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Efficient Monitoring of Multi-Disciplinary Engineering Constraints with Semantic Data Integration in the Multi-Model Dashboard Process

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Motivation & Goals

Motivation:

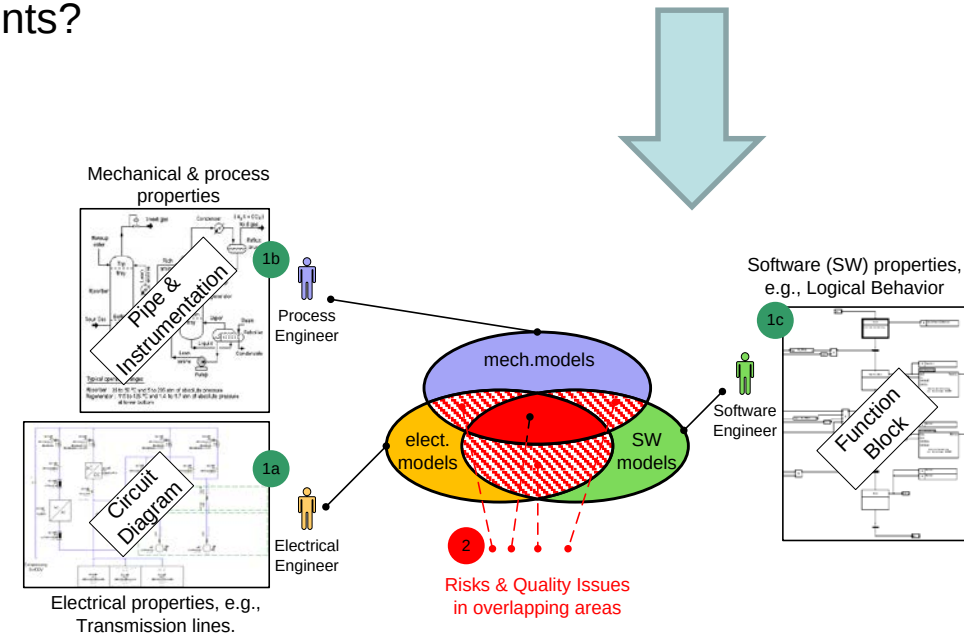
- Heterogeneous and Multi-Disciplinary Engineering (ME) Environments.
- Changes in individual disciplines can have an impact on product and project quality and need to be identified early.

Key **research question** focus on:

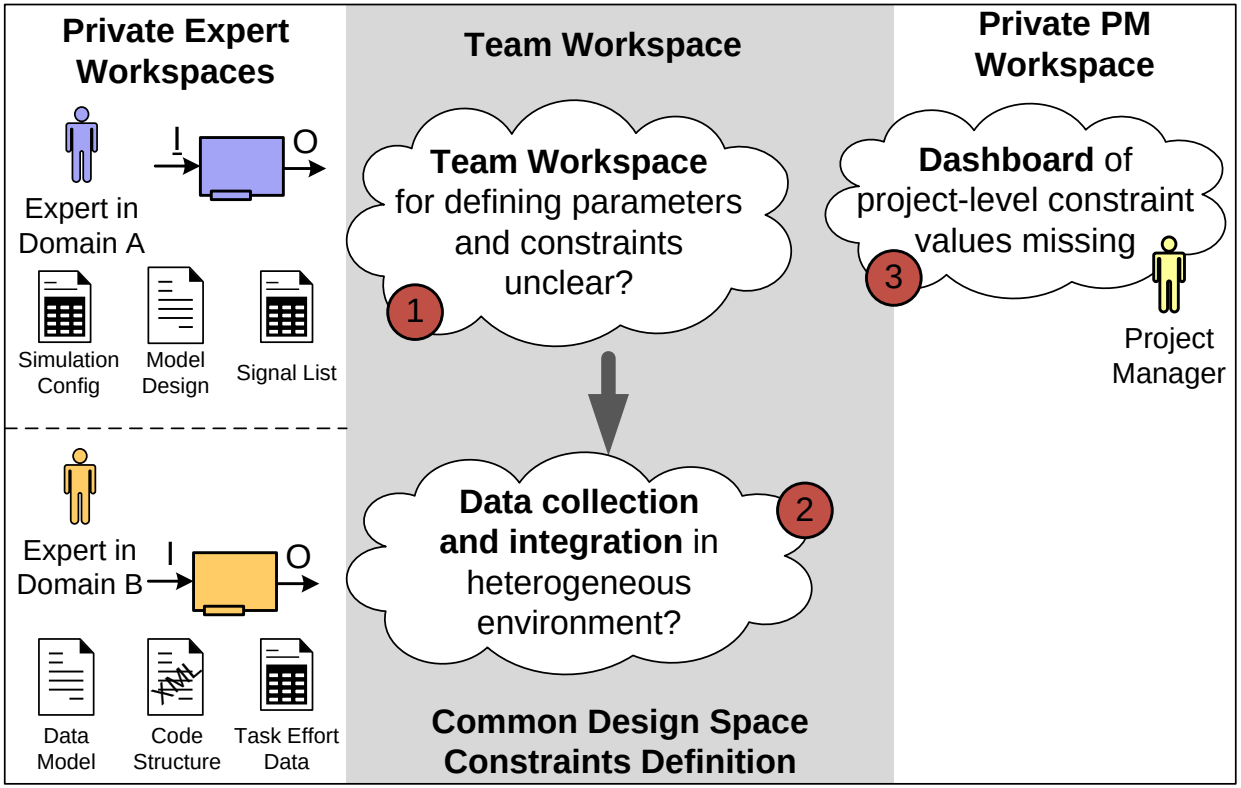
- How to enable selective observation of critical project parameters in heterogeneous environments?

Goals of the paper:

- Multi-Model Dashboard Process (MMD).
- Feasibility Study on MMD Prototype Tool Implementation.



Engineering Process Data in ME Projects Challenges & Needs



1. Engineering Team Workspace for parameter and constraint definition unclear.
2. Data collection in heterogeneous engineering environments are inefficient and error-prone.
3. Central Dashboard approach for project-level parameter and constraint evaluation is missing.

Related Work and Research Issues

- **Risk Management** in Heterogeneous Engineering Environments
  - Distributed and heterogeneous engineering tools and data models might lead to defects (even across disciplines) that are hard to identify.
  - Critical project parameters need to be monitored to identify changes / deviations early.
- **Awareness of Constraints** in Multi-Model Industrial Plant Engineering Environments
  - Dependencies of parameters/constraints across engineering disciplines.
  - E.g., Constraints must be observed to guarantee max. power consumption, max. heat radiation, max. weight, or available development effort.
- **Data and Tool Integration in Engineering Environments**
  - Individual tools apply a variety of tools and data models that need to be well integrated.

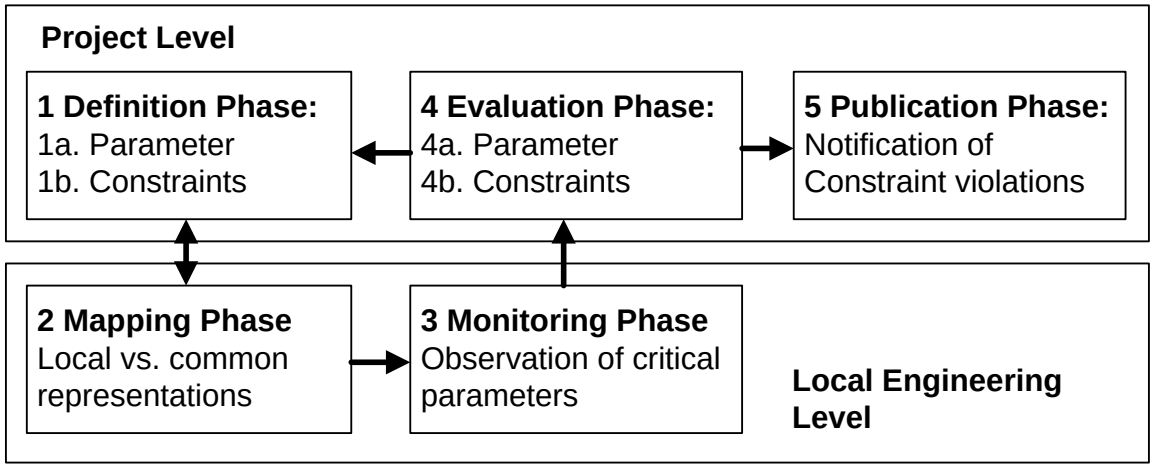
Research Issues:

- How to establish a **process that supports the selective observation** of critical engineering project parameters and constraints (the MMD process approach).
- How can a **tool support** the MMD process to enable efficient and effective parameter and constraint observation (prototype implementation).

MMD Process Approach

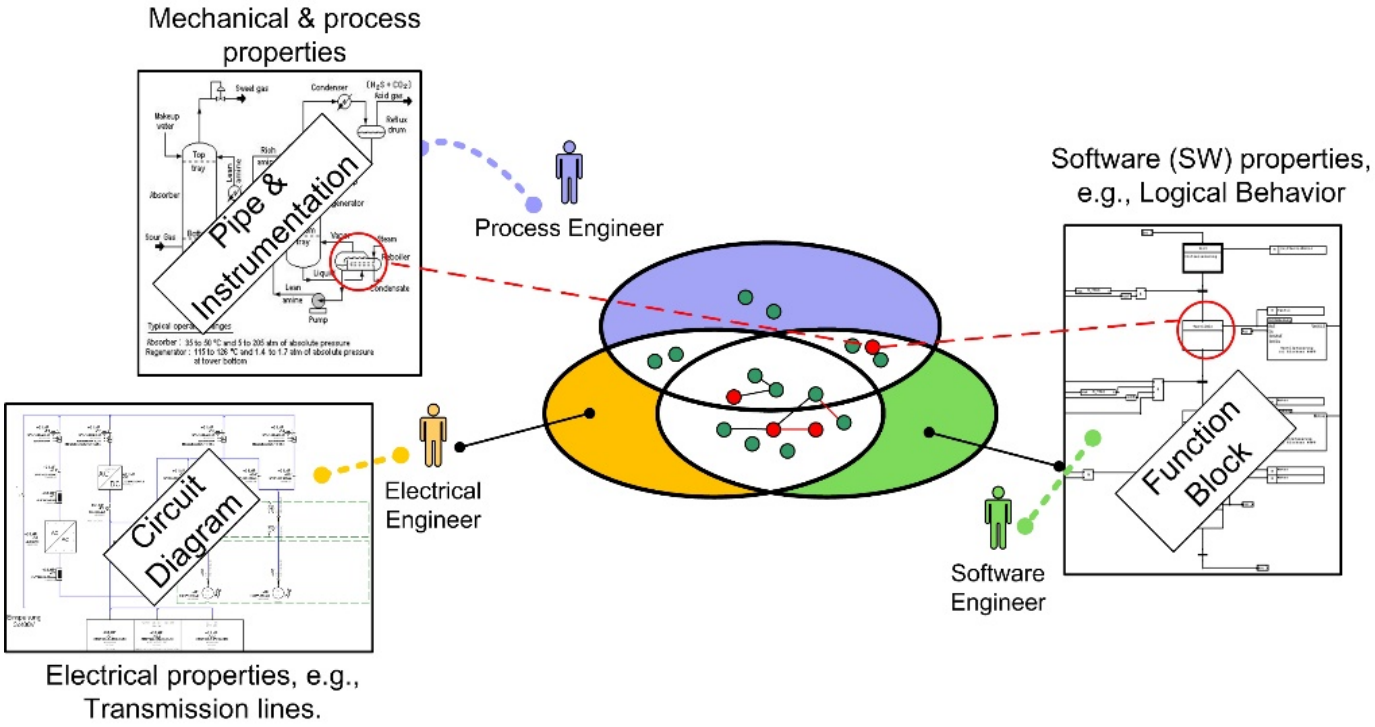
- Local Engineering Level (within private workspaces) vs. Project Level (in team workspaces).

- **Definition** of parameters and constraints according to stakeholder needs; Goal is to have an agreed list of **required** and **available** parameter/constraints.
- **Mapping** of local concepts to common concept (knowledge engineer).
- **Monitoring** of subscribed parameters on local engineering level.
- **Evaluation** of parameters and constraints on project level.
- **Publication** of evaluation results and notification of changes and/or constraint violations.



Mapping of Local Representations to Common Concepts

- Individual Local tools and data models.
- Overlapping (data) areas to enable synchronization between engineering plans coming from different disciplines.
- Mapping of local representations to the common data model (contribution of a knowledge engineer).



Candidate Use Cases

- Observing critical project parameters can address several needs within heterogeneous and distributed engineering projects (e.g., in project consortia)
- Examples Use Cases:
  - UC-SI: Automated process monitoring of a production system simulation, e.g., observation of conveyor capacity.
  - UC-DE: Plant design and construction, e.g., impact of process design on heat radiation.
  - UC-EL: Electrical systems design, e.g., observation of the overall power consumption in a configuration of devices.
  - **UC-PM: Project effort and cost monitoring based on project planning and individual effort reporting systems within project consortia.**

Use Case	Parameters	Related Data
UC-SI	Throughput,	Items per time interval, duration, number of items
	Cycle Time	
UC-DE	Maximum weight and applied weight	Capacity of basement, individual weights of equipment
	Cooling power needs and capacity	Cooling capacity, heat radiation of machines
UC-EL	Power consumption and needs	Power needed by equipment, overall power available
UC-PM	**Time and project plans and effort**	**Individual milestone planning, working effort per person/artifact**

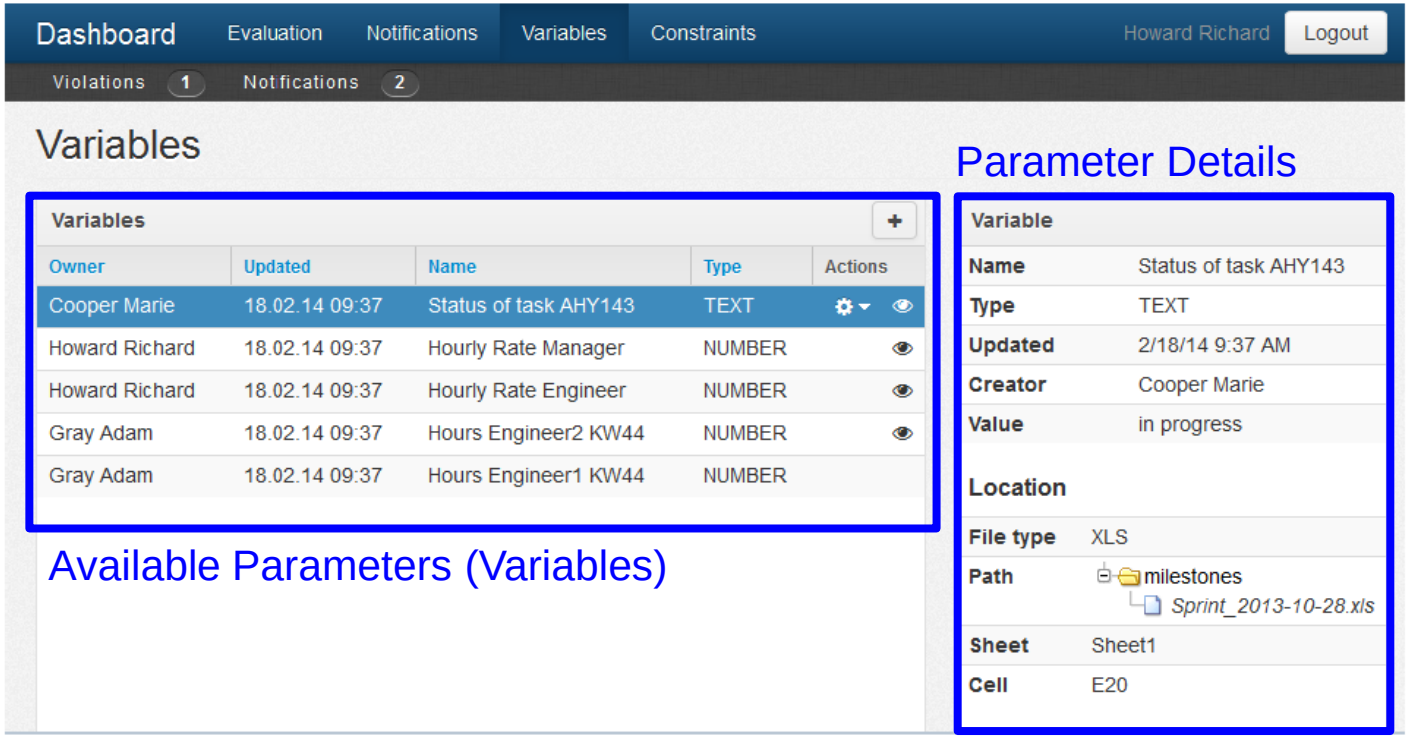
Evalution Use Case

Step 1: Parameter / Constraint Definition

Evaluation of the Prototype Implementation

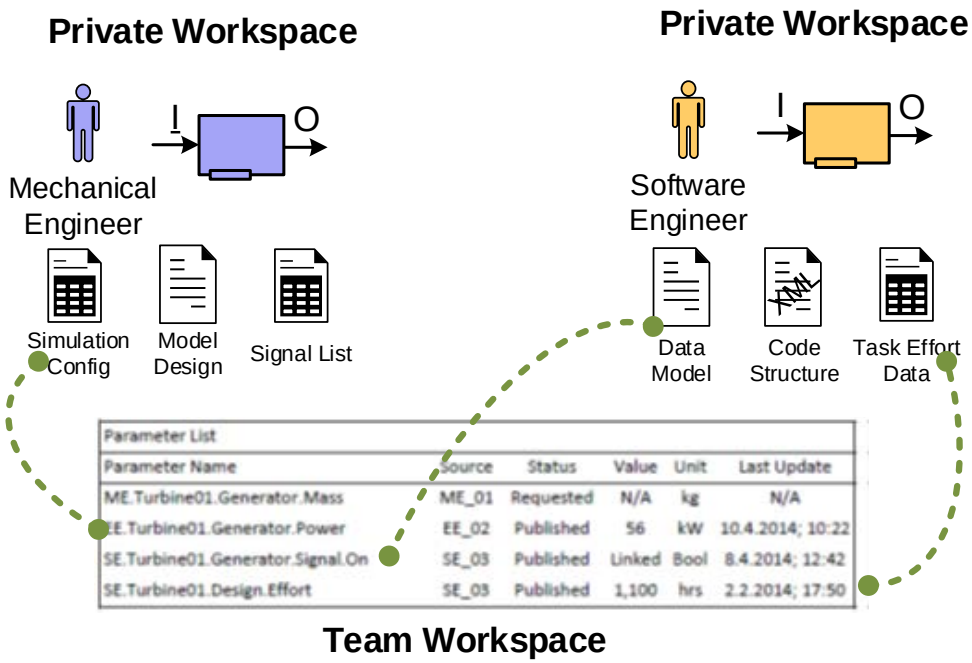
- UC-PM: Project effort and cost monitoring based on project planning and individual effort reporting systems within project consortia.

- Parameter (Variable) and Constraint definition.
- Available Artifacts/Files: XLS, CSV, PDF, TXT, individual engineering plans (if needed)



Step 2: Mapping and Step 3: Monitoring
Evaluation of the Prototype Implementation

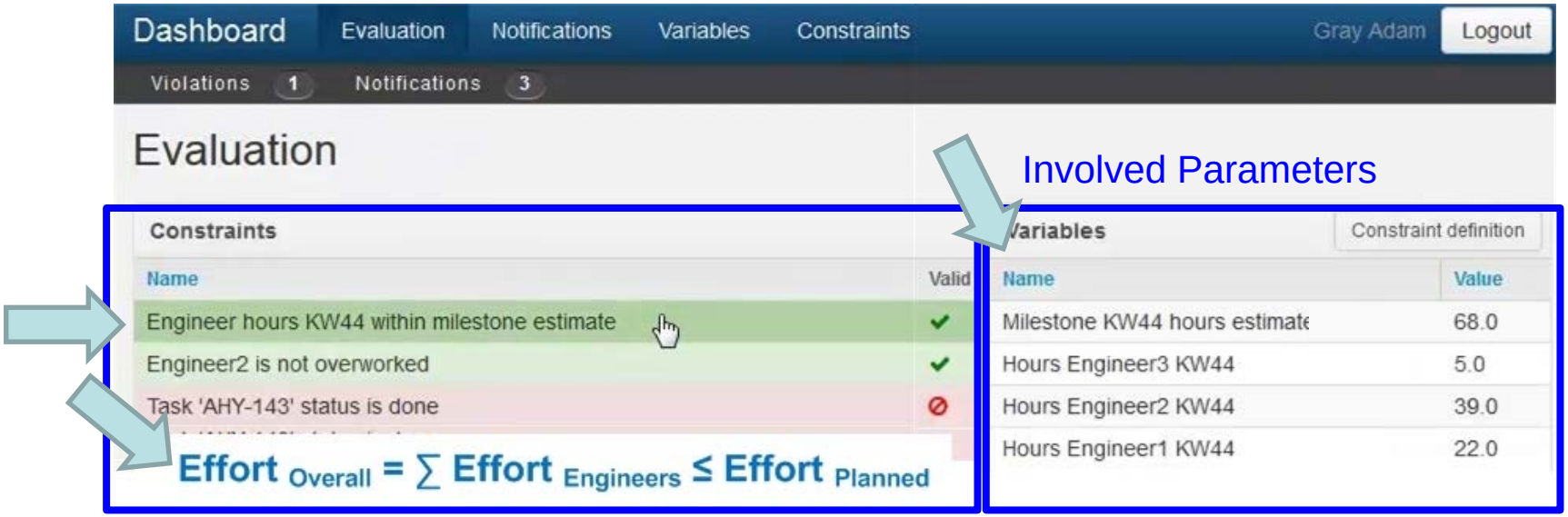
- **Mapping** of local representations to common concepts (representations).
- Typically Knowledge Engineers support the mapping process.
- Established links can enable **continuous monitoring** (of subscribed) parameters in local representations.



Step 4: Parameter / Constraint Evaluation

Evaluation of the Prototype Implementation

- Parameter and Constraints Observation
- Evaluation of simple and more complex parameters/constraints
- Short summary of evaluation results (validity flag)
- More details on involved parameters for further analysis



Step 5: Publication and Notification
Evaluation of the Prototype Implementation

- Role-specific selection of parameters and constraints (in individual contexts) to be evaluated, e.g., for project management purposes.
- Notification based on changes and constraint violation
  - Via E-Mail
  - Accessible via MMD

Cost / Benefit Considerations

- MMD enables
  - Focused definition of success-critical parameters and constraints
  - Selective observation and monitoring of subscribed parameters and constraints
  - Efficient publication and notification mechanisms.

- Process Performance Consideration

Process Step		Effectiveness		Effort	
		Manual	MMD	Manual	MMD
1a	Parameter definition.	o	++	+	-
1b	Constraint definition	o	++	+	-
2	Linking parameters to local representations	-	+	--	-
3	Change monitoring in local engineering models	-	+	--	++
4a	Parameter evaluation	o	++	o	++
4b	Constraint evaluation	o	++	+	++
5	Publication of parameters / constraints	o	++	-	+
	Overall	**o**	**++**	**o**	**+**

Legend: ++ Positive Effects, -- Negative Effects

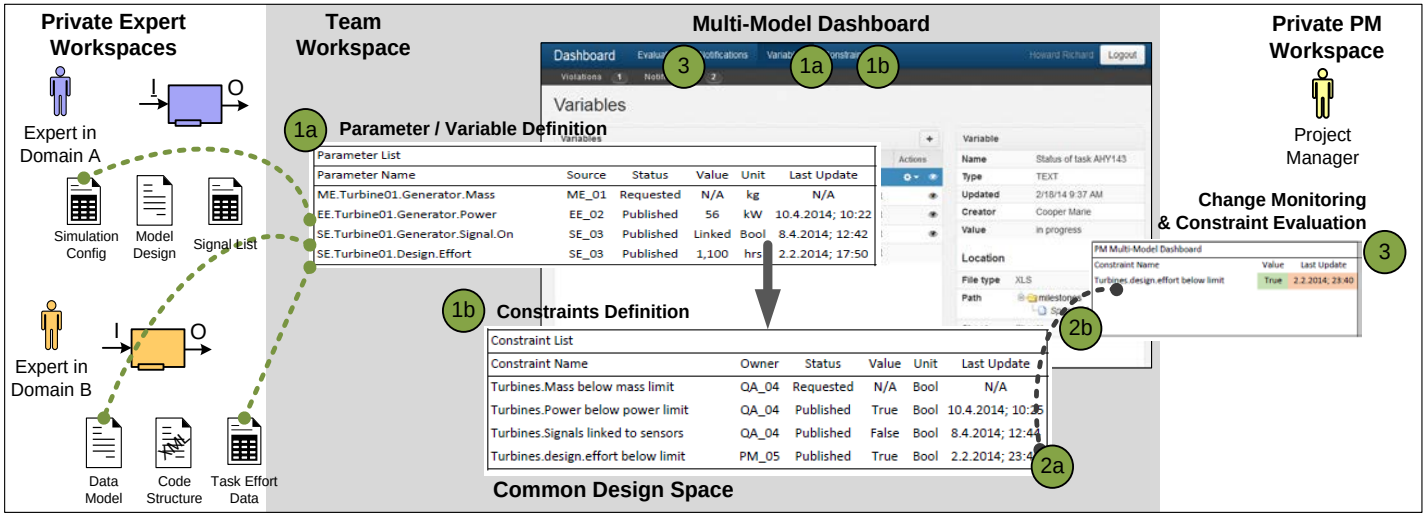
Summary & Future Work

Summary

- Heterogeneous and Multi-Disciplinary Engineering (ME) Environments.
- Changes in individual disciplines can have an impact on product and project quality and need to be identified early.
- The MMD enables the selective observation of subscribed parameters and constraints across engineering disciplines in heterogeneous environments.

Future Work

- Investigation of scalability constraints and further development of MMD features.
- Application in various industry contexts.



Thank you ...

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