Towards the Digital Twin

Milestones reached
in ENPRO Datenintegration
and ModuLA

M. Soemers, M. Theißen

VDI/VDE-GMA FA 6.12
September 14, 2020

AixCAPE® e.V.

www.aixcape.org

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www.plants-and-bytes.de

AixCAPE e.V. – Organization

- AixCAPE® = Aix la Chapelle (Aachen) + Computer Aided Process Engineering
- goal: research transfer in computer aided process engineering & plant technology for energy and material conversion
- not-for-profit registered association (eingetragener Verein)
- originated from the chair of Process Systems Engineering (AVT.PT, RWTH Aachen University) as a spin-off in 2002

industrial members

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AixCAPE e.V. – Phases of research transfer

Phase II: implementation of phase I software prototypes
for industrial applications for expert users

Phase I: long-term
research
@universities

Phase III:
commercialization
for standard users

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pnb plants & bytes GmbH

- February 2019: incorporation of pnb plants & bytes GmbH
- founder team from AixCAPE e.V. and RWTH Aachen University
- software and services for digital plants

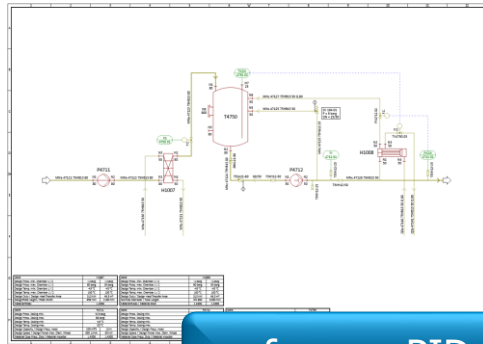|	Software	Services
Data analysis	Alanda	future
Data exchange	DEXPI tools	support for DEXPI Initiative
Data integration	future	future

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Alanda – Configuration-free analysis of process data

- features
  - variance estimation
  - outlier detection
  - denoising
  - polynomial trend search
  - PIMS compression tuning
  - etc.
- releases
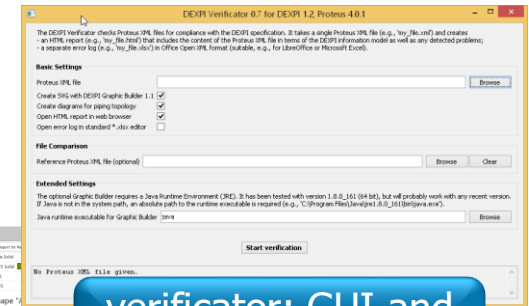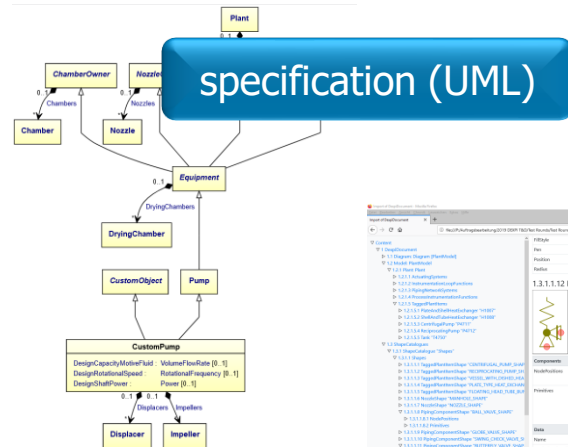 - stand-alone
  - API

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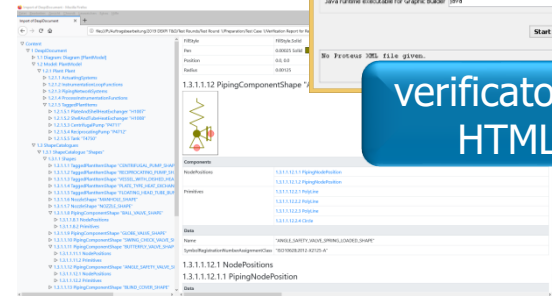plants & bytes
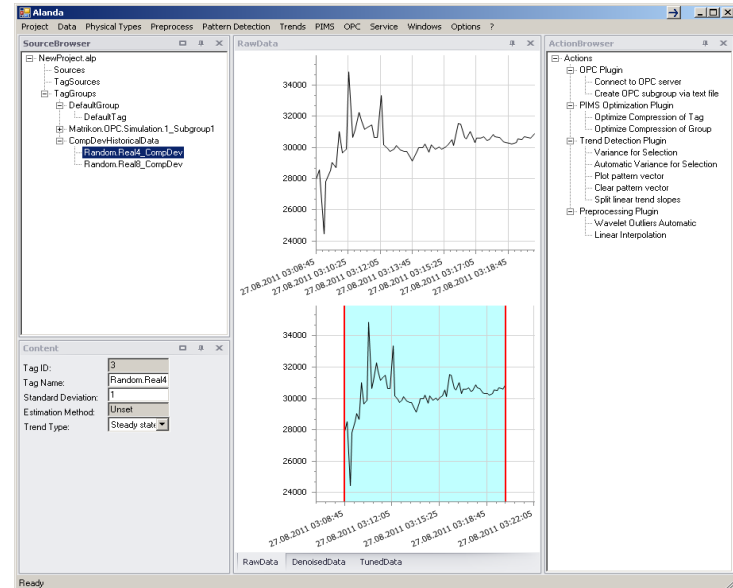
DEXPI – Data Exchange in the Process Industry

- working party of ProcessNet
- goal: general data exchange standard for the process industry
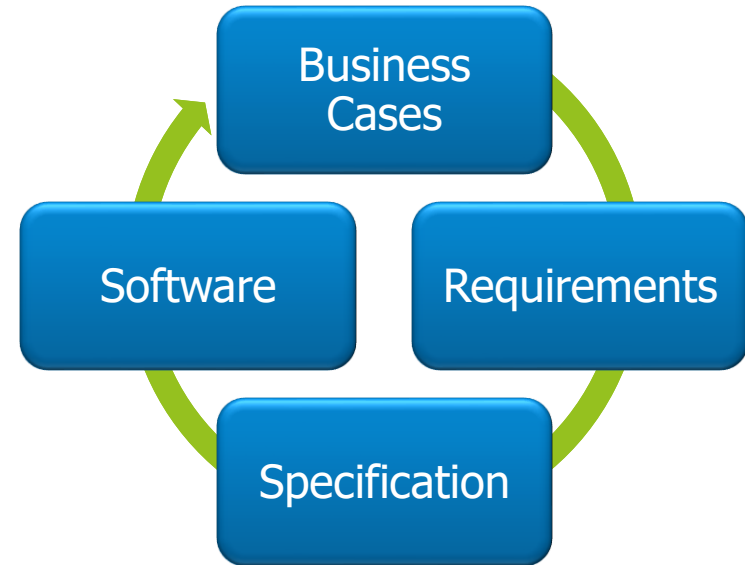- current focus: exchange of piping and instrumentation diagrams (PIDs)

specification (UML)

verificator: GUI and HTML report

reference PID

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DEXPI Initiative – Members

- owner / operators (OO)
- engineering procurement contractors (EPC)
- software vendors
- research organizations

www.dexpi.org

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Overview

- **ENPRO Datenintegration and ModuLA**
- application scenario: exchange of solvent
- information models – general motivation
- some modeling principles
- applications and software prototypes
- follow-up: OCEAN

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ENPRO

- „Energieeffizienz und Prozessbeschleunigung für die Chemische Industrie"
- research collaboration within BMWi research field CVT (chemical engineering)
- goals
  - significant increase in energy efficiency of chemical manufacturing processes (through the creation of new technologies that are not yet established)
  - while at the same time shortening the processing times of innovation projects

www.enpro-initiative.de

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ENPRO 2.0 – Working areas

- 2nd funding period
- working areas
  - neue Apparate und Smart Analytik
  - intelligente Module, Prozesse und Betrieb
  - Systemorchestrierung
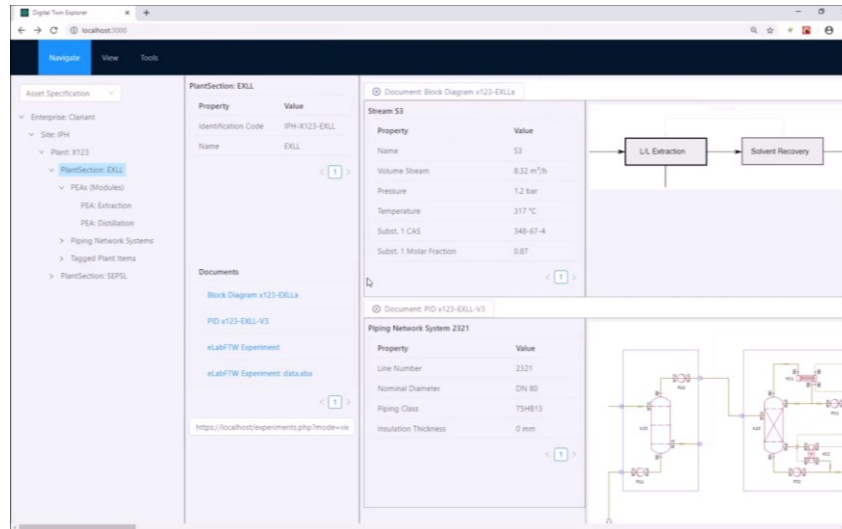 - Logistik und Datenintegration
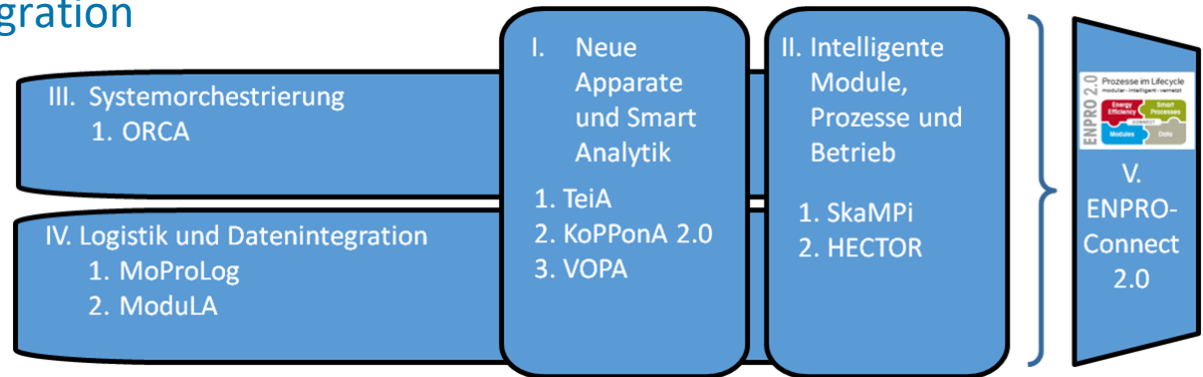
ENPRO Datenintegration and ModuLA

- ENPRO 1.0 Datenintegration
  - start & duration: September 1, 2014 / 36 months
  - partners: AixCAPE, BASF, Bayer, Evonik, RWTH Aachen University
  - results: methodology for data integration, specification of Life Cycle information model, application examples

- ENPRO 2.0 ModuLA
  - start & duration: September 1, 2018 / 36 months
  - partners: AixCAPE, BASF, Clariant, Evonik
  - results: validation of methodology, application to modules, prototypical software

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Application scenario: exchange of solvent

video: http://downloads.aixcape.org/PAAT2019.mp4
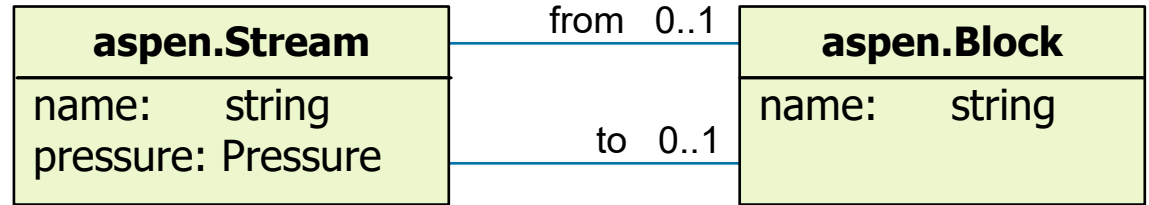
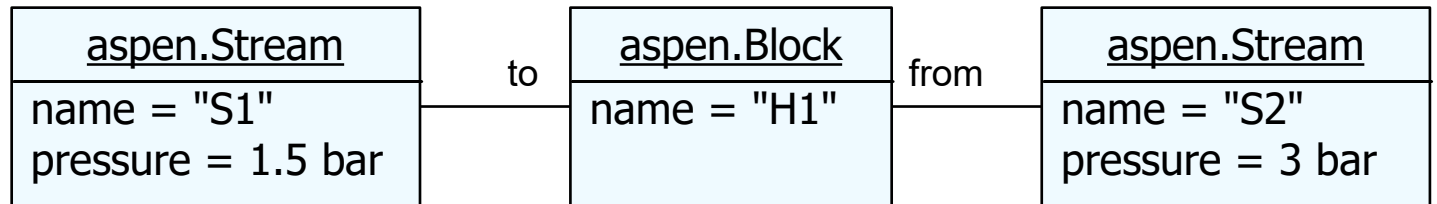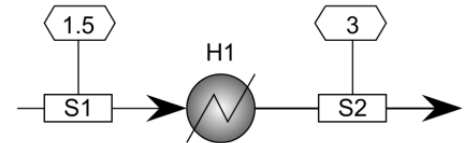article: http://enpro-initiative.de/ModuLA.html (in German)

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Information models and information

Excerpt from
information model
of Aspen Plus®

aspen.Stream
name: string
pressure: Pressure

from   0..1

to   0..1

aspen.Block
name: string

Application of information model to represent
information about a concrete Aspen Plus®
document: instances (data)

aspen.Stream
name = "S1"
pressure = 1.5 bar

to

aspen.Block
name = "H1"

from

aspen.Stream
name = "S2"
pressure = 3 bar

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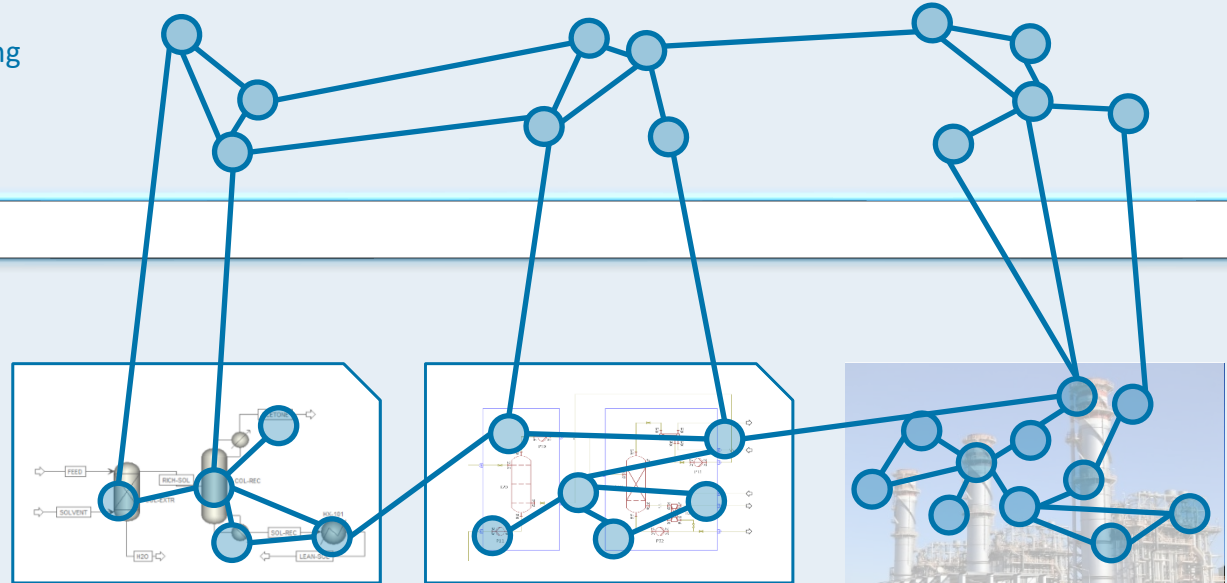# Information models – Basis for the Digital Twin

Integration model
- covers entire life cycle
- recurrent and consistent modeling principles
- open
- flexible and easily extendable

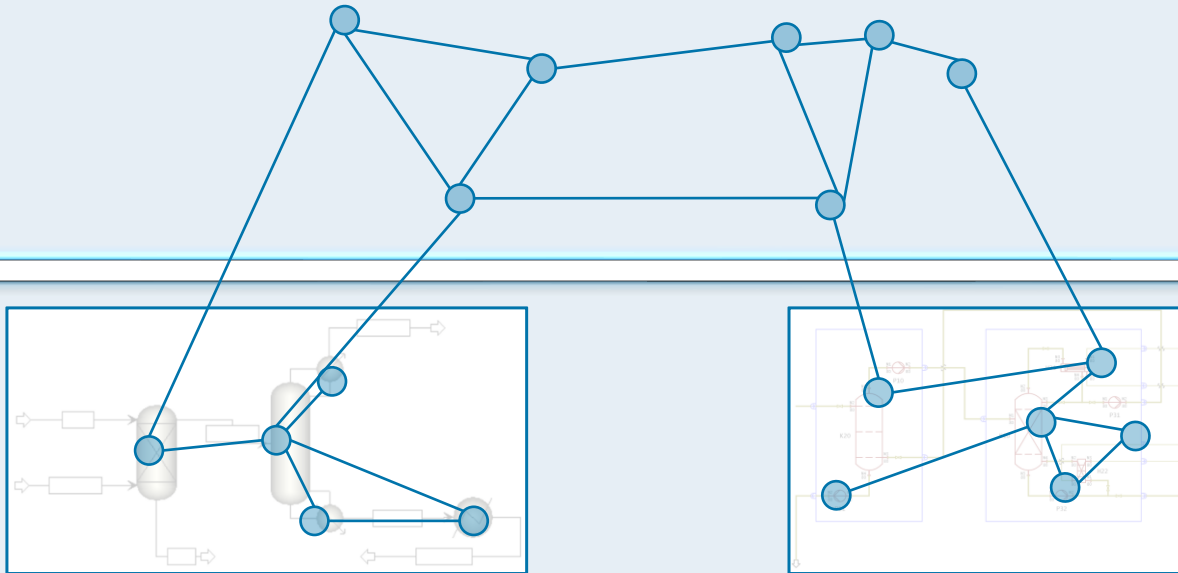**Focus of ModuLA: specification and validation of class model**

Domain models
- fragments of life cycle
- various, often incompatible modeling principles
- complex and detailed
- ideally international standards, but often proprietary formats
- inclusion of new kinds of information difficult

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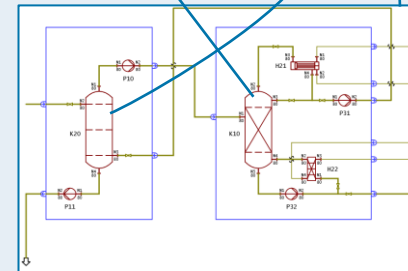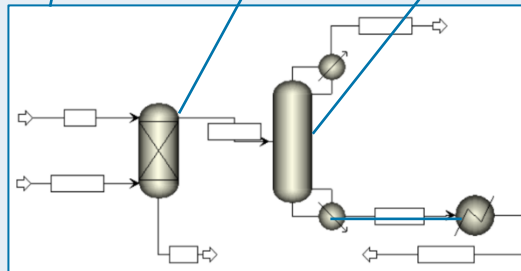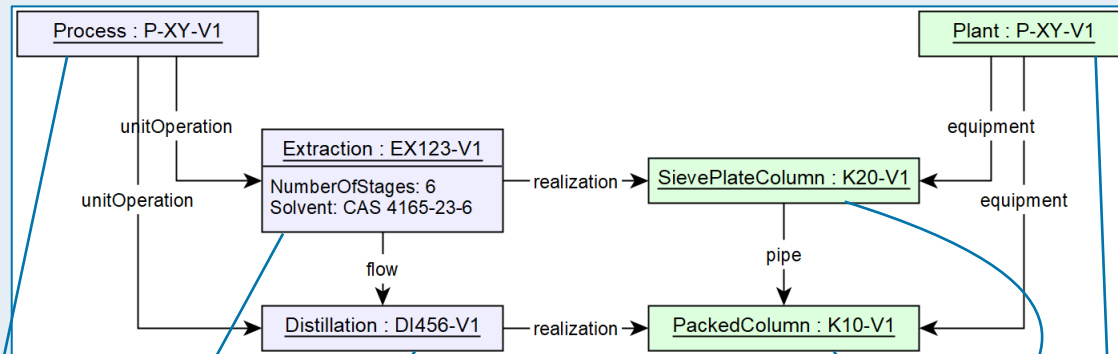- inclusion of new kinds of information difficult

Digital Twin of a physical system (e.g., of a plant, process, module, pump): comprehensive digital representation of the system over its Life Cycle

Integration concept

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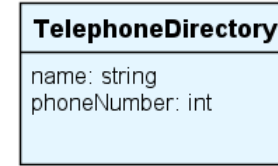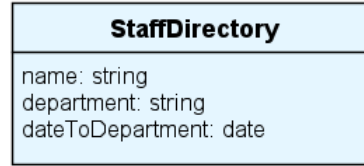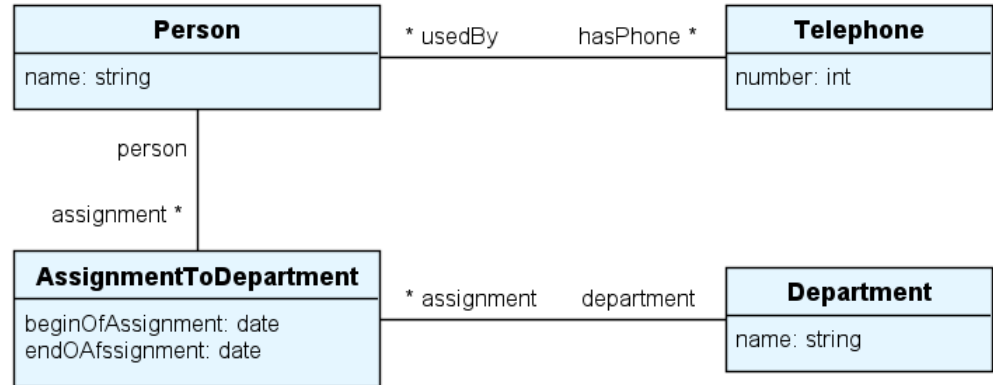
Integration concept

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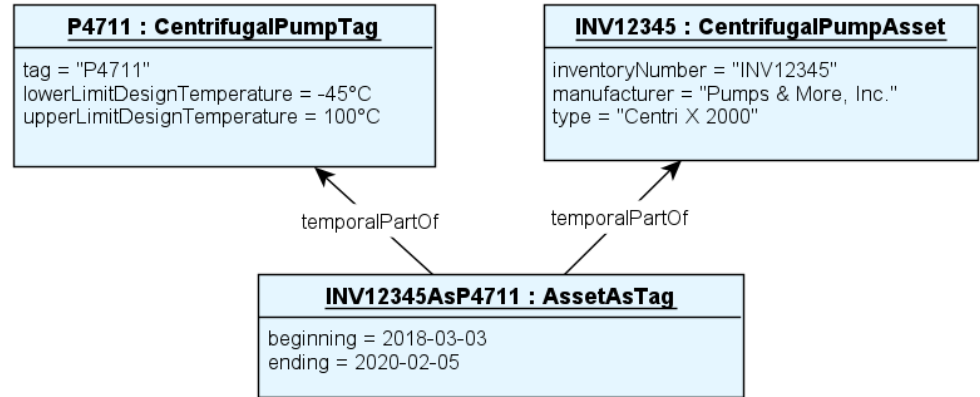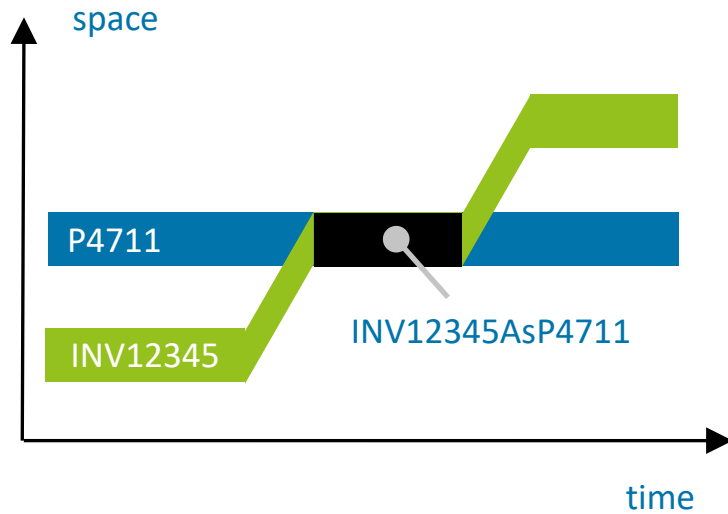
Do not model existing data, but reality

starting point:
separate domain models

StaffDirectory

name: string
department: string
dateToDepartment: date

TelephoneDirectory

name: string
phoneNumber: int

goal:
integration model

Person

name: string

* usedBy   hasPhone *

Telephone

number: int

person

assignment *

AssignmentToDepartment

beginOfAssignment: date
endOAfssignment: date

* assignment   department

Department

name: string

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4D Paradigm

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Generic information model: why?

EquipmentTag	EquipmentAsset
↑	↑
PumpTag	PumpAsset
↑	↑
CentrifugalPumpTag	CentrifugalPumpAsset

non-generic information model (classes)
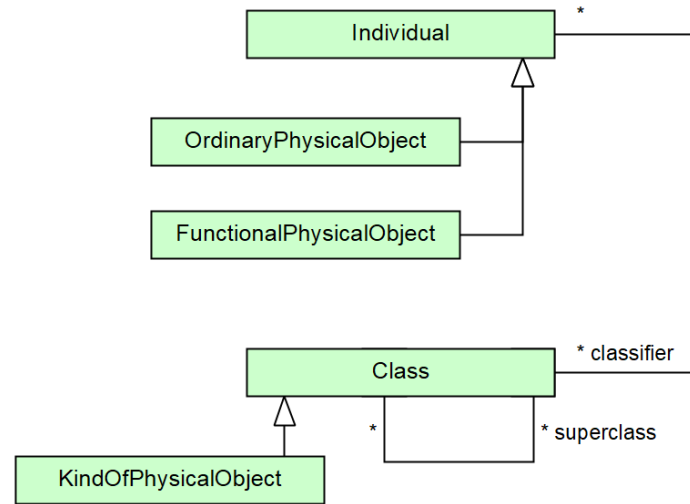
P4711 : CentrifugalPumpTag

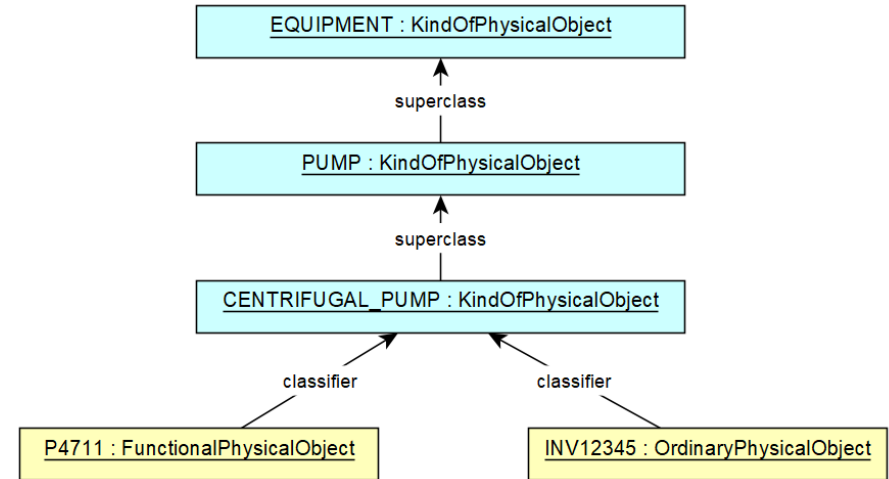INV12345 : CentrifugalPumpAsset

data (instances)

new kinds of equipment cannot be represented without changing the information model

Generic information model: how?
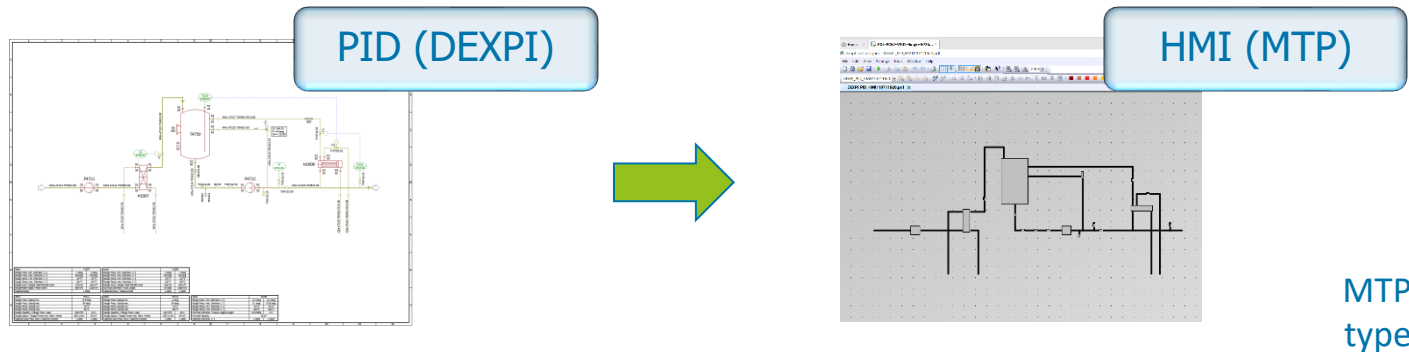

generic information model (classes)

data (instances)

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- **applications and software prototypes**
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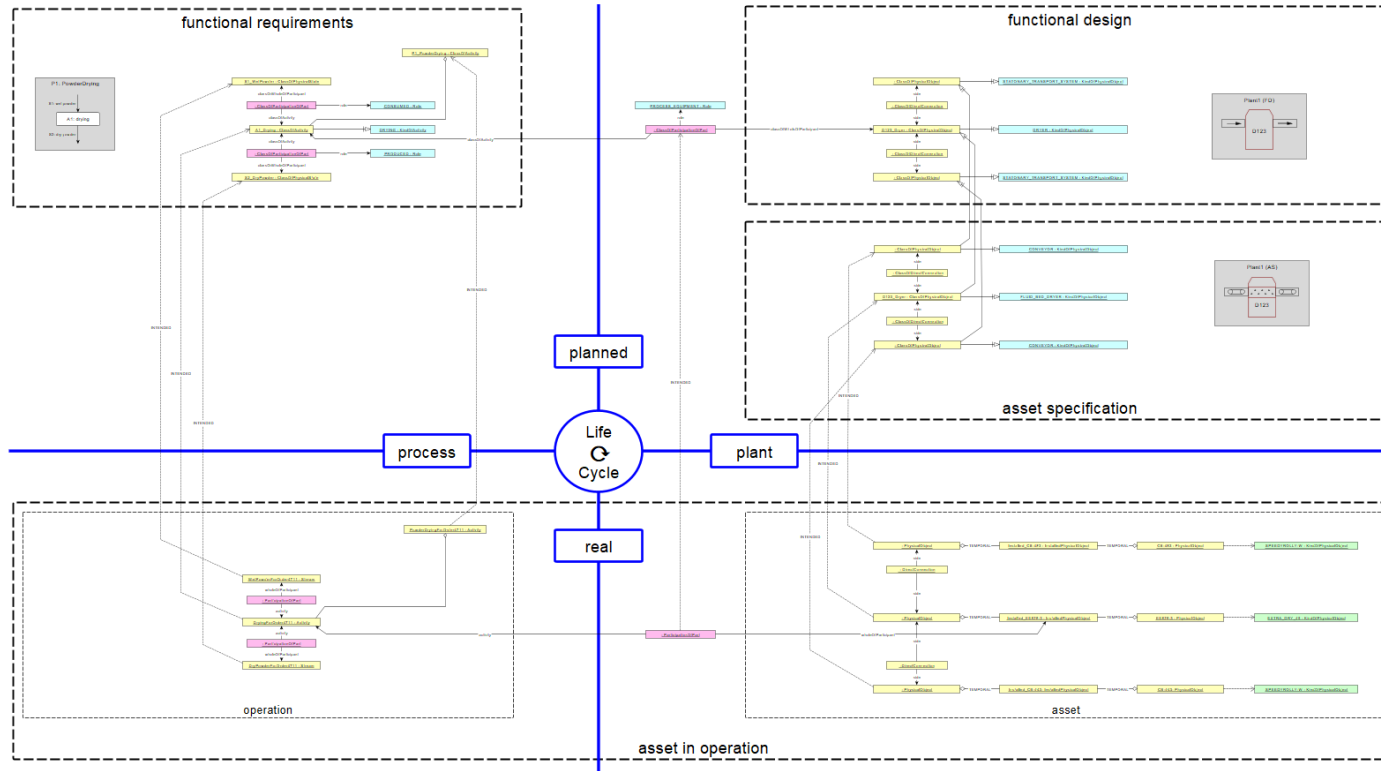
Applications and software prototypes in ModuLA

- application in overall development project Life Cycle

- root cause analysis across domain boundaries, e.g., production – logistics (ENPRO MoProLog)

- information exchange, synchronization and consistency checks across domain boundaries (ENPRO ORCA)

PID (DEXPI)

HMI (MTP)

MTP: module type package

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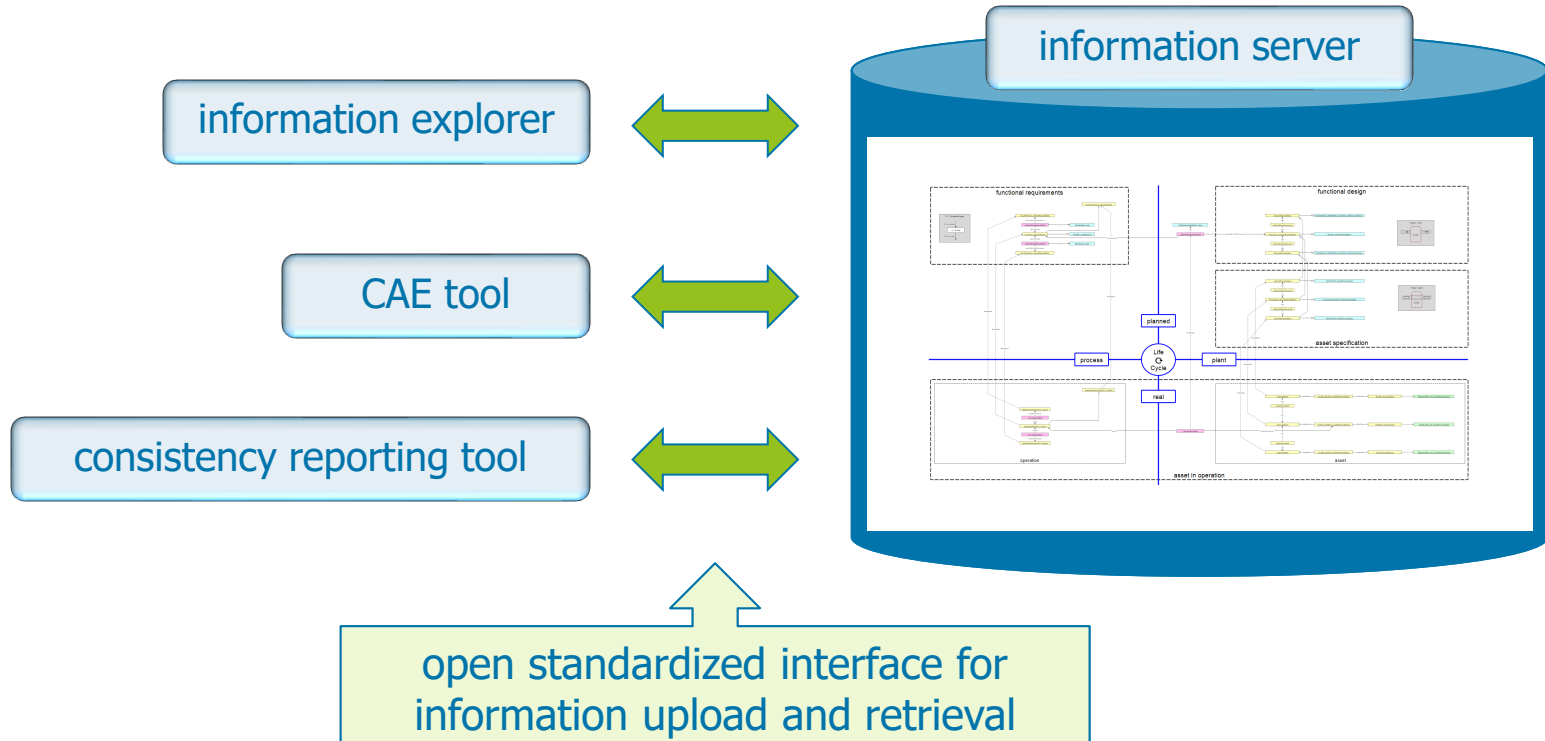
Integration across the Life Cycle

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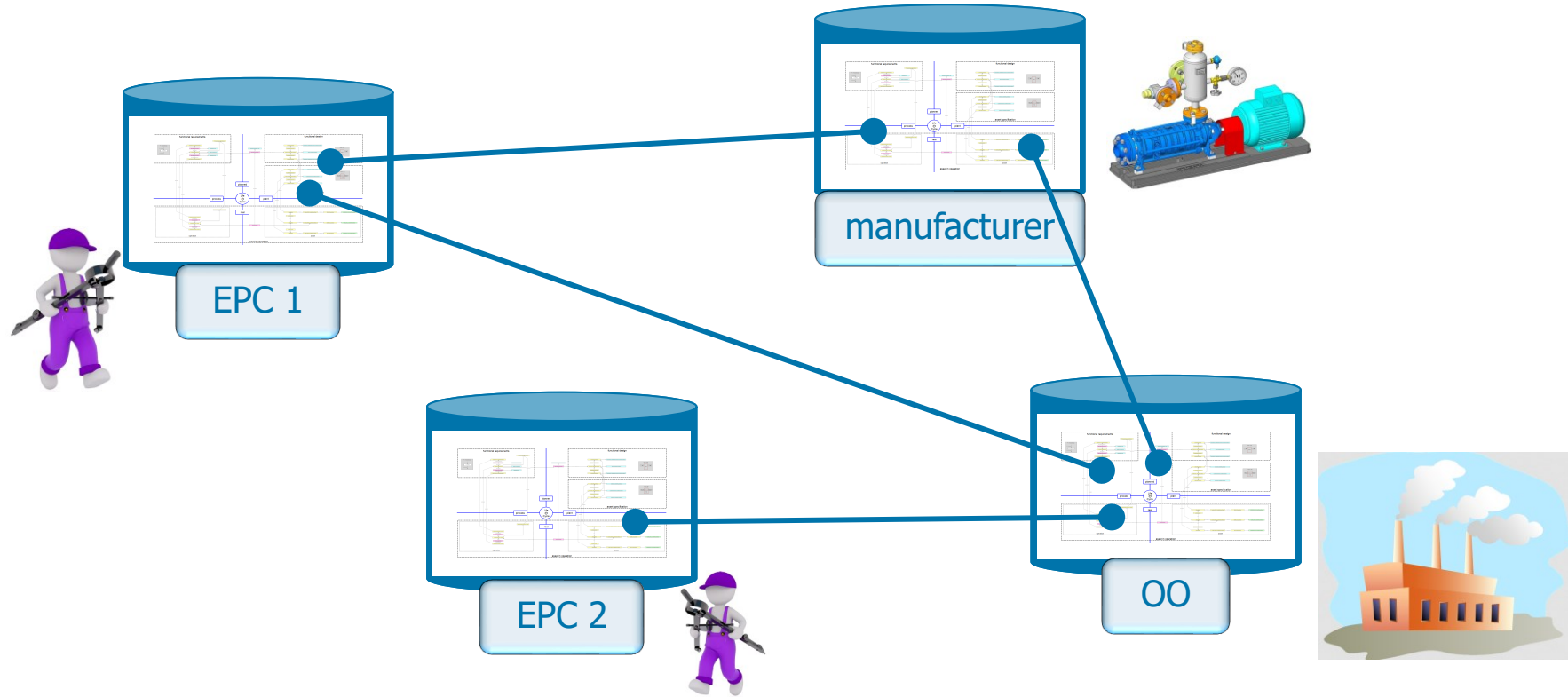- applications and software prototypes
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Follow-up: OCEAN

- inf**O**rmation ex**C**hang**E** in digit**Al** process e**N**gineering
- goals
  - best practices and quality gates for business processes in engineering
  - information server to support information exchange between tools and organizations
  - integration of further domain standards, e.g., BIM
- partners: OOs, EPCs, software vendors, academia

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Information server

information explorer ⟷ information server

CAE tool ⟷

consistency reporting tool ⟷

open standardized interface for information upload and retrieval

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Distributed architecture

manufacturer

EPC 1

EPC 2

OO

Funding

Gefördert durch:

Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

Thank you for your attention!

Questions

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