

# Arrowhead fPVN - flexible Production Value Networks

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project coordinator



The Arrowhead fPVN project is supported by the Chips Joint Undertaking and its members, including the top-up funding by Sweden, Finland, Denmark, Spain, Italy, Rumania, Portugal Hungary,

[www.arrowhead.eu](http://www.arrowhead.eu)



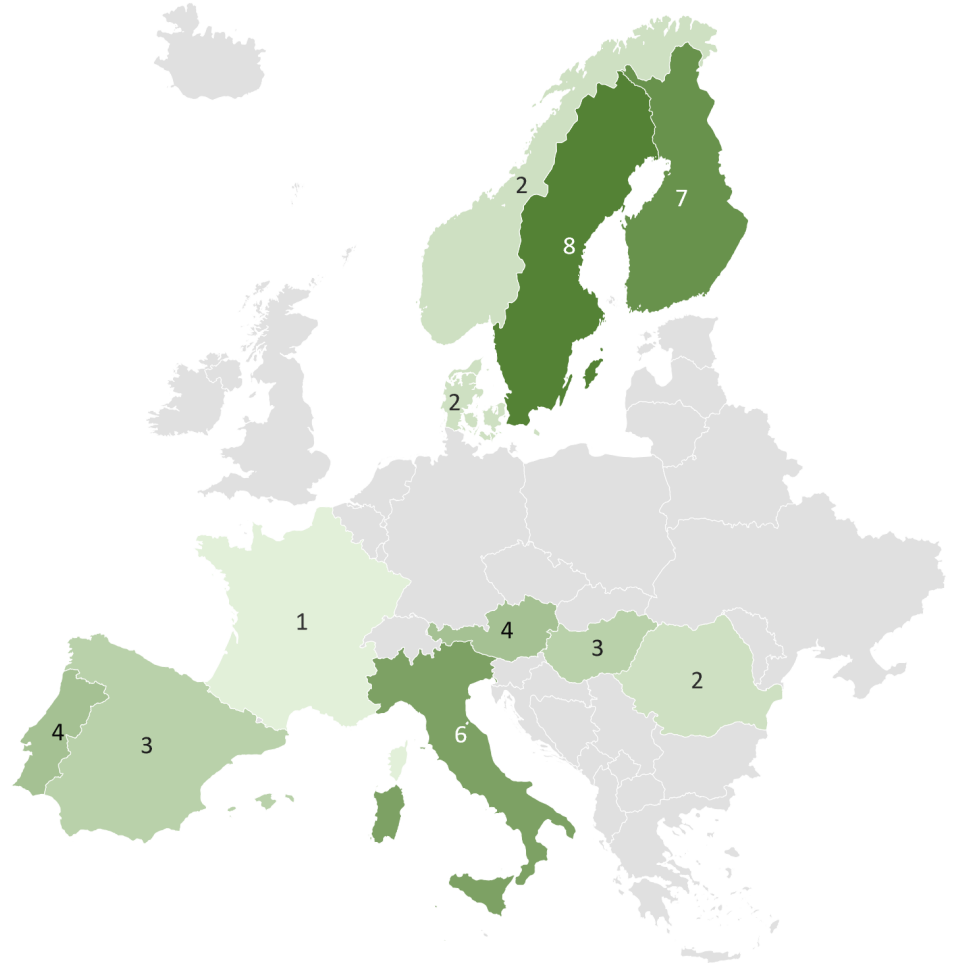
# Overview

Arrowhead fPVN is a European project funded by the CHIPS-JU

- 30M€
- 43 Partners
- 12 Countries

Participants from

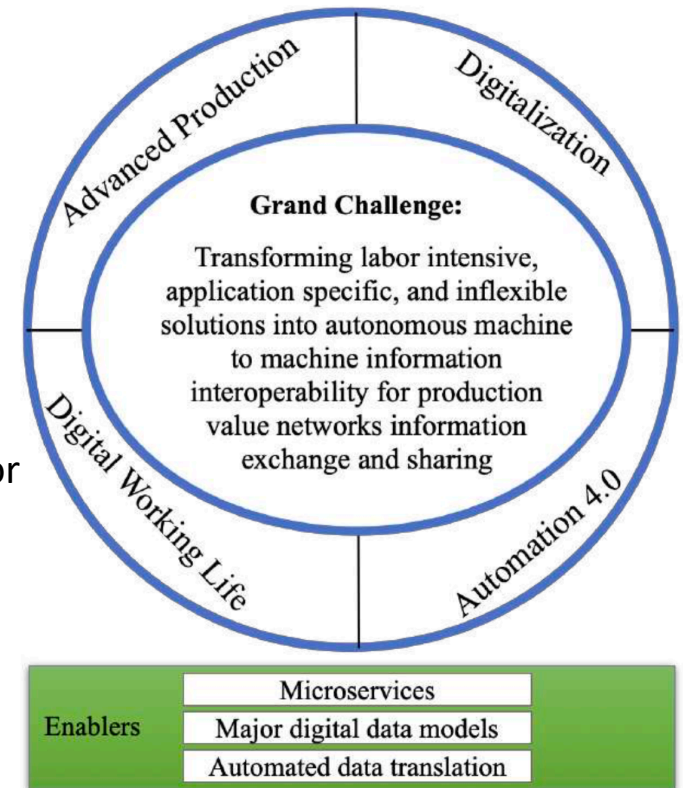
- Automotive services
- Aerospace services,
- Process industry production.



# Grand Challenge

Key technology gaps identified:

- Too many and non-interoperable standardized data models
- Non-mature technology for machine translation in-between data models
- Lack of open architectures and implementation platforms for interoperable fPVNs, having properties such as:
  - Flexible,
  - Secure,
  - Scalable,
  - Autonomous, and
  - Evolvable



# Technology Pillars

Arrowhead fPVN consortium has identified the following three technology pillars a combination of which can substantially boost the interoperability in PVNs:

- **Microservice paradigm - Eclipse Arrowhead**  
An open, extensible solution architecture with reference implementation platform enabling seamless information interoperability between involved entities, operational technologies (OT) and information technology (IT).
- **Major industrial data models (preferably standardized)**  
Promoting the data models of a few major standards, between which autonomous translation is enabled and integrated, to automation/digitalization solutions using the microservices architecture and associated implementation platform.
- **Automated translations between data/information models**  
Automated information model translation between the major data modelling languages enabling on the fly understanding of the entities in PVNs.

# Interoperability

## Multi-protocol, multi-technology

### Translator

HTTP (REST), CoAP, MQTT, Websocket,  
Encodings, JSON, XML, ....

### Adaptors to other communication protocols

OPC-UA <-> Arrowhead

Modbus TCP <-> Arrowhead

Z-wave <-> Arrowhead

ZigBee <-> Arrowhead

IO-link <-> Arrowhead

Thing of Web <-> Arrowhead

# Datamodel interoperability

Very complex problem

# Major industrial data models addressed

Industrial domains covered

Automotive

ASAM-ODS, ISO-IEC 25012

Aeronautics

**ISO 10303-239 and 242, S5000F, S2000M, S3000L, IPC 2581**

Process Industry, e.g. Paper & Pulp, Water distribution ...

**DEXPI, DEXPI+, CFIHOS, ISO 15926-2 and 4, ISO 18101,  
IEC 61987, IEC 61131-3, ISO 81346-1, ISO 10303-239 and 242,  
ISO 12006, ISO 19650, ISO 61499, OPAF, OPC UA**

**ISO 23726-3 Industry data ontology (IDO) will be used as upper  
ontology**

# Considered encodings of major industrial data models

XML

JSON

PDF

SysML

HTML

BPMN

BPML

UML, Express, OWL



# Translation/integration approach

1

Identification of standards  
for interoperability

2

Selection of data sets for all  
standards

3

Selection of data sets for all  
standards

## AI based translation

Training

Test

Evaluation

## Ontology based translation

Ontology selection

Test

Evaluation

## Model based translation

Model definition

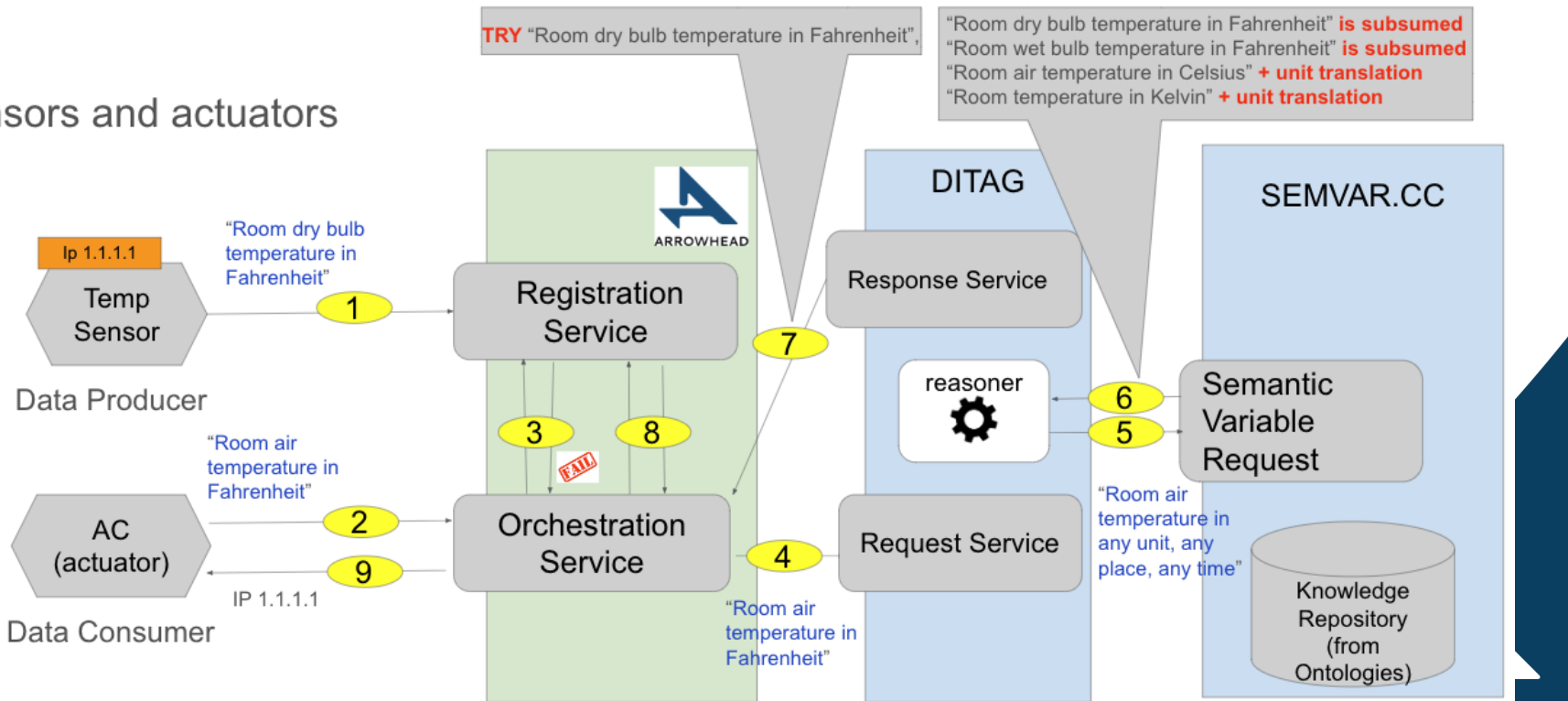
Test

Evaluation

# Ontology based translation approach

## DITAG tool

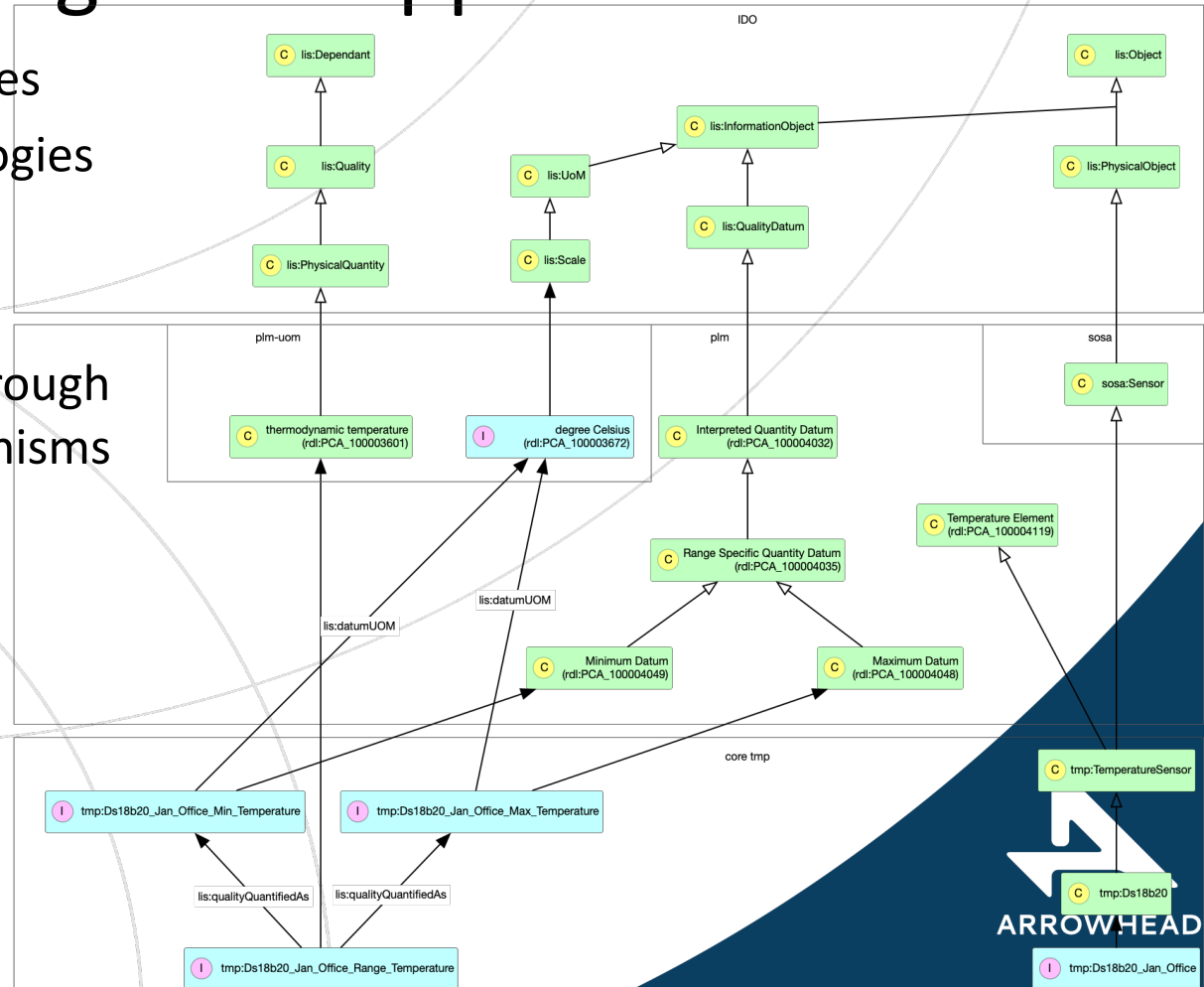
### Sensors and actuators



# Translation/integration approach

## Ontology based approaches

- Integration of ontologies
  - Semantic web
  - IDO
- Model validation through reasoning mechanisms

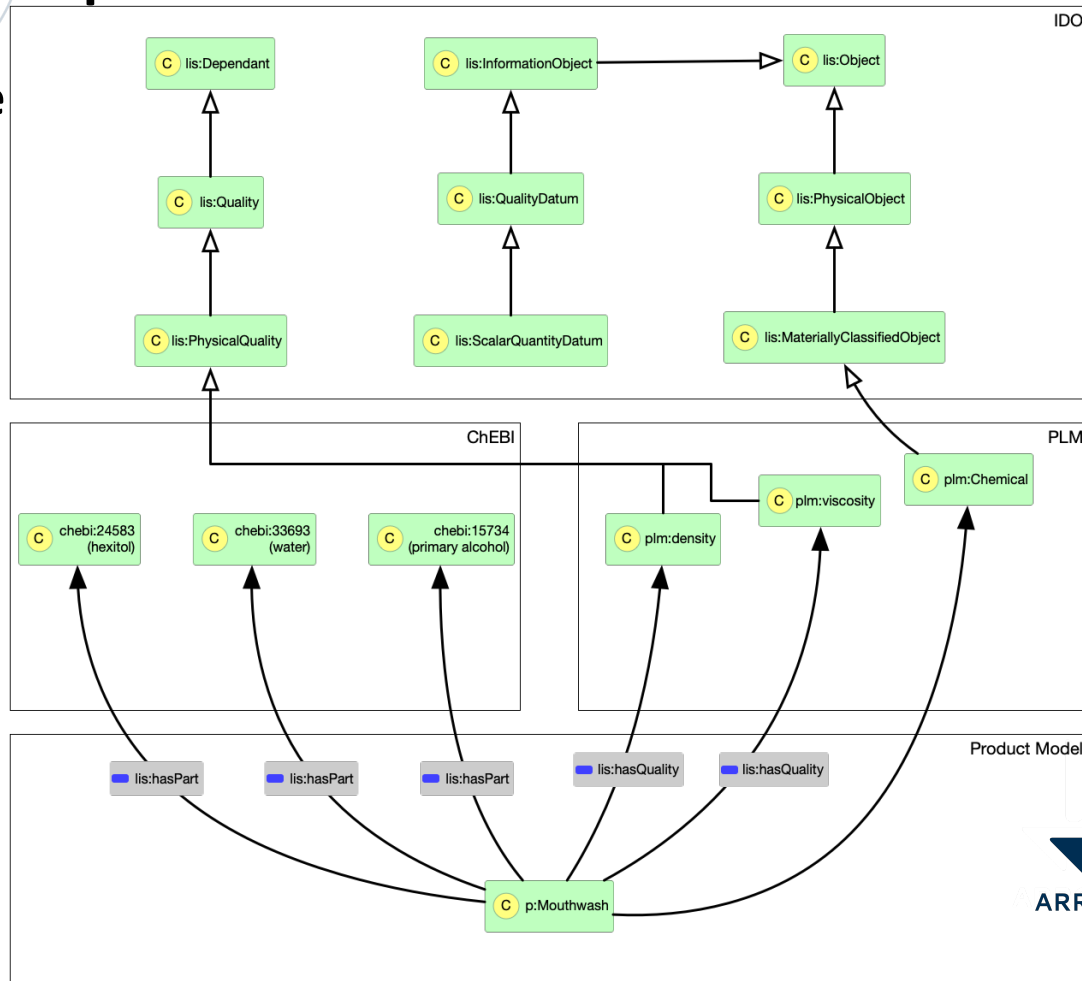


# Chemical composition semantic model

## Mouthwash example

Composed of

- Alcohol
- Sorbitol
- Water



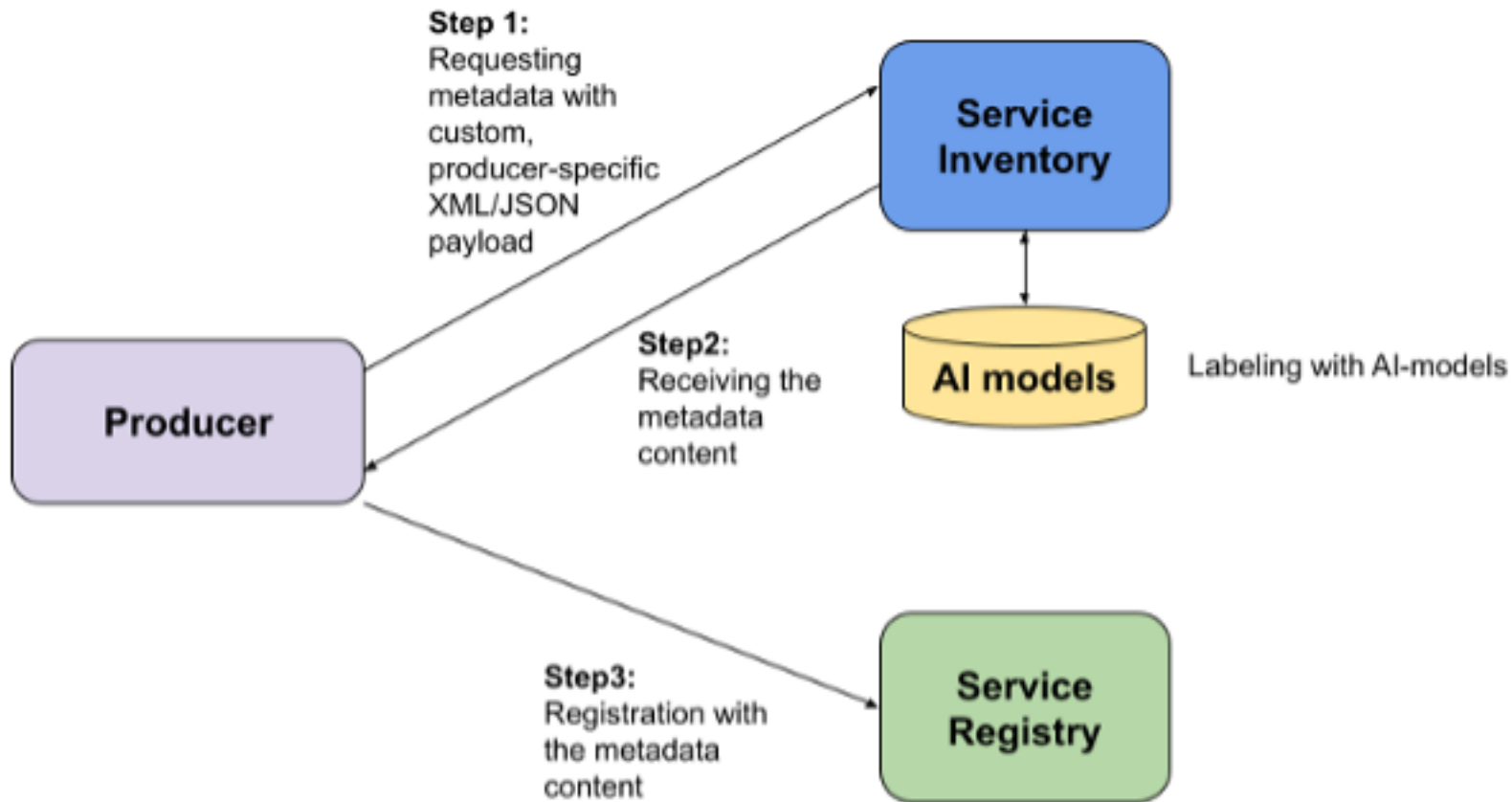
# AI based translation

The following list summarizes a set of interesting Machine Learning tools and libraries being evaluated:

- PyTorch
- OpenNMT
- Scikit-learn
- Word2Vec
- SpaCy
- Microsoft CoPilot
- Wit
- ChatGPT
- NLTK
- LangChain

Very extensive data sets are required for training

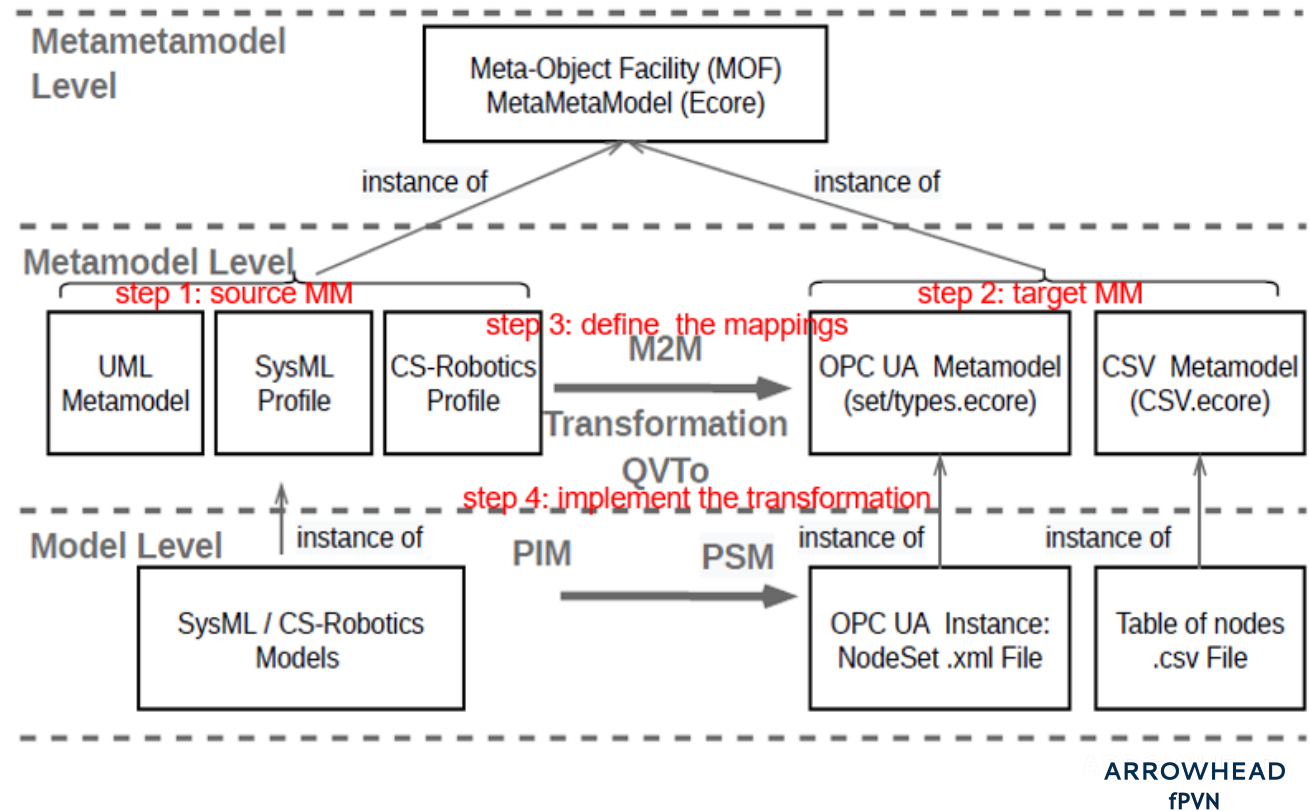
# AI-based data set labeling and metadata filling



# Model based translation

Multiple examples are available:

AAS2UML,  
SysML2OPCUA,  
UML2JSON,  
UML2Java,



# Translator tools

To be provided open source

Eclipse Arrowhead v5 support microservices

Supported by Eclipse Arrowhead engineering tools like:

Eclipse Arrowhead DSL

OMG - SysML v1.6 and

OMG - SysML v2

Integration to

ISO - ISO

W3C - Semantic web

IETF - power of attorney



# Tool usages

## Steel industry

Unified Environmental Data Model

PRISMA project to start April 1, 2025

## Semiconductor industry

Unified Environmental Data Model

GP2 project, expect start April 1, 2025

# Conclusions

Data model translations in general is very complex

Translation and/or integration of well documented standards is advancing

Translation technology is emerging

Being made available as open source microservice

Automation of engineering is key

Engineering support open source through Eclipse Arrowhead

# Thanks

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