Reference:	**QSE:MDEG**
Topic:	**Multi-Domain Engineering Graph Generation with Common Concepts**
Course Type:	Bakk / Master Thesis
Start:	Oct 2021
End:	
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Background

Established process models for distributed collaborative work are workflows for source code management, e.g., Git supports an efficient distributed, non-linear workflow that provides (a) staging areas for different development stages, (b) data integrity by formalized workflow, and (c) is very well for tracking changes in text-based artifacts on a structural level, but lacks analysis capabilities on a semantic level, which is needed for model tracking.

Figure 1 shows the concept of an adapted Git workflow that enables semantic tracking on model level. First (1) View Model A is integrated into a common view, (2) the a second model is integrated, and finally (3) a modified View Model A is extracted from the common view.

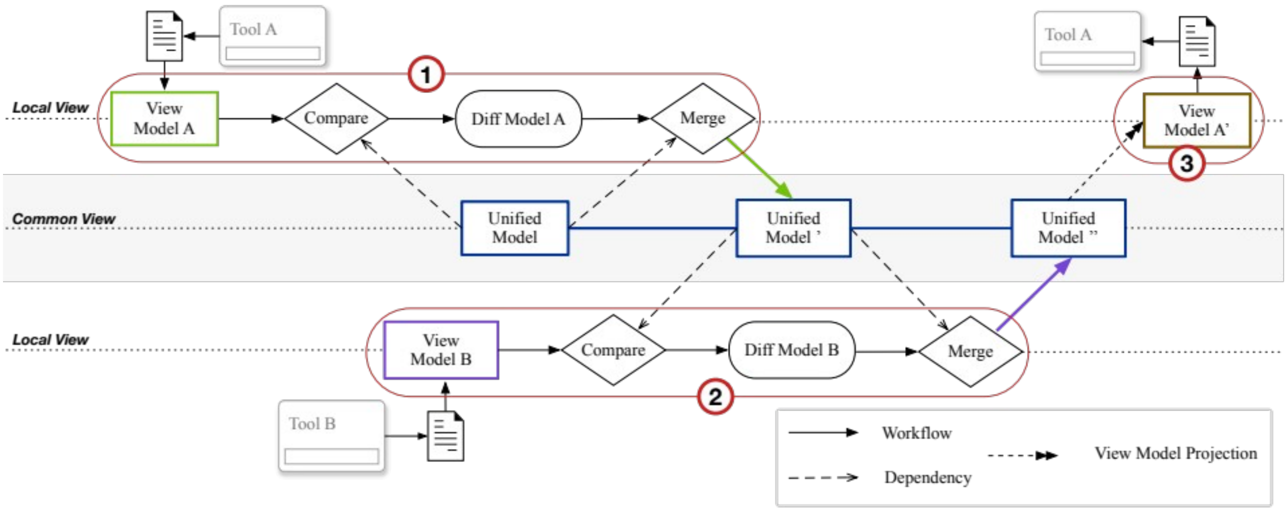

Figure 1: Multi-domain model integration workflow for combining engineering views into a single underlying model adapting the Git workflow.

In Cyber-Physical Production System (CPPS) engineering consistent, cross-disciplinary data models are increasingly important for engineers and project managers to validate system designs or implement new functionality in existing systems. Yet, due to discipline-specific designs (mechanical, electrical, automation), isolated data models and proprietary software tools often lead to information silos. Hence, crucial knowledge from other workgroups or previous projects might be available but not visible or accessible in an interoperable structure. Legacy engineering often uses discipline-specific concepts that hinder seamless information integration across disciplines due to missing common understanding. This limits approaches that aim to formalize a common understanding as a basis for integrated knowledge systems.

Such knowledge systems can provide a holistic view across domains and enable analysis and constraint checking along the CPPS life-cycle. A concept that facilitates building a common understanding to support such knowledge systems are Common Concepts (CCs).

Using CCs for defining a common view of all engineering disciplines address factors that hamper efficient data integration towards a shared Multi-Domain Engineering Graph (MDEG). An integrated MDEG provides analysis capabilities, e.g., to investigate engineering data inconsistencies and logical constraints.

Building a MDEG needed process capabilities that (a) support of the distributed engineering work process (b) provides advanced model comparison approaches that extend text-based diffs.

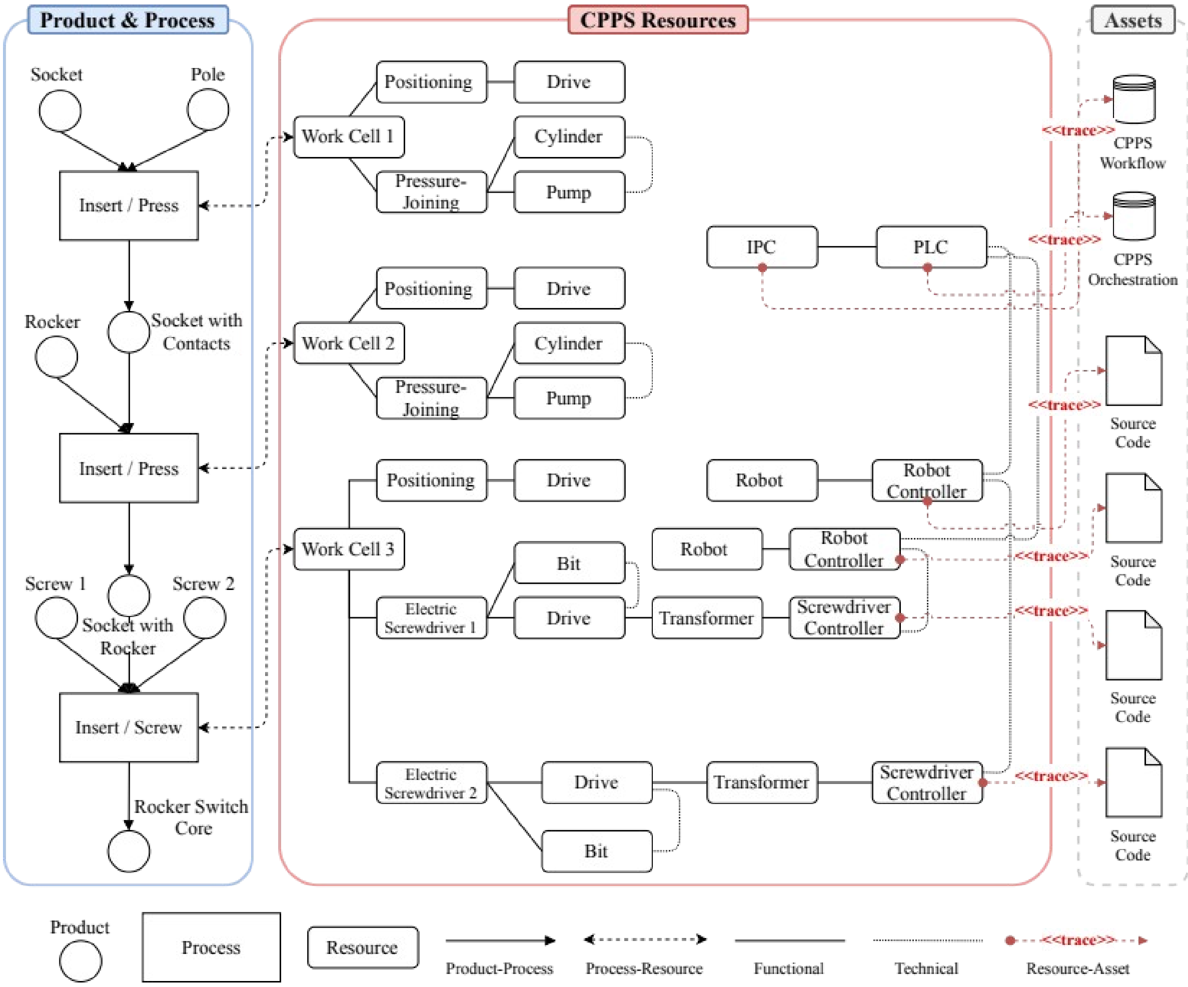

Figure 2: Multi-Domain Engineering Graph in simplified SysML and VDI 3682 notations.

Figure 2 shows an engineering graph based on the industrial use case. In addition to the product, process and resource information, aspects such as trace links are shown to motivate the potential of a MDEG.

Goal of this project is to develop a service-oriented application for guiding the definition and generation of multi-domain engineering graphs: (1) collect system element data from several sources as a knowledge graph to build a common understanding of system information and boundaries; (2) map system elements to common concept definitions; (3) define the initial engineering graph using the common concepts (4) design an agile multi-domain model integration workflow to populate the MDEG with data, and (5) transform the multi-domain engineering graph to a property knowledge graph in a graph database to enable visualization and analysis capabilities.

This topic is provided and supervised in cooperation with our industrial/academic partner *TU Wien Pilot Factory*.

Tasks

- Elicit detailed requirements for designing a meta-model that captures the required aspects of a multi-domain engineering graph using aspects of semantic web and model-driven engineering.
- Design a service-oriented application that provides functions on graph manipulation using agile workflow architectures.
- Design mappings of the engineering graph to graph database formats such as property graphs
- Prototype implementation and evaluation of traceability of changes in the engineering graph.
- Empirical evaluation of change traceability (collect and analyze quality data).

Expertise

For this topic the following skills are recommended (at least two are mandatory).

- Java programming skills
- Graph database skills, e.g., Neo4J/Cypher.
- Data modeling
- Empirical evaluation, e.g., case study, pre/post comparison.
- Semantic web / model-driven engineering skills.

References

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