

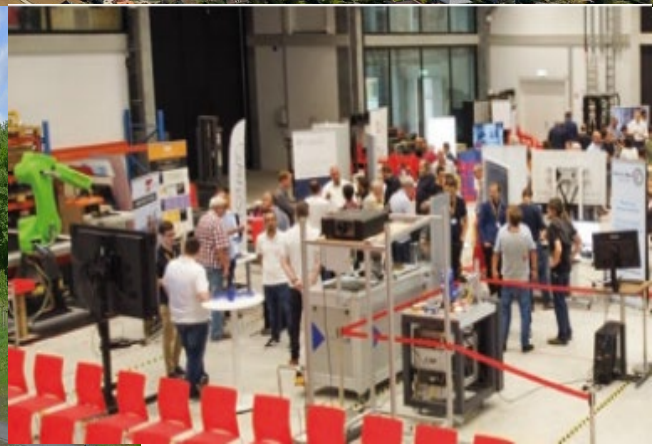
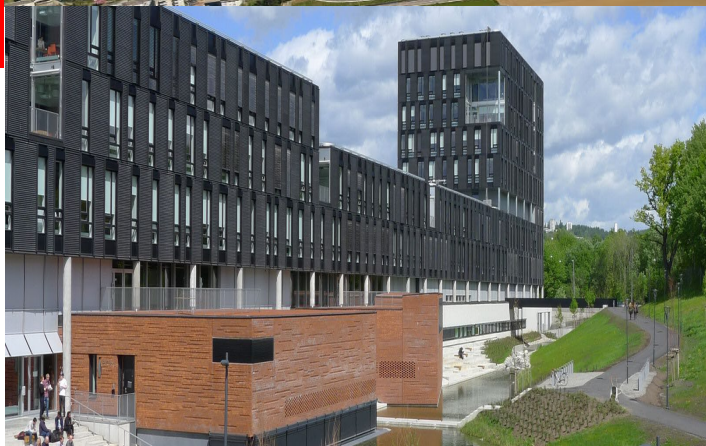
Information Modelling Framework for Cognitive Industrial Solutions

Dimitris Kyritsis (Kiritsis)

- Professor Emeritus of ICT for Sustainable Manufacturing, EPFL
- Senior Advisor, SIRIUS labs
Dept. of Informatics, UiO, Norway
- Senior Advisor, Swiss Smart Factory,
Biel/Bienne
dimitrky@ifi.uio.no

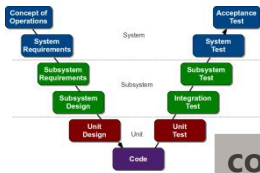
Arild Waaler

Professor, SIRIUS labs
Dept. of Informatics, UiO
arild@ifi.uio.no





Standards



Process



Business model

Electronic engineers



Software



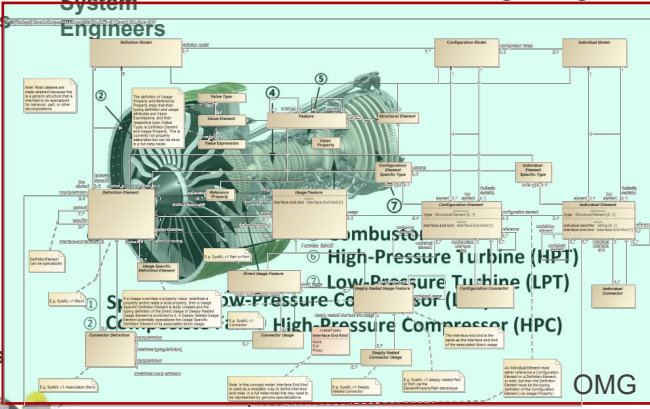
Project managers



Mechanical Engineers



System Engineers



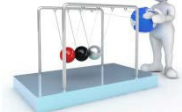
Testers



Training managers



Domain engineers...



IT managers



Information



Data...



Knowledge



Model...



enable

Quality engineers



Safety engineers

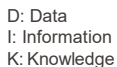


Stakeholders

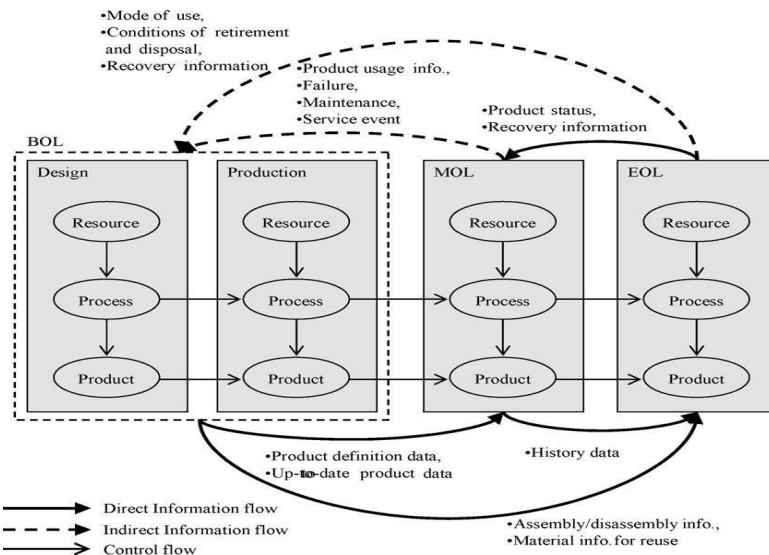


Efficiency





- Closed-Loop Life cycle
Data-Information-Knowledge Transformations
- Semantic Model-Based Systems
Engineering for Industrial Data Analytics



Data

38.5 °C

Body
temperature

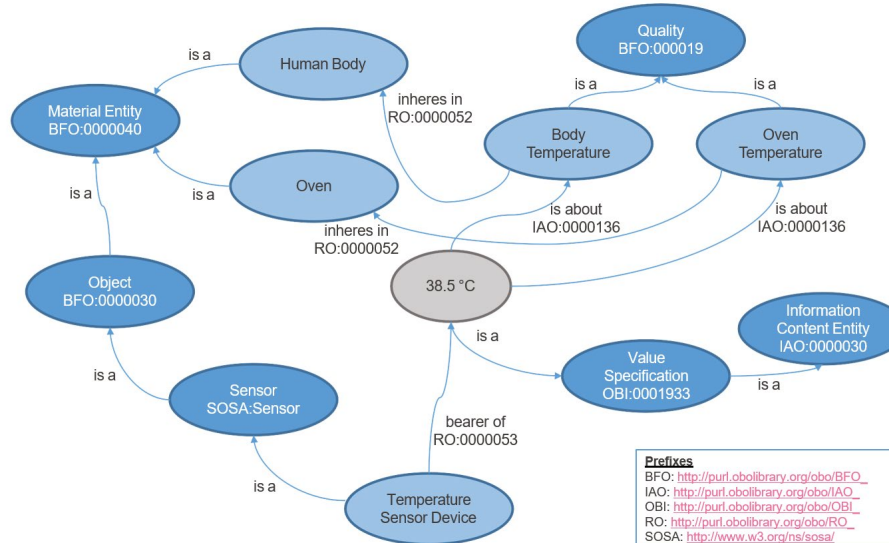


Oven
temperature



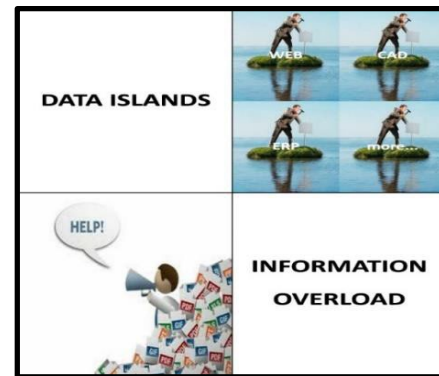
**Source of Data
Context**

**Source of Data
Context**



Ontologies allow to capture the meaning of data

- Scattered data in several sources, systems and services
- Different actors with multidisciplinary skills



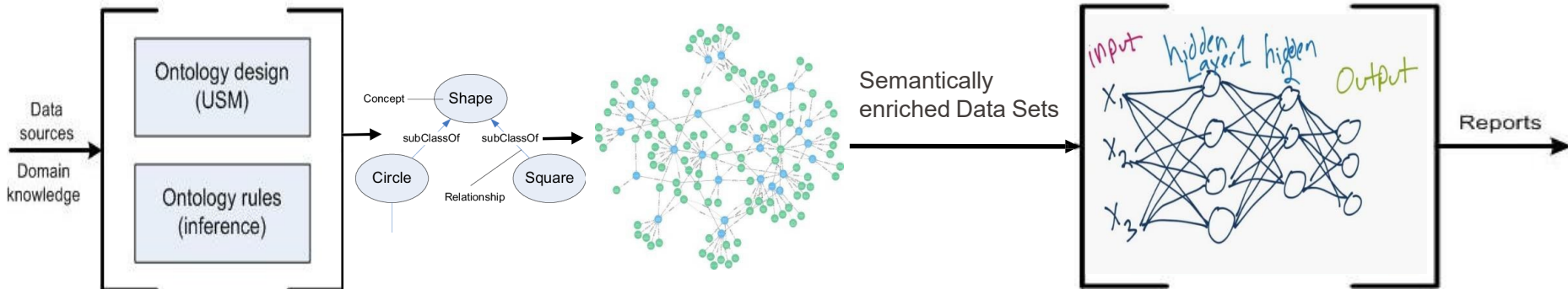
Semantic modelling

Ontology

Knowledge Graph

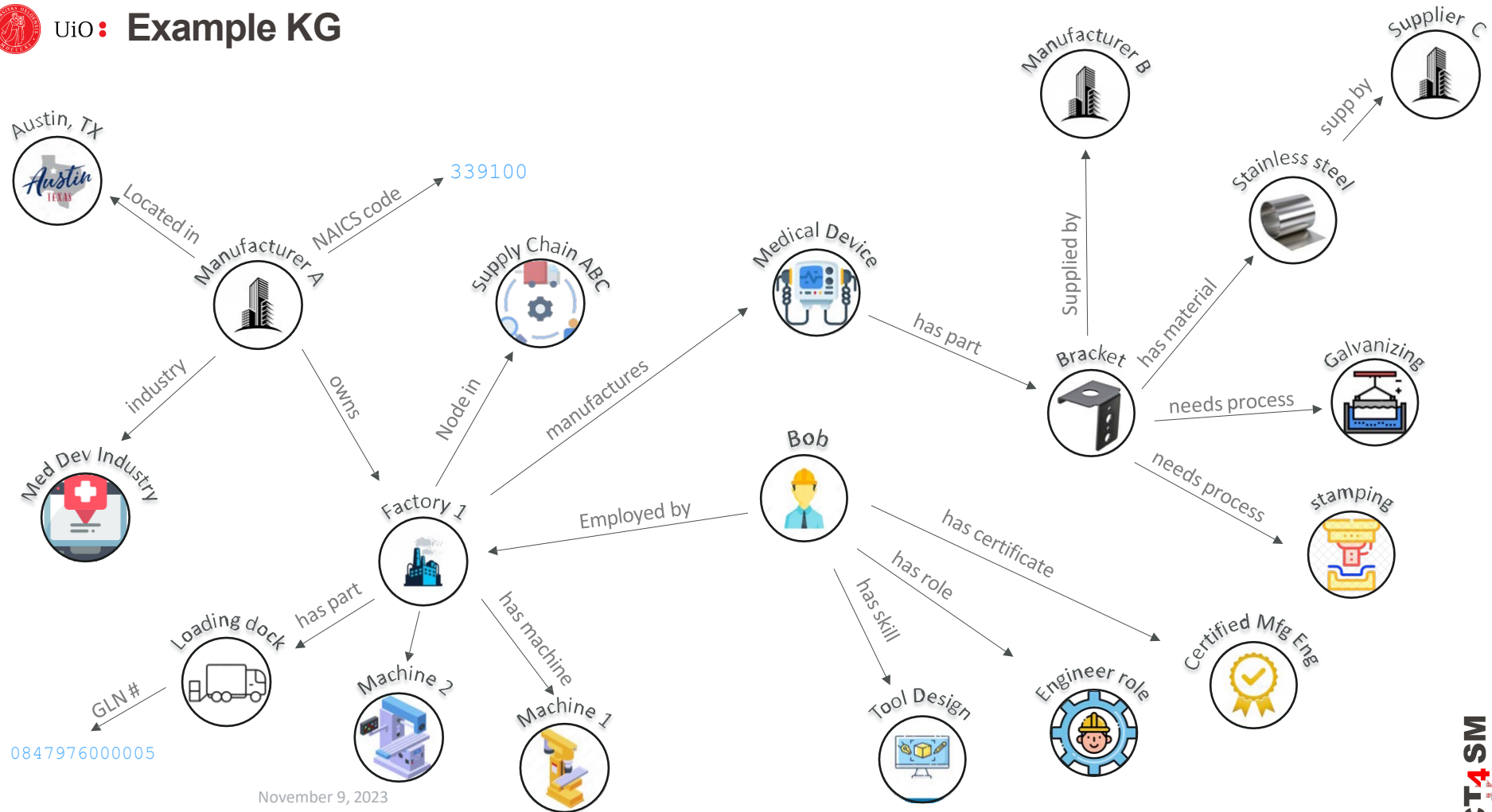


Data Mining+Analytics module:
on context and on purpose

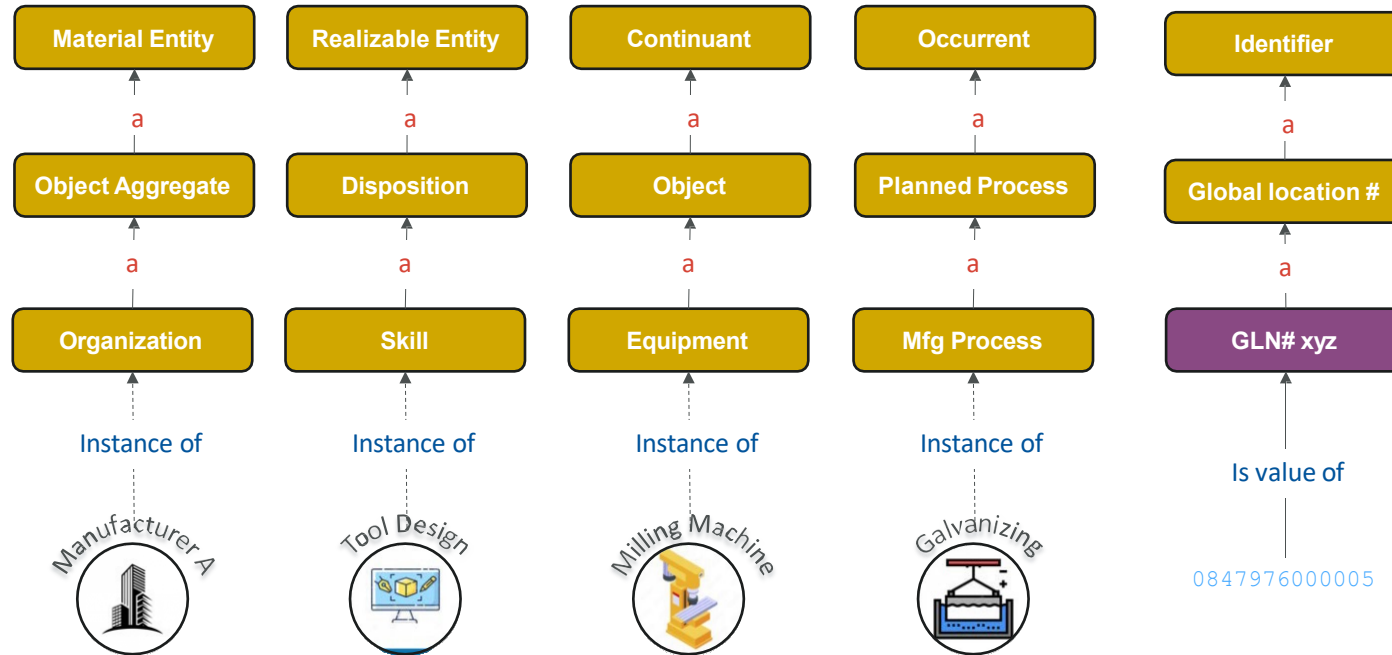


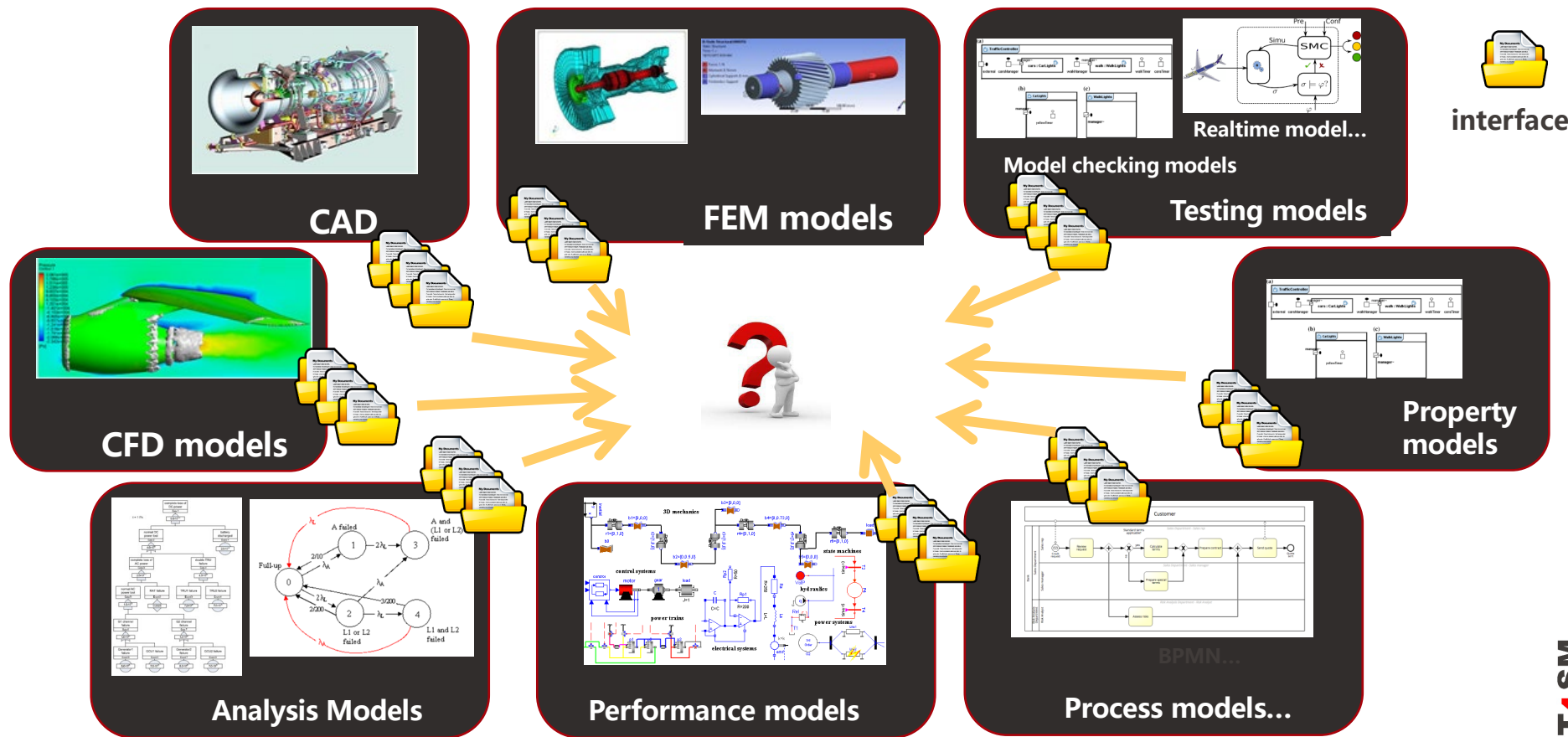


Uio: Example KG

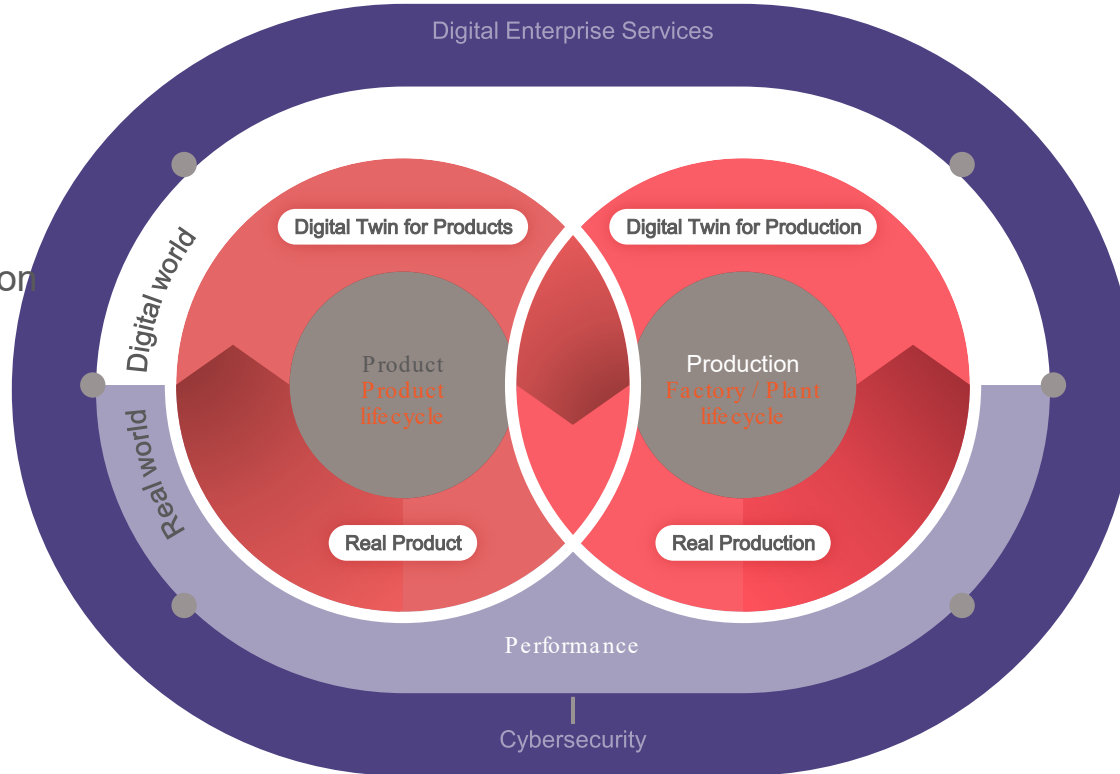


November 9, 2023



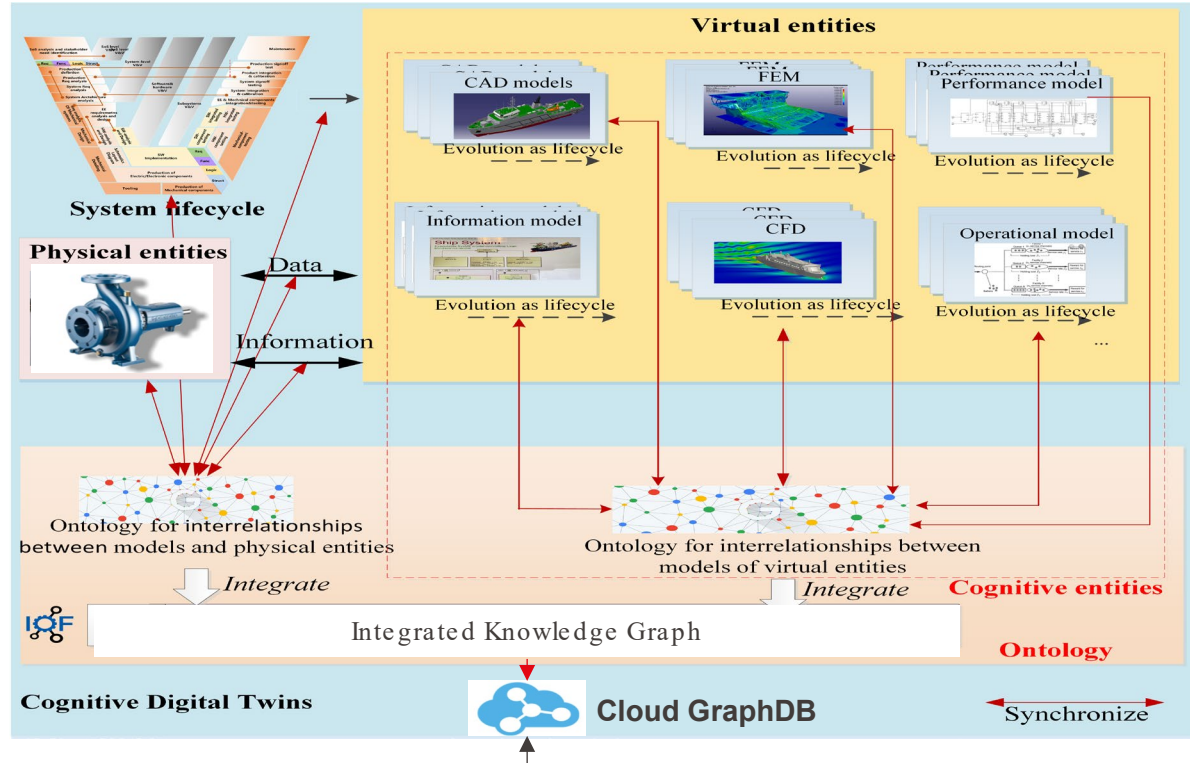


The comprehensive Digital Twin approach allows the realistic simulation and validation of products, machines, lines and complete plants



They're the foundation for flexible and efficient manufacturing

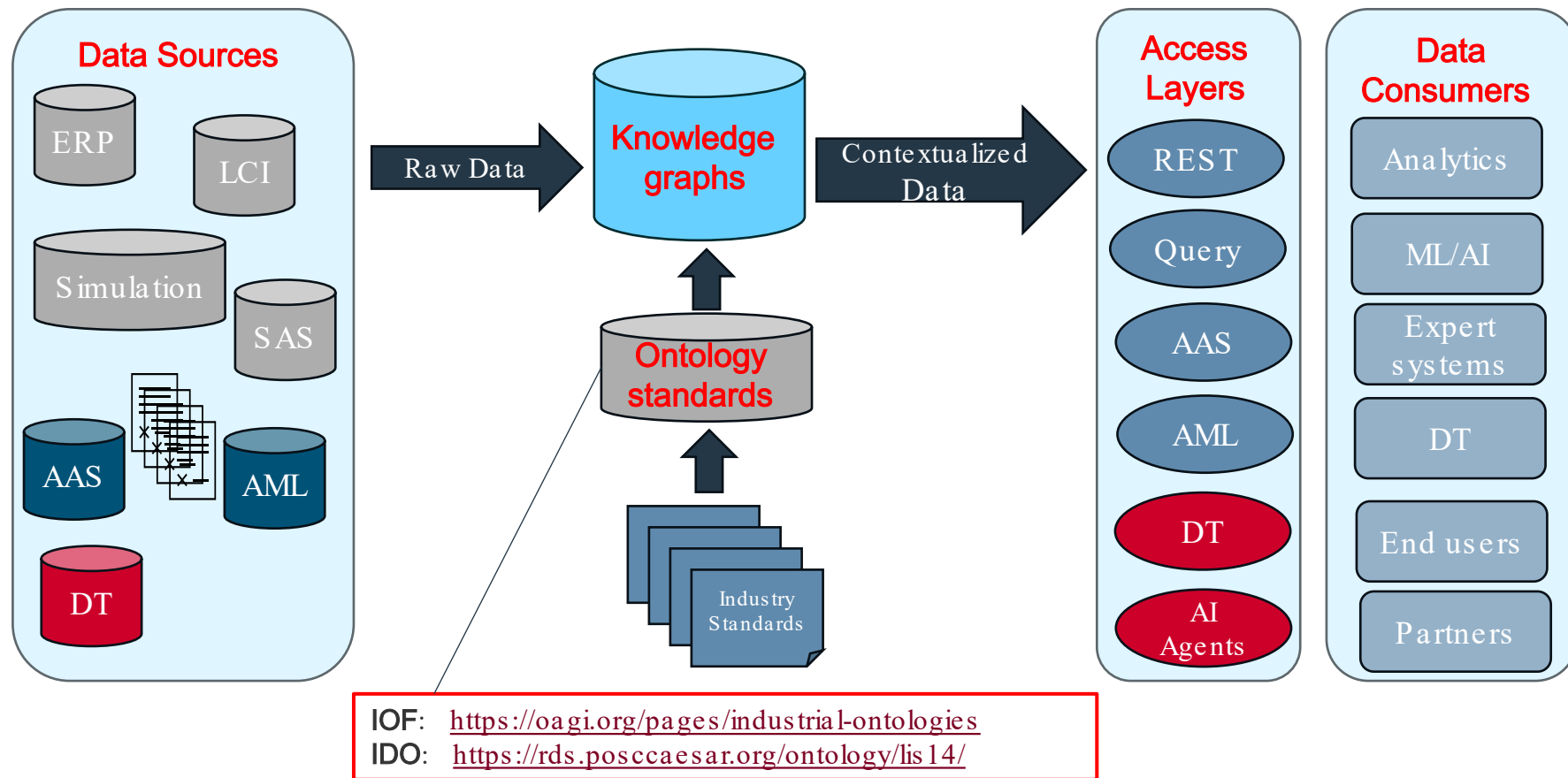
- Cognitive Digital Twin: a digital representation of a physical system augmented with **cognitive capabilities** and enables **autonomous activities**; comprises **semantically interlinked digital models** related to **different lifecycle phases**; **continuously evolves** with the physical system across the entire lifecycle.



AI & DS Agents – Digital Twins – Apps – other software

AI: Artificial Intelligence
DS: Decision Support

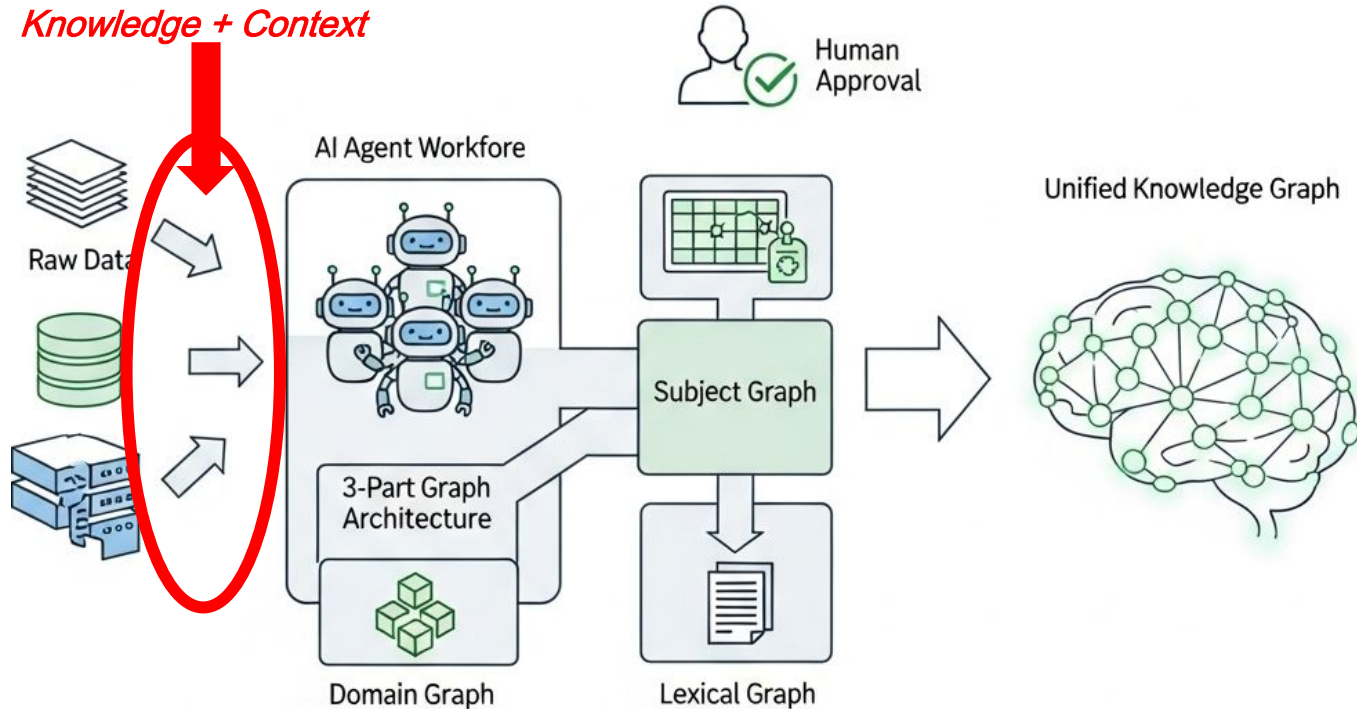
NEED FOR STANDARDS



Starting directly with data models does not allow to capture the knowledge of the **REAL WORLD** data owners

NO MODEL HERE !

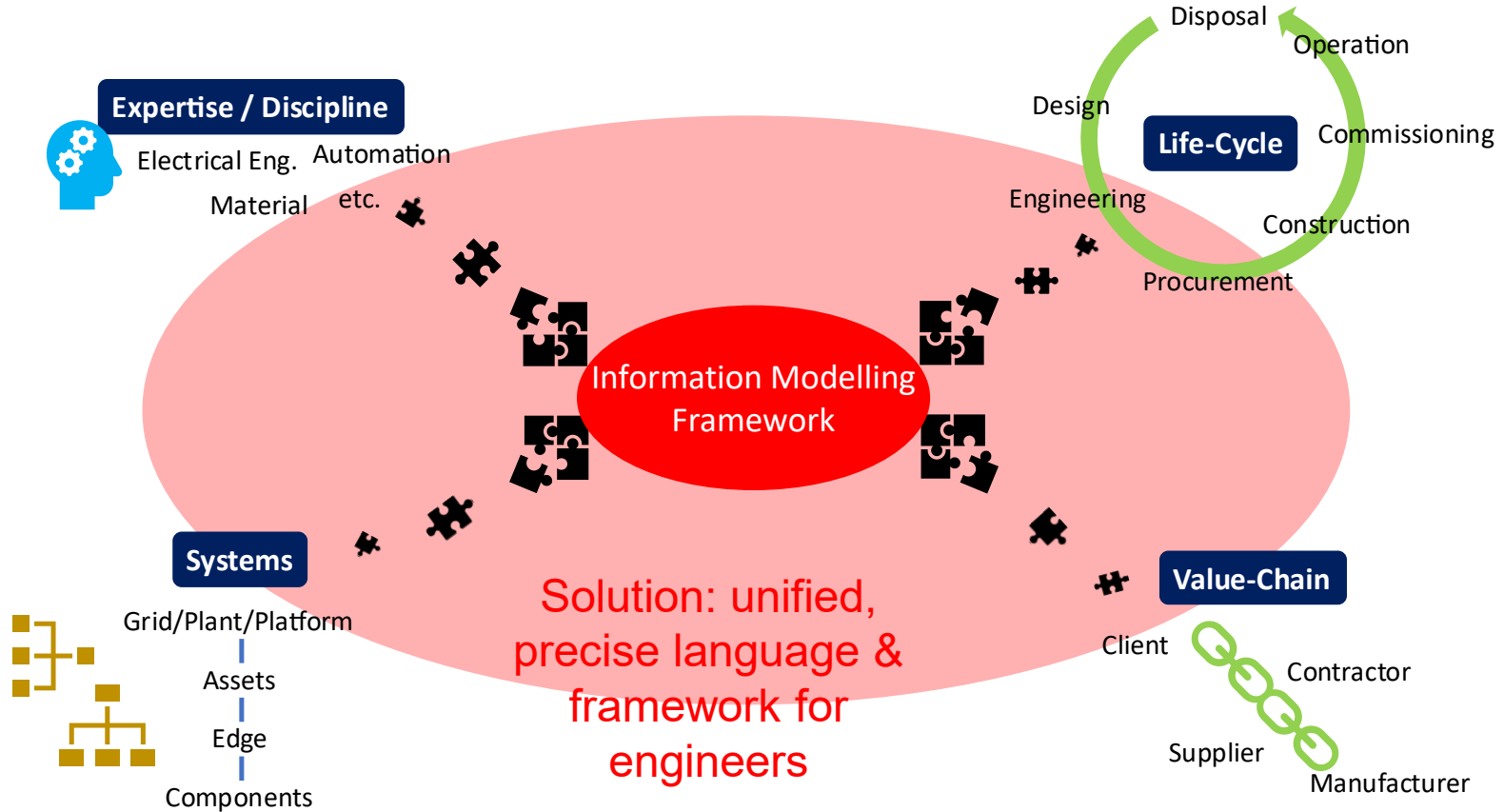
*Real World
Knowledge + Context*



SOLUTION: Model Based Systems Engineering - MBSE

How to create an Integrated KG of a Twinned System?

Connecting Fragmented System Elements



- Information modelling **language** and **framework**
 - Last version of IMF material available here: <https://www.imfid.org/>
- Language for identifying and describing objects of **industrial assets** in different **aspects**
- Language for integrating across ...
 - different **domain** and **discipline** specific descriptions
 - different **ontologies** and **domain standards**
 - descriptions using different **abstraction** levels
 - the complete **asset lifecycle**
- Designed to be used and understood by **subject matter experts**
- Based on
 - ideas from **systems engineering**, ISO/IEC 81346*'s aspect concept
 - **formal logic**, **semantic web** technologies
 - **graph data** formats

DNV-RP-0670 | Based on **ISO IEC RDS 81346** standards

<https://www.dnv.com/digital-trust/recommended-practices/asset-information-modelling-dnv-rp-0670/>

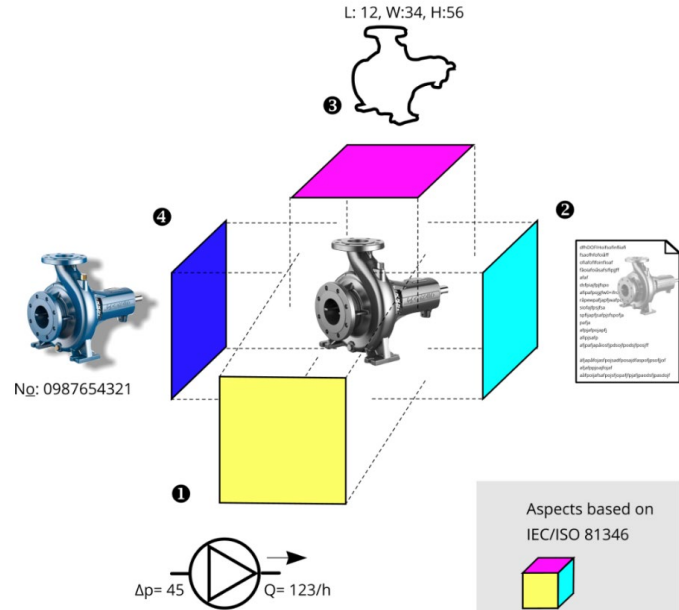
*Industrial systems, installations and equipment and industrial products – structuring principles and reference designations

Descriptions are categorized by **aspects**

Aspects are distinct perspectives on entities

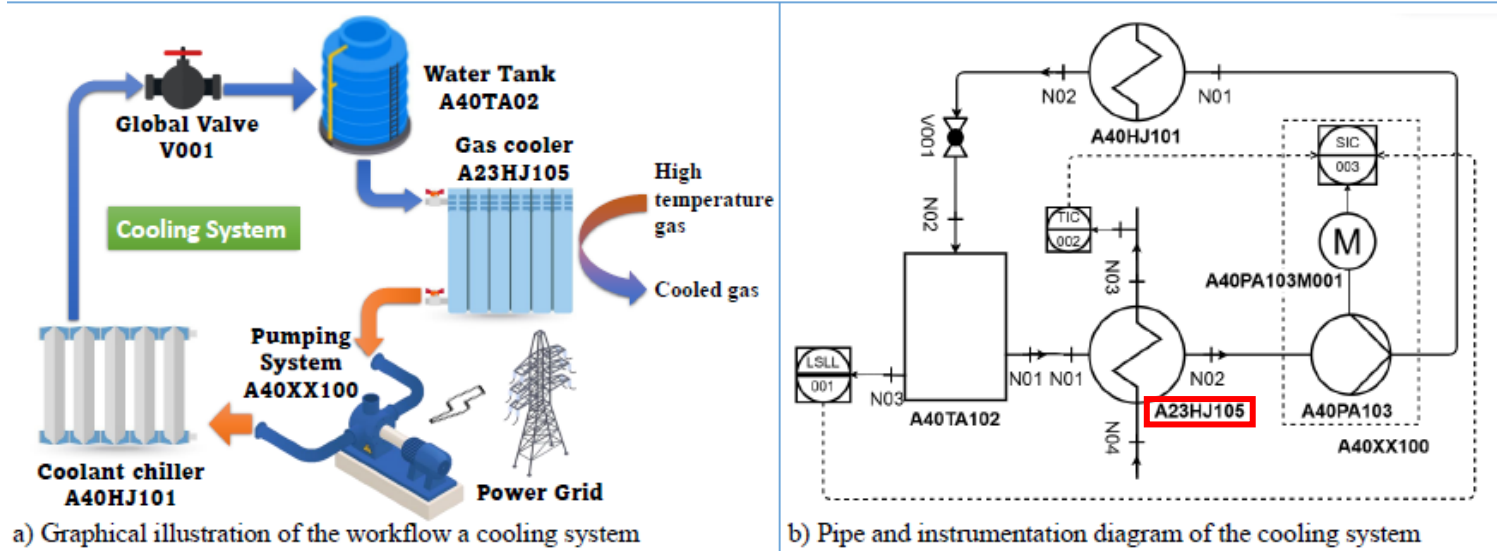
Example:

- Function aspect (Yellow) ① is about the intended activity, providing information about required activity, perform
- Product aspect (Cyan) ② is about the specification, perform the activity, in this example the specification
- Location aspect (Magenta) ③ is about the spatial e specified pump and the requirements imposed by th
- Installed aspect (Dark blue) ④ is about information about the actual pump, with information such as serial number, run hours, and status.



Example: cooling system

displayed in graphical and P&ID form



what it does !

Automation function model

Top-level breakdown

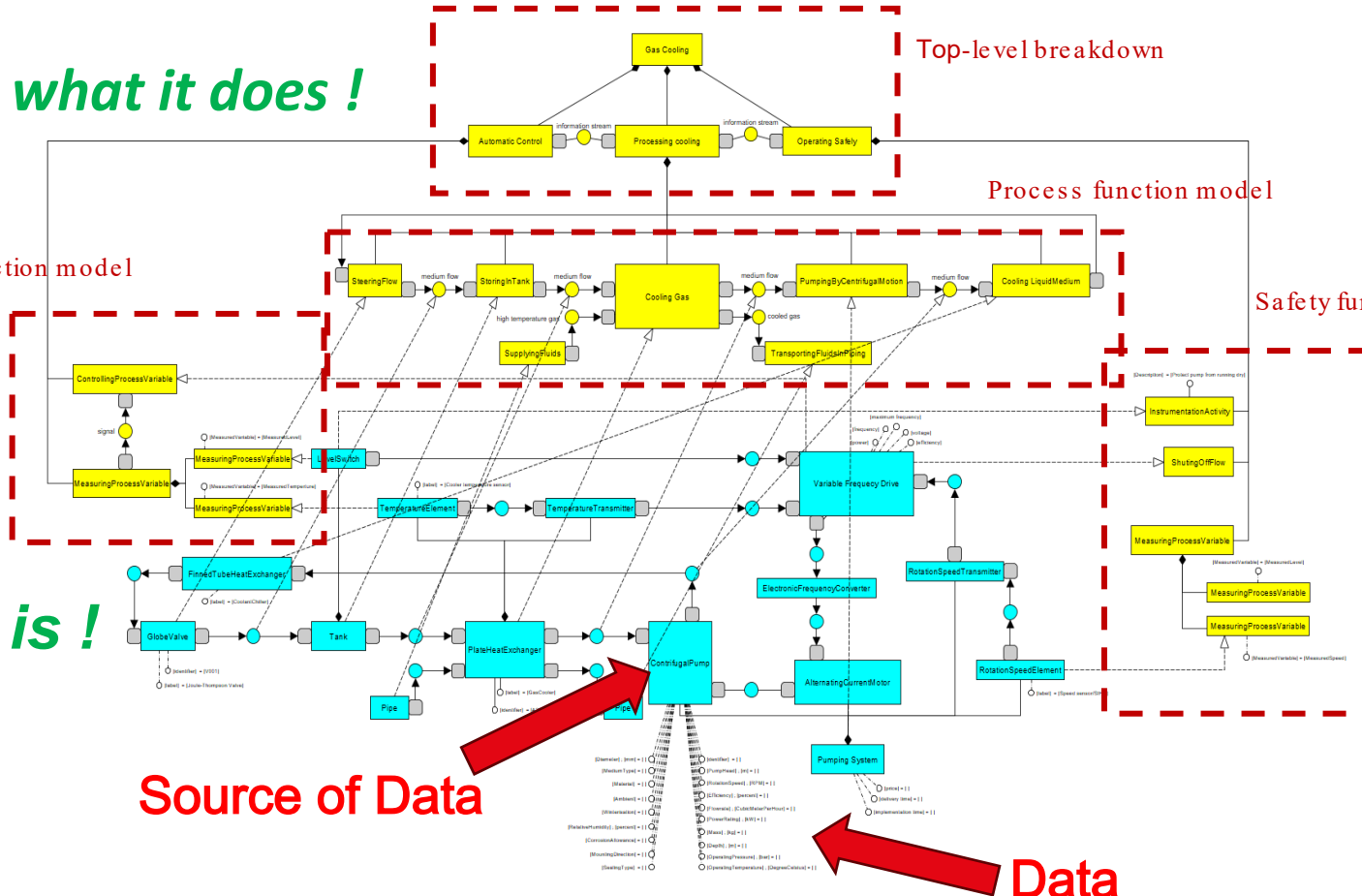
Process function model

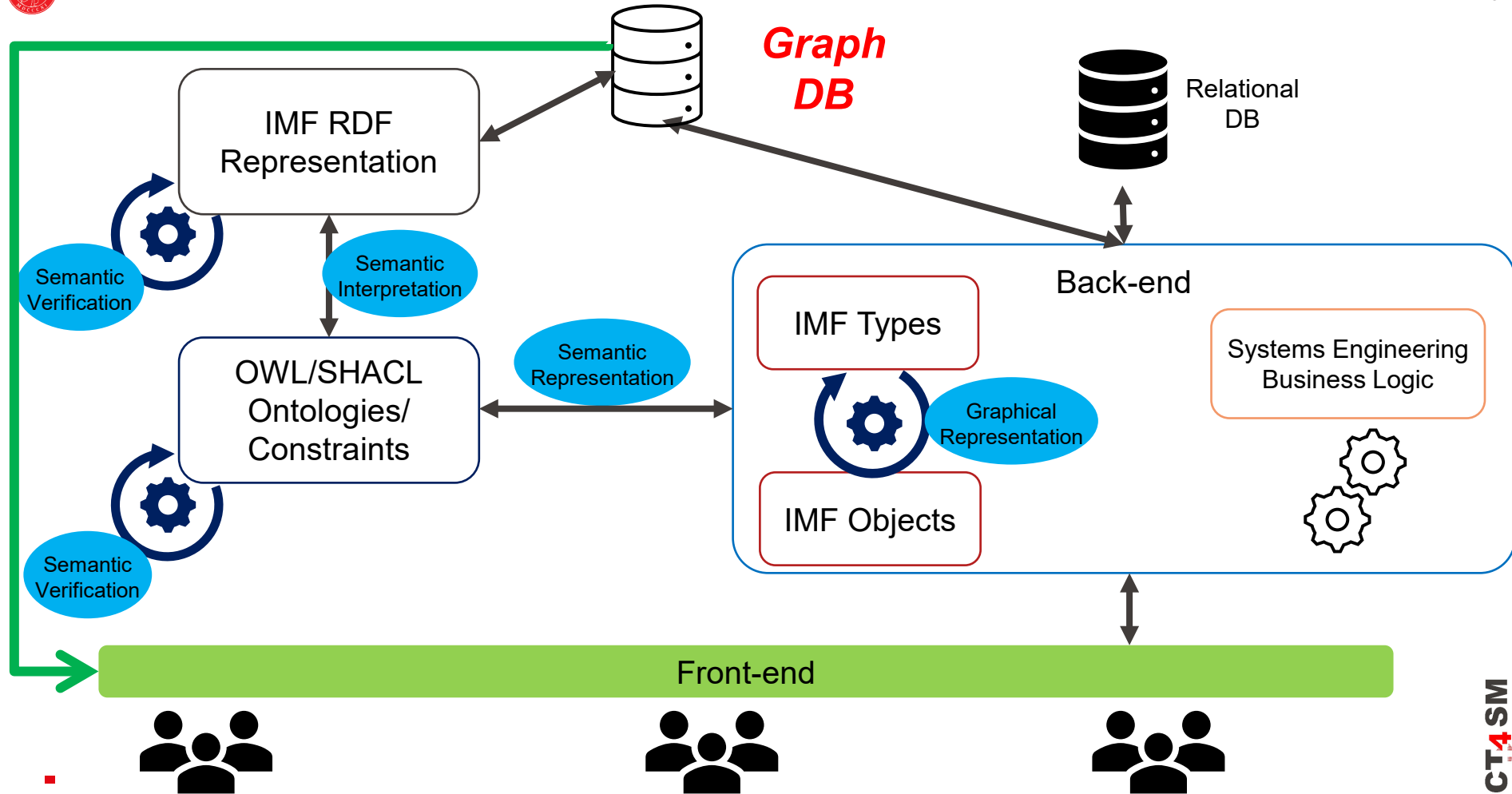
Safety function model

what it is !

Source of Data

Data



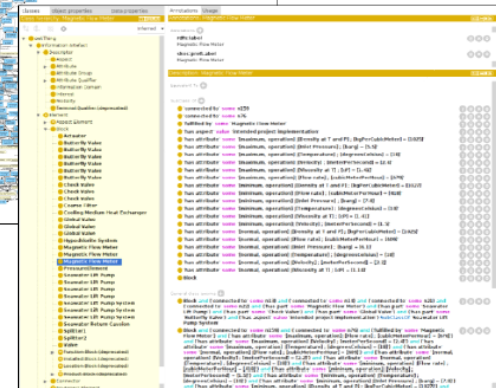
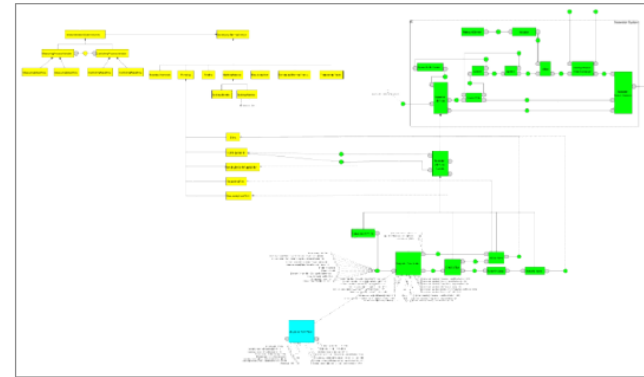
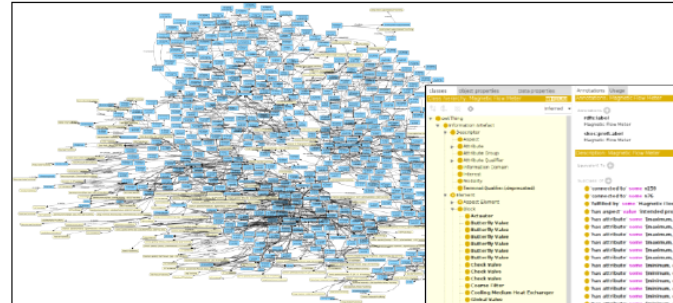




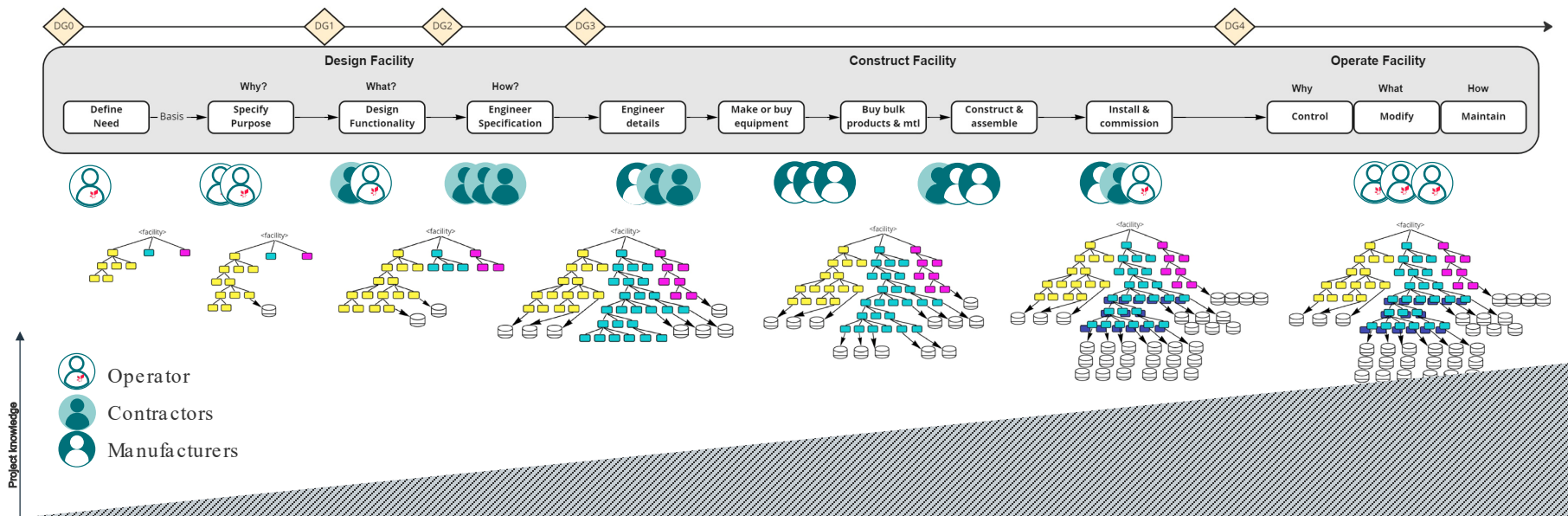
```
PREFIX dc:    <http://purl.org/dc/terms/>
PREFIX id:    <http://example.com/id/>
PREFIX imf:   <http://ns.imfid.org/imf#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdf:   <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs:  <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdl:   <http://example.org/rdl#>
PREFIX skos:  <http://www.w3.org/2004/02/skos/core#>
PREFIX xsd:   <http://www.w3.org/2001/XMLSchema>
```

```
id:n73  rdf:type          imf:Block;
        rdfs:label       "A23HJ105" , "Heat Exchanger Gas";
        imf:hasAspect     imf:productAspect;
        imf:hasTerminal   id:n65 , id:n58 , id:n72 , id:n57;
        imf:proxy         id:n82;
        imf:tagID         "A23HJ105";
        skos:prefLabel    "Heat Exchanger Gas" .
```

ICT4SM



The Vision and the Larger Picture



Added values:



Become more effective by hindering loss of information during handovers



Automation of manual procedures possible using machine integrable information models



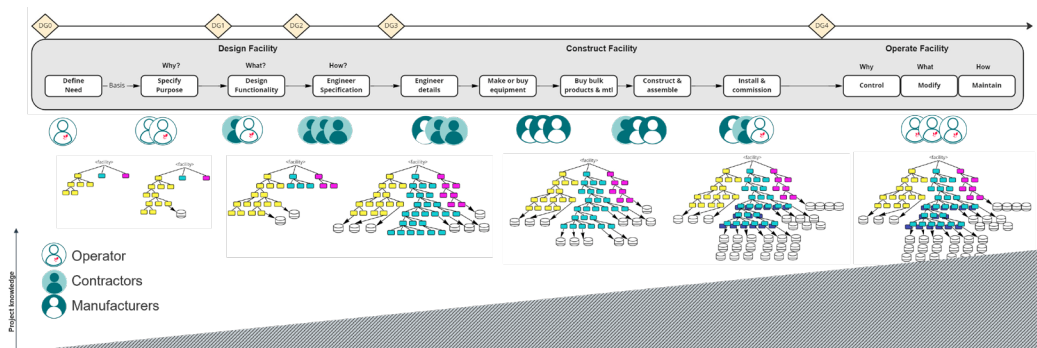
Reduce cost and time spent by the possibility of building in smartness



Improved safety and quality by better control of technical information



New business opportunities by combing information in new ways



Information Modeling Framework - IMF



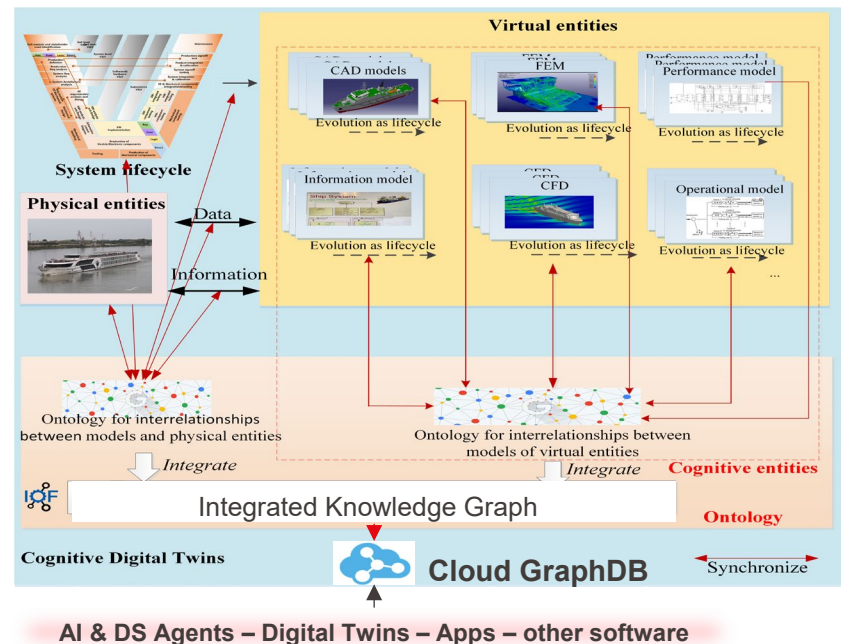
<https://eurofmx.eu/>

FOUNDATIONAL MODELS FOR TRUSTWORTHY INDUSTRIAL
GENERATIVE AI IN EUROPE

Making Industrial AI Work

Open-sourced and European by design. Autonomous manufacturing solutions built in Europe, for European industry, aligned with European values, sovereign GenAI technologies and international standards.

Cognitive Digital Twin - CDT



Thank you for your attention!



<https://www.mn.uio.no/ifi/english/research/networks/im-lab/>



<https://www.linkedin.com/in/dimitris-kiritsis-07124/>



dimitrky@ifi.uio.no