MODPROD

Center for Model-Based Cyber-Physical Product Development

VTT

# Early modelling of interactions between humans, AI and low-level automation towards system resilience

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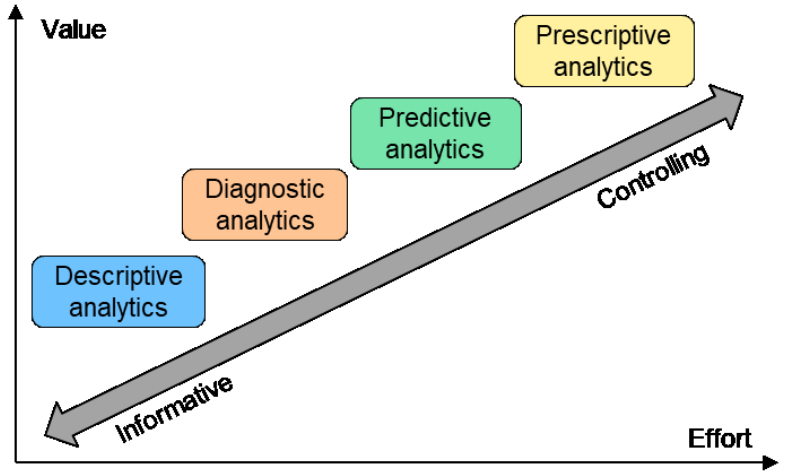
# Industry 5.0 and the evolution of control

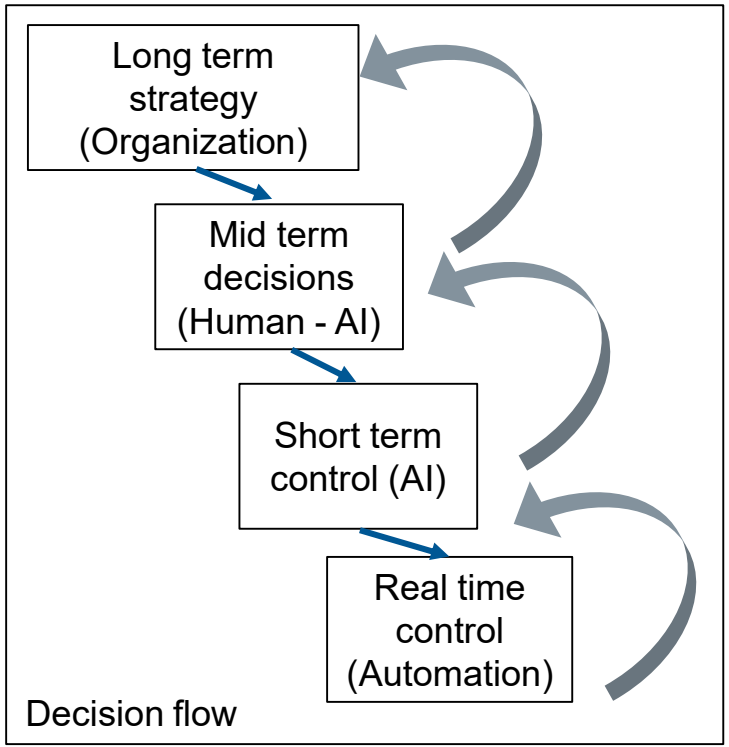
- Competition and decreasing time-to-market imposes high demands
- IIoT and data-driven AI to designed to handle higher-level decisions
- There is a need to model the interactions between humans, AI and low-level automation of CPSoS

## Model-driven approach

- Advantages
  - Reusability, Formal semantics,
  - Early review and approve
- Disadvantages
  - Initial knowledge, planning of complex models



# AI in Cyber Physical System of Systems



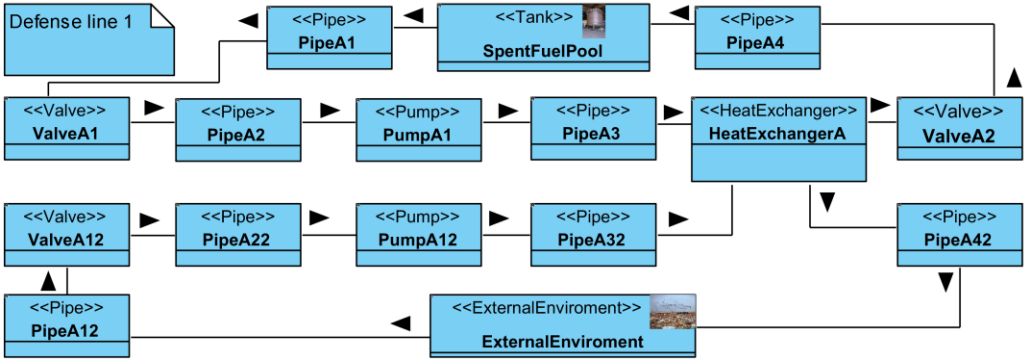

- Flow of decisions
- Disturbances?
- Models for answering stakeholder questions
- Models for transparency for resilience

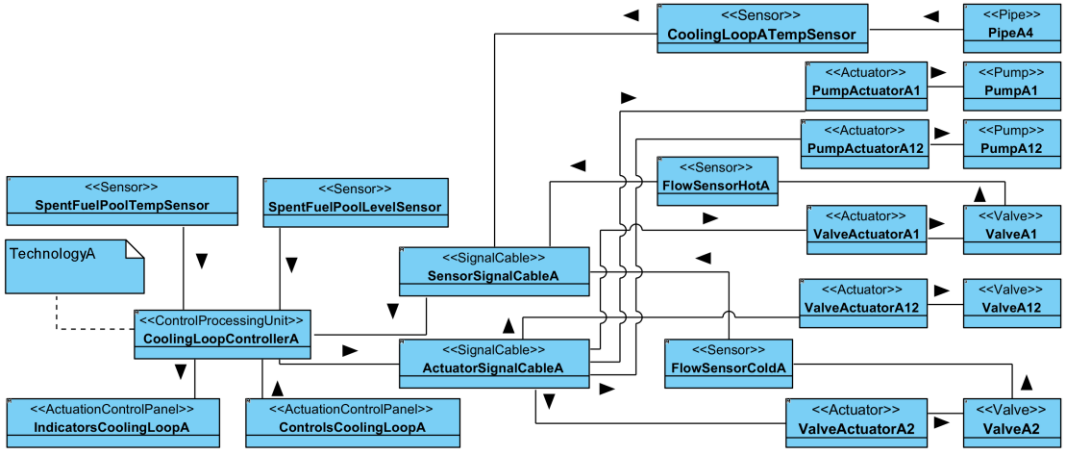
# UML Modelling interactions in AI CPSoS

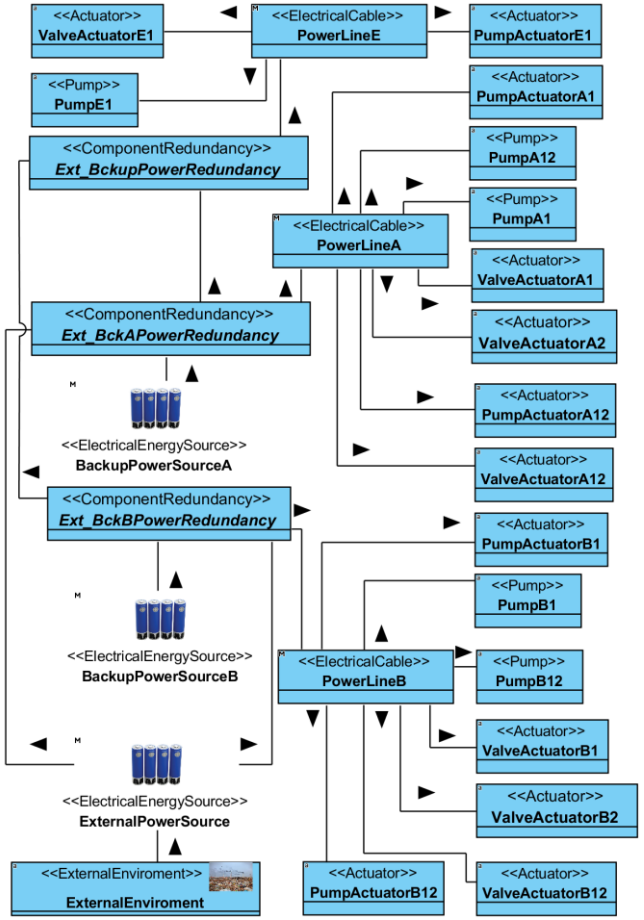
- Interactions between the humans, the AI and the low-level automation of CPSoS for system resilience

- Models are used to capture topology/behavior/timing of systems, e.g:
  - UML **use case diagrams** to show the functionality of the system
  - **Class diagrams** to describe the functional decomposition and the overall system structure/topology
  - **State machine diagrams** to capture the system behavior
  - **Sequence diagrams** to model interactions.

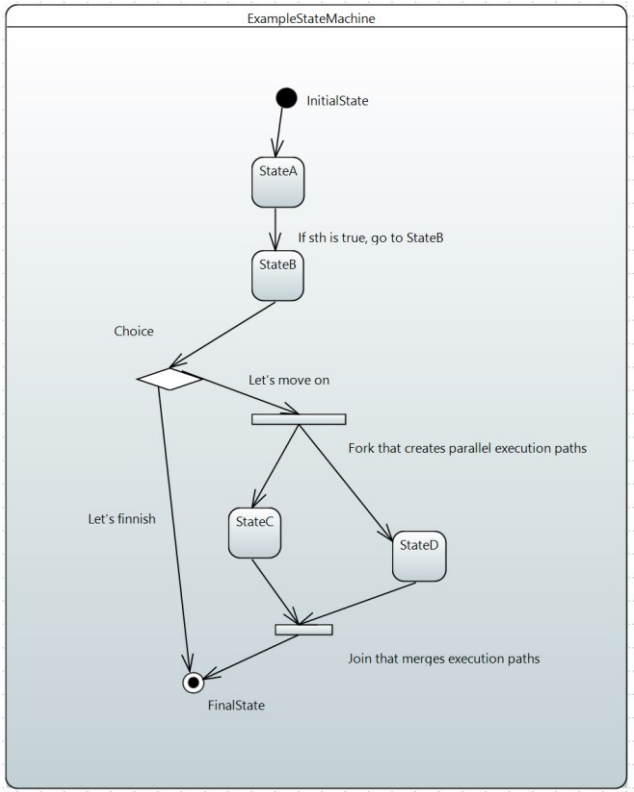
# Examples – topology (process, control, energy flow)

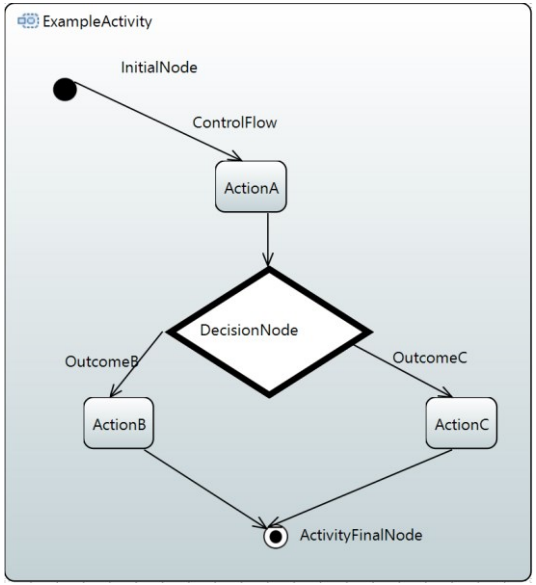


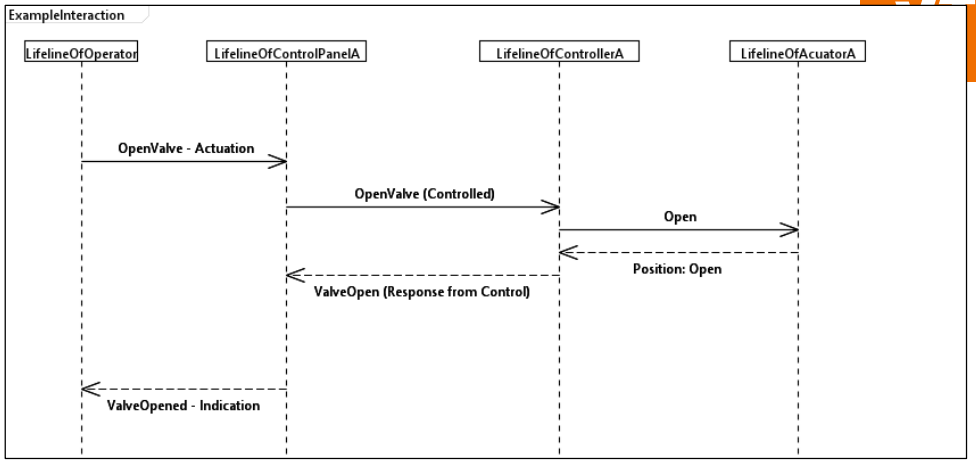



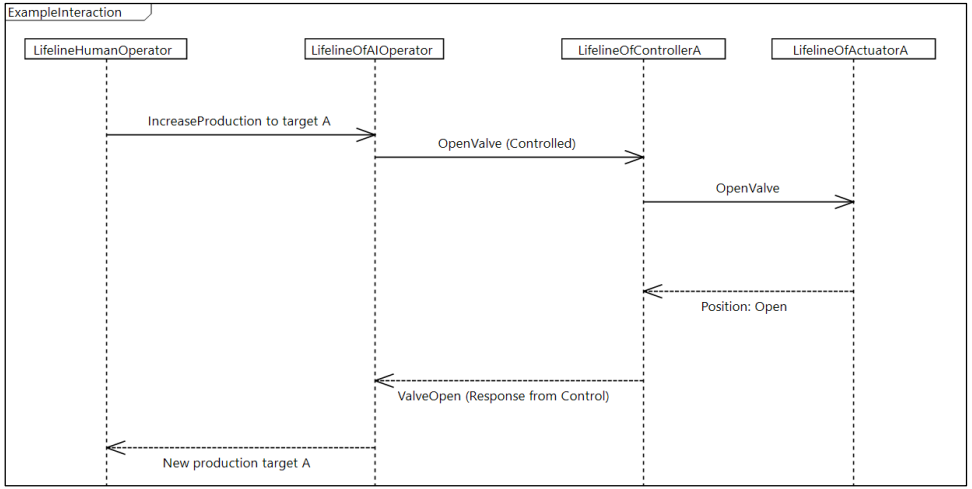
# Examples – behaviour



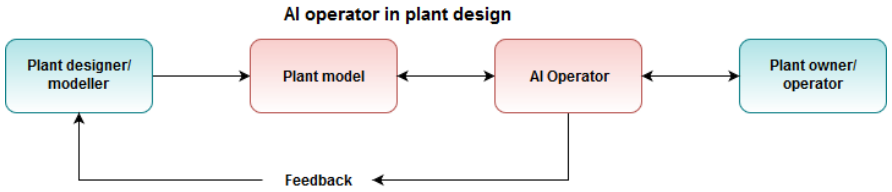
# Examples – role of AI

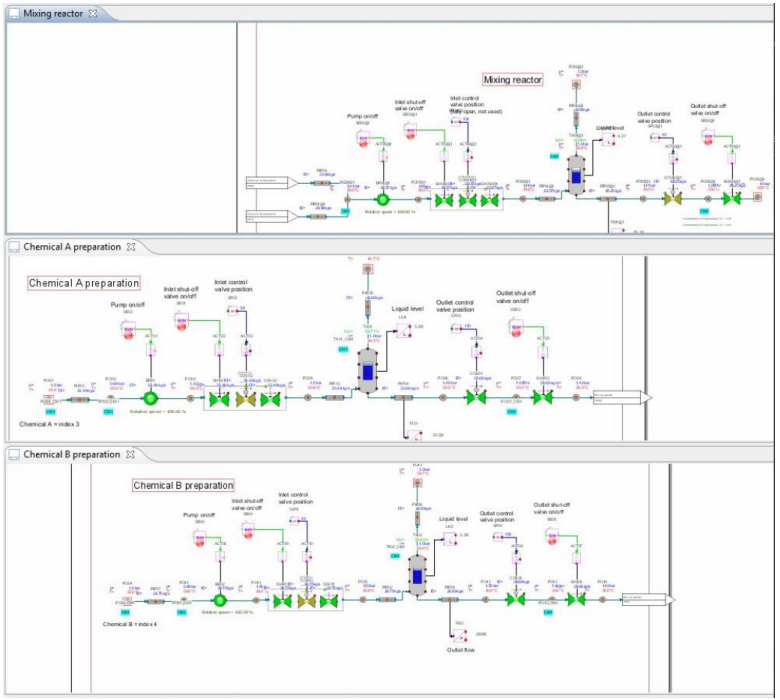


# Example: “AI Operator”

- **Exhaustive simulation → Learning how to act**
  - The AI Operator tries to learn how to control the simulation model.
  - If controlling is possible, the plant design is sound → proceed.
  - If not, a safety risk is found early → much cheaper to fix.

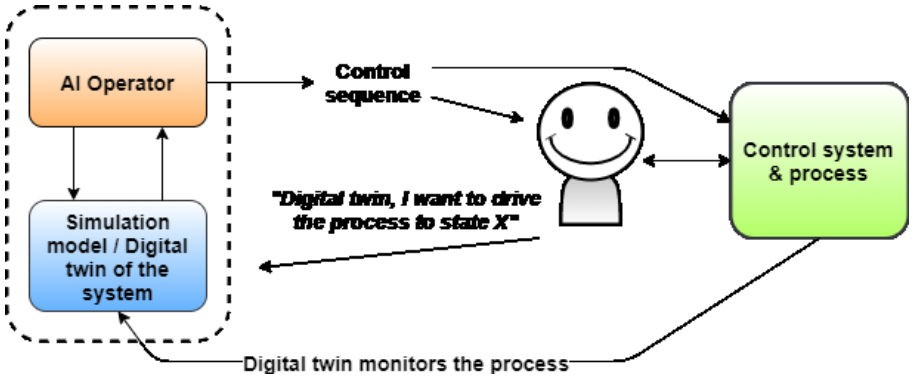


# Controlling the process

# Future: AI boosted digital twin

- AI has novel potential as an operation support tool and in handling fault situations on plant level.
- Digital twin (DT) can be used to predict the future state given the current and past states of the system, but it does not tell how to get to a specific state.
- However, DT could be used to train an *AI* to
  - Create control sequences to operate the plant from state to another (e.g. from fault situation to a safe state) and
  - Give operation support for plant operator.



# beyond
## the obvious

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