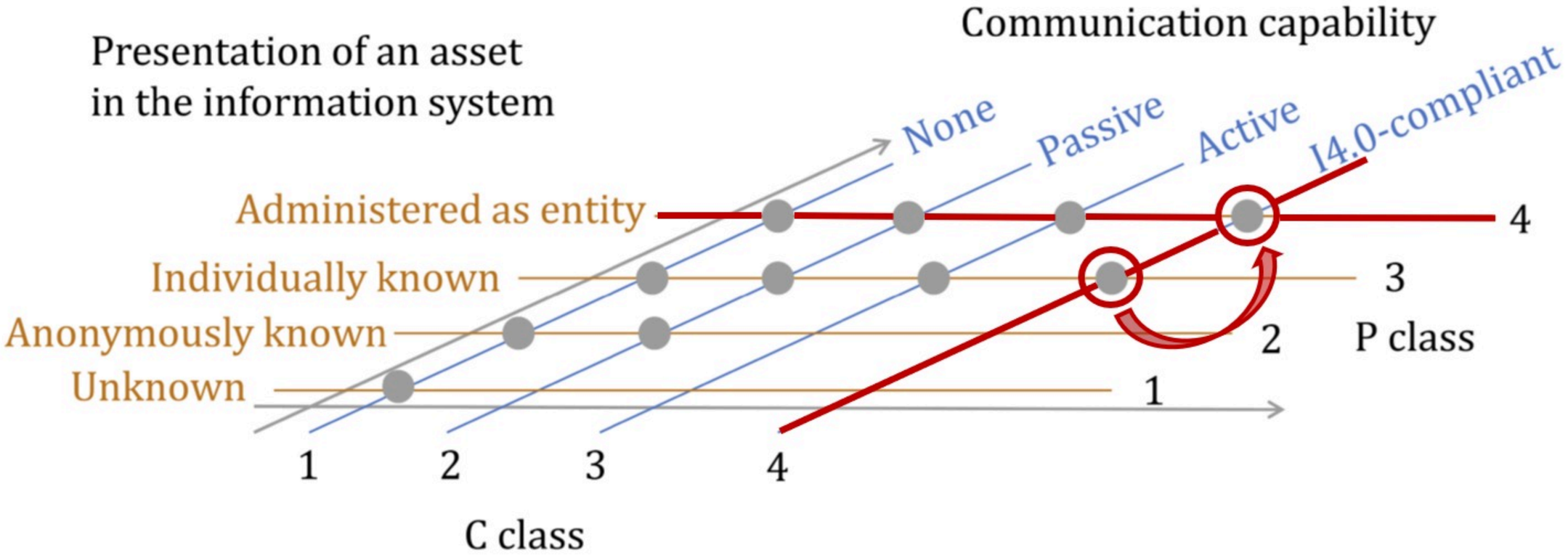
- UR5e OPC UA Server



Asset: hardware & software components [2]

Implementation

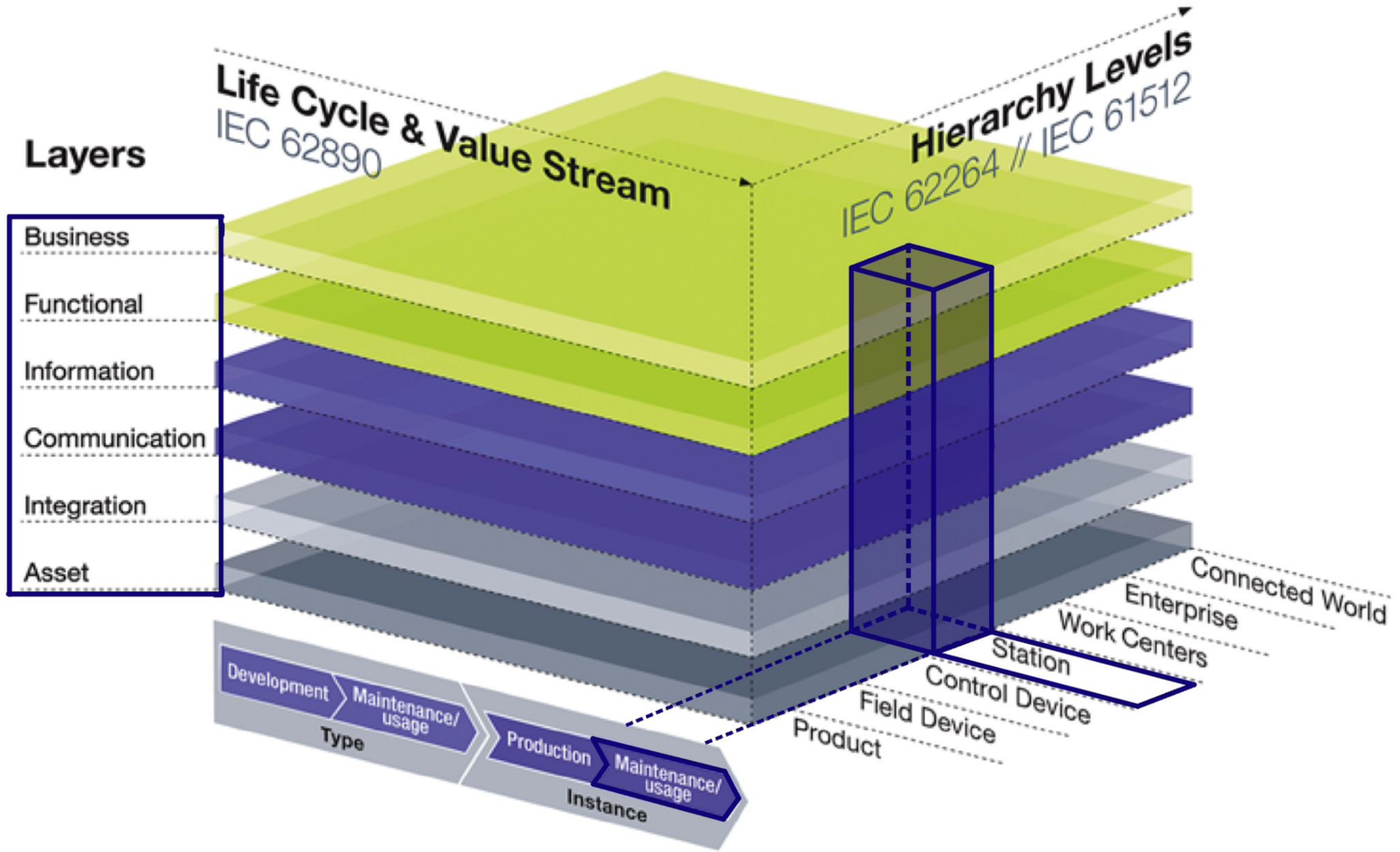
CP Notation System Specification : From CP43 to CP44



CP Notation Diagram: Defined Asset Communication and Presentation [3]

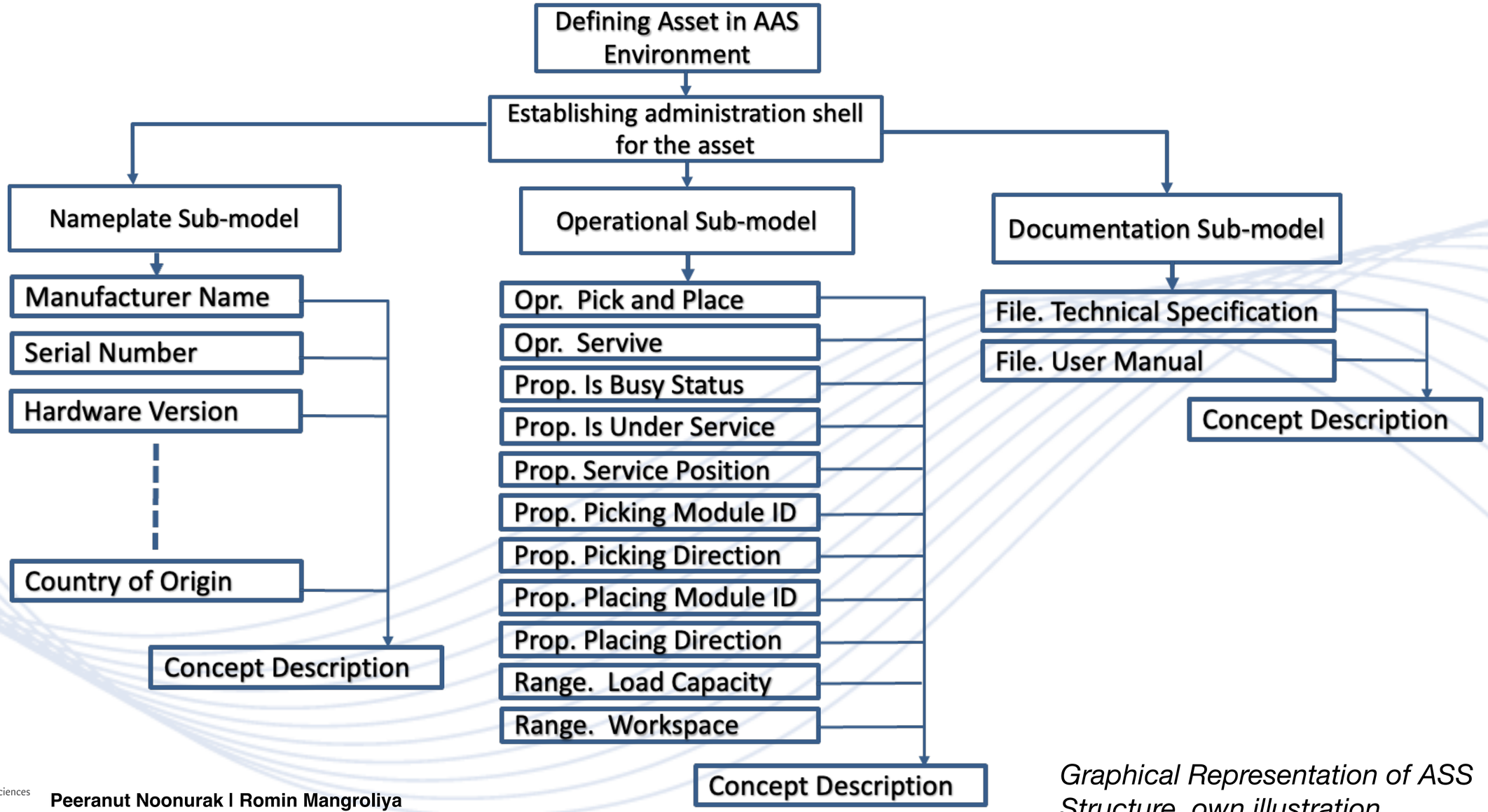
Implementation

RAMI 4.0 Specification : Integrator view



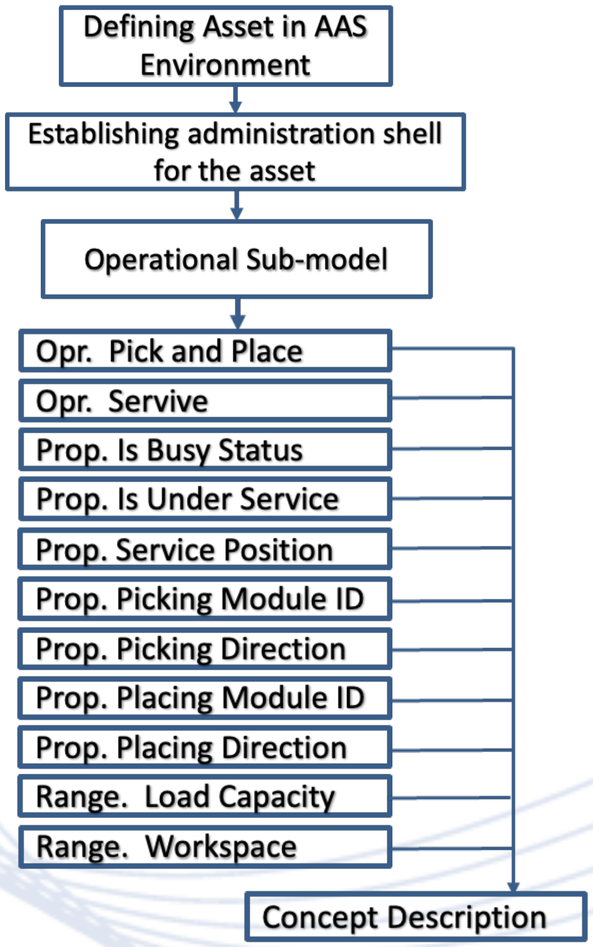
RAMI 4.0 specification for the integrator view [3]

Implementation : AAS Structure Specification - Overall



Graphical Representation of ASS Structure, own illustration

Implementation : AAS Structure Specification - Operational Sub-model

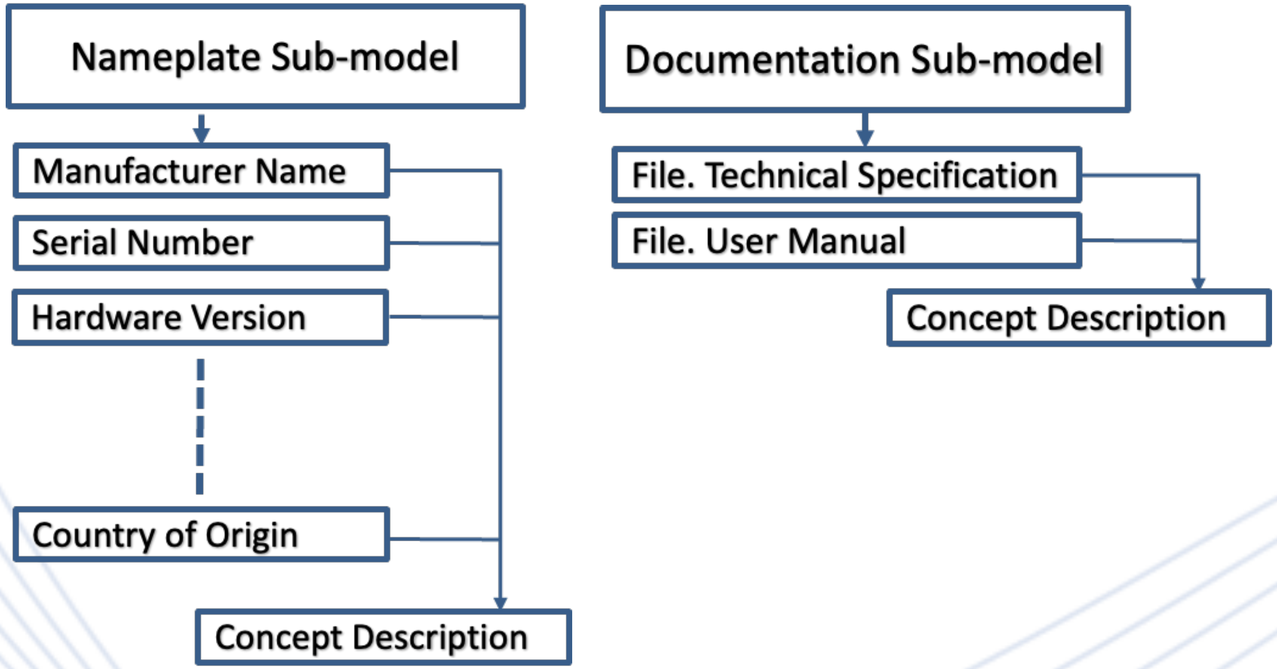


Graphical Representation of ASS Structure, own illustration

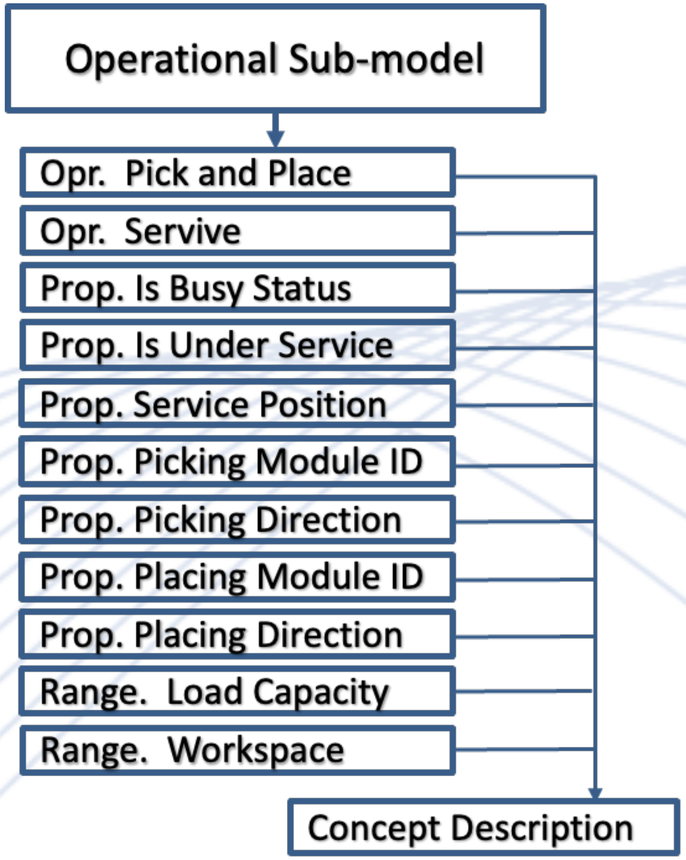
Submodel Element	Element	Description
Property	Occupancy Status	The status indicates whether the robot is active or inactive. This information is necessary for optimizing production procedures and resource allocation.
	Maintenance Status	The status indicates whether or not the robot is being maintained. The asset identifies the digital factory location of maintenance in progress.
	Operation Status	Tracking the current operation of the robot.This indicate the picking and place position and module id
	Queue Management	Tracking the workpieces in the queue assists in scheduling and planning production tasks. This increases production output and decreases waiting time.
Operation	Pick & Place Function	The function offer the pick-and-place operations of the Universal Robot UR5e. Users are able to specify picking and placing directions, module IDs, and positions for precise workpiece manipulation.
	Maintenance Function	The function offer the maintenance operation of the Universal Robot UR5e. This function allows users to initiate service maintenance on a running Universal Robot UR5e. The robot will complete its assigned task before stopping, allowing for safe and effective maintenance.
Range	Load Capacity	Specifies the maximum load capacity of the robot (0 to 2 kg).
	Workspace	Defines the permissible workspace or operating range of the robot (151 mm to 1,050.5 mm).

Summary of properties, operations, and ranges within Operational Submodel, [2]

Implementation : AAS Structure Specification - Views



Views of Technical Information

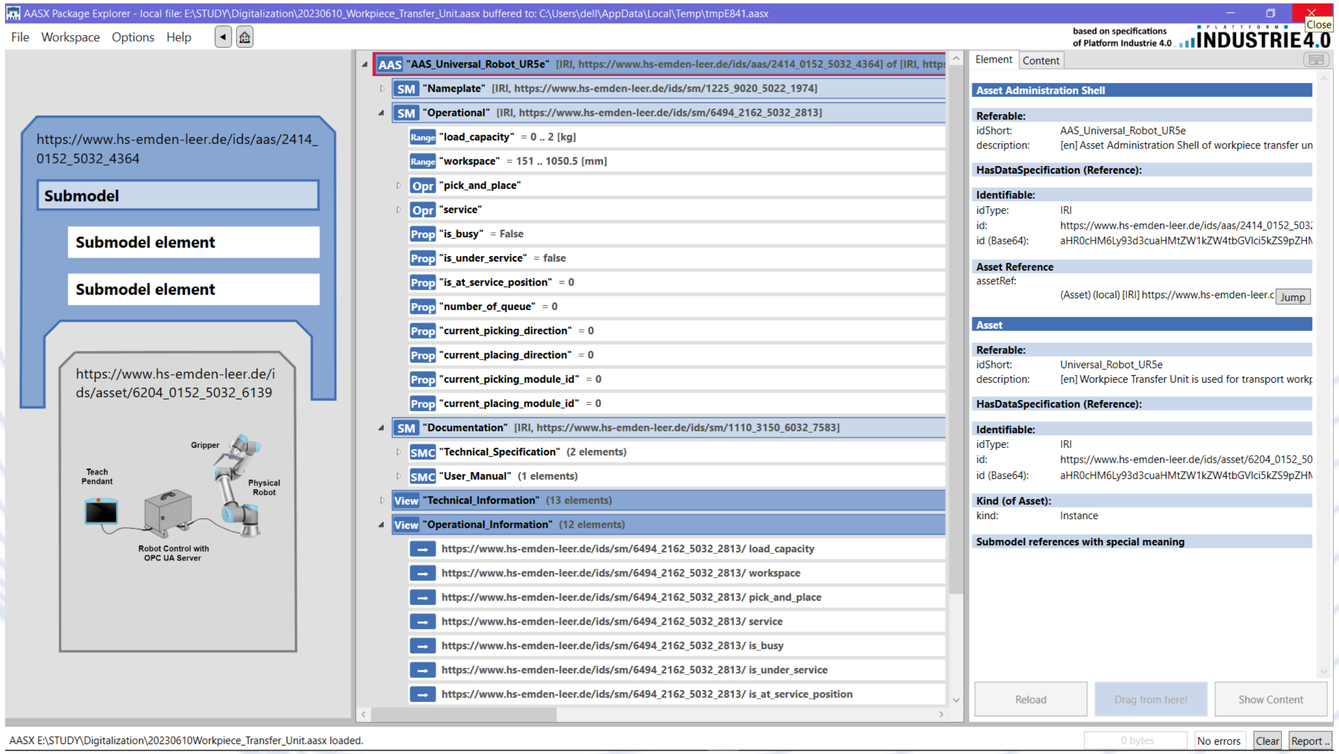


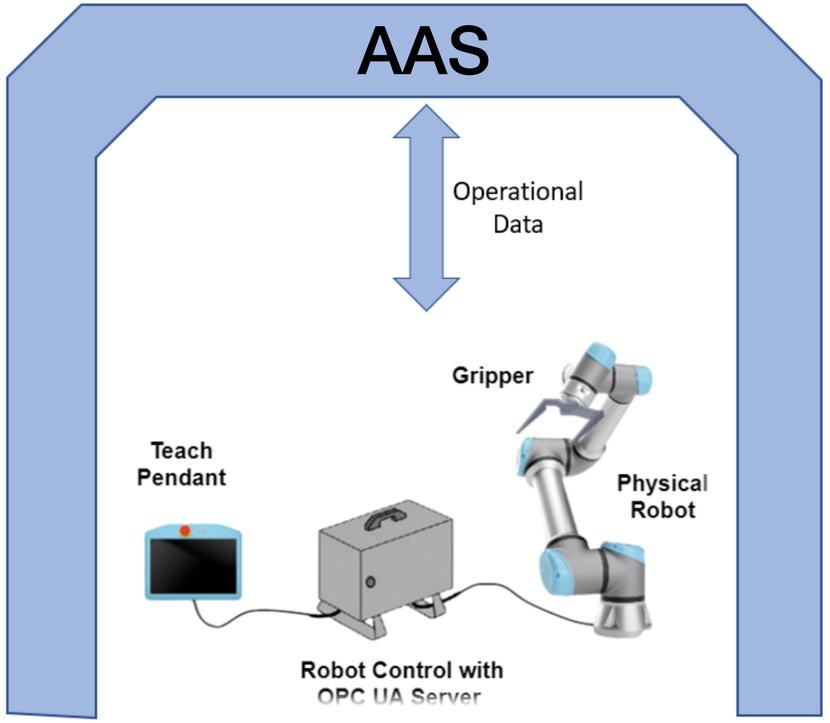
View of Operational Information

Graphical Representation of ASS Structure, own illustration

Implementation

Practical Implementation - Creating AAS & OPC UA Server - AAS Based



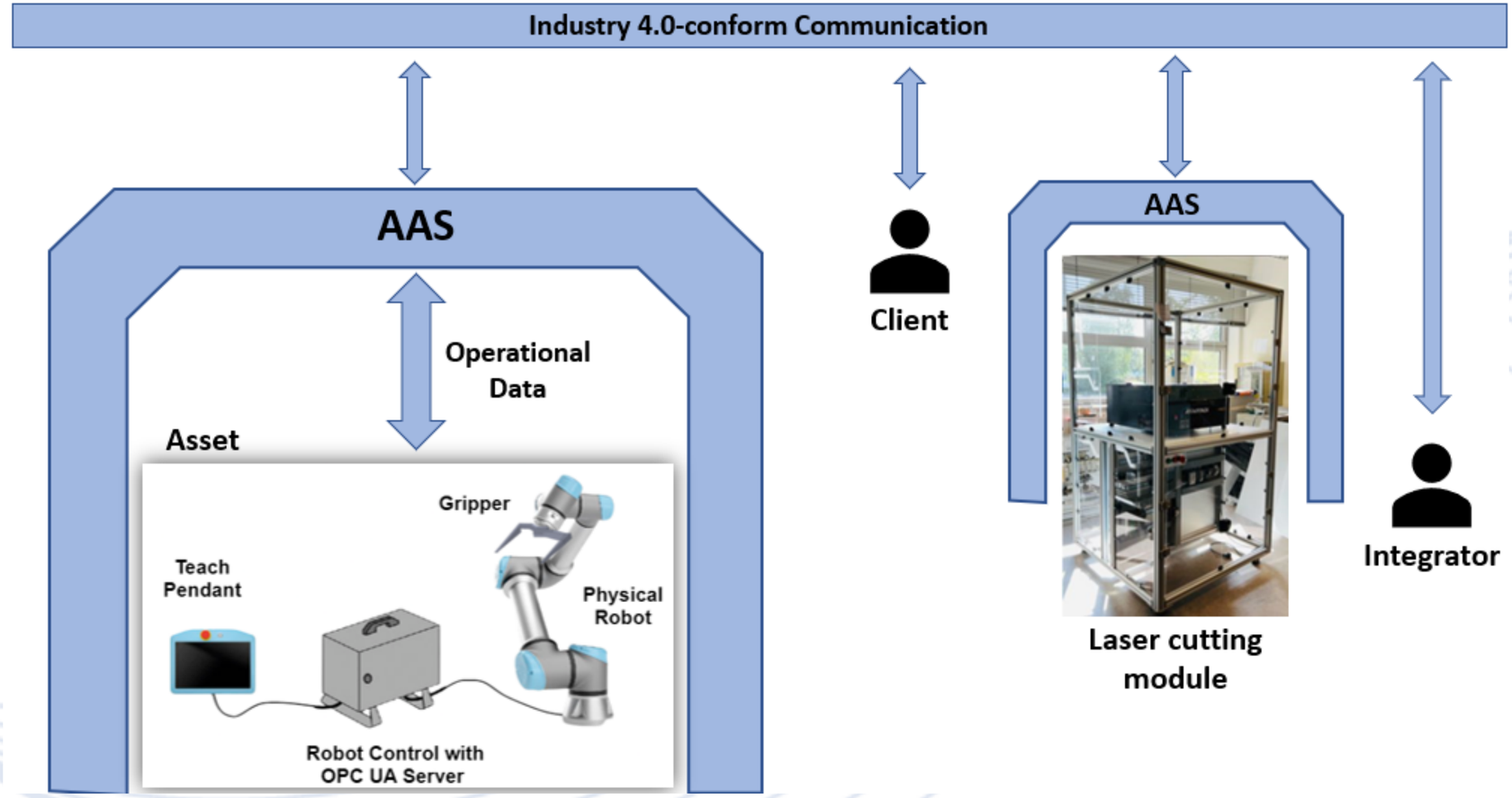


Implementation of Asset Administration Shell of Universal Robot UR5e [2]

OPC UA Server Implementation - Based on AAS [2]

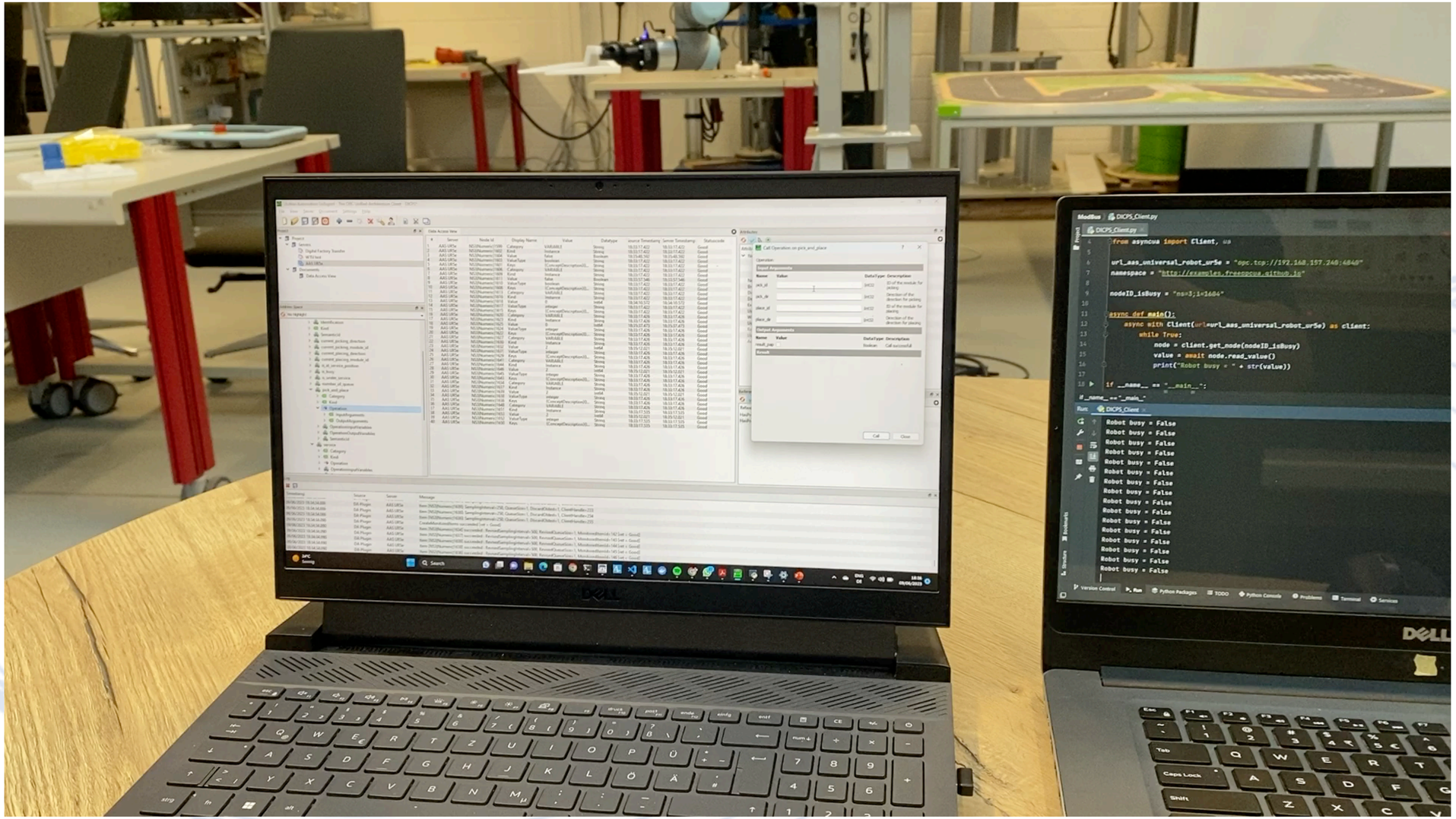
Implementation

Practical Implementation - Creating OPC UA Client - Demonstrating User



OPC UA Client implementation - Demonstration of User [2]

Implementation



Video showcases the implementation of OPC UA Server based AAS and OPC UA Client - Demonstrating User, own video recorded

Conclusion

1. **AAS Implementation in Digital Factory:** Successfully addressed integrator's requirements.
2. **UR5e Robot's Communication Capability Upgrade:** Aligned with industry 4.0 standards.
3. **Successful AAS Structure Implementation:** Namesplate, Operational, and Documentation submodels.
4. **Demonstrated Implementation Result:** Video showing Pick & Place and OPC UA Client.
5. **Compliance with CP Notation and AAS Structure:** Achieved goals until CP44.
6. **Resource Availability:** Document, code, AASX files available on GitHub.

QR Code of GitHub, own illustration

Outlook

1. **Workpiece Transfer Unit AAS Enhancement:**
   - Expand integration and monitoring for complete unit.
2. **Industry 4.0-Conform Communication Protocols:**
   - Integrate diverse communication frameworks for seamless data exchange.
3. **AAS Expansion for Multiple Stakeholders:**
   - Serve operators, maintenance, and collaboration needs

Bibliography

[1] HS Emden Leer, *Projects for the digital factory*: *Winter semester 2022/23*, 2022

[2] P. Noonurak and R. Mangroliya, *Practice of implementing the asset administration shell: Universal robot ur5e in digital factory*," Jun. 11, 2023. (visited on 06/12/2023)

[3] Plattform Industrie 4.0 *et al.*, *Reference architecture model industrie 4.0 (rami4.0)*, DIN SPEC 91345, English translation of DIN SPEC 91345:2016-04, 2016. [Online]. Available: https: //www.beuth.de/en/technical-rule/din-spec-91345/2482458 (visited on 10/18/2021).