



# PMD Core Ontology

## A Community Driven Mid-Level Ontology in the MSE Domain

Speaker: Bernd Bayerlein

The Material Digitalization Platform

A joint project by:

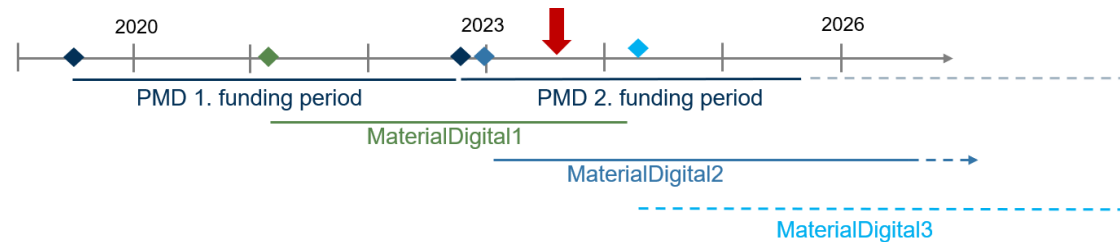


# Overview: Initiative MaterialDigital & PMD



## Long-term goals of the Initiative MaterialDigital (currently 20 materials digitalization projects)

- represent the digital material in its lifecycle
- map the digital material throughout entire process chains
- provide reliable materials/process data for component design and evaluation



## Platform MaterialDigital (PMD)

- offers prototypical solutions for infrastructure and tools
- develops common standards for data structuring and transfer

**PMD remains a neutral intermediary**

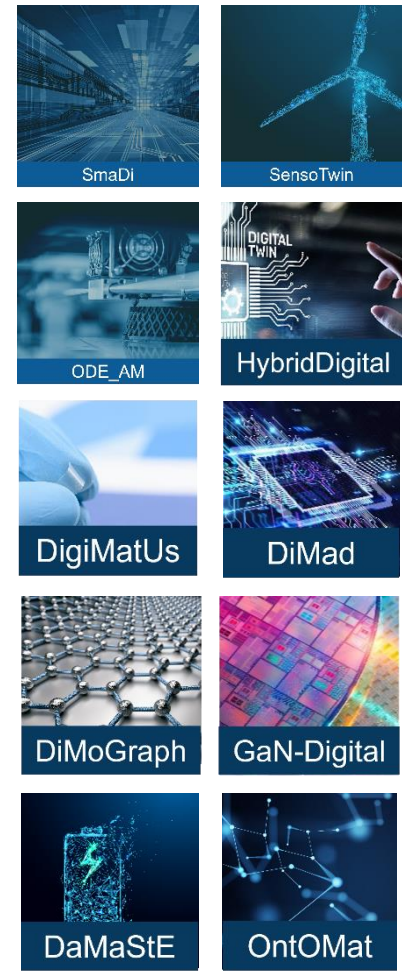
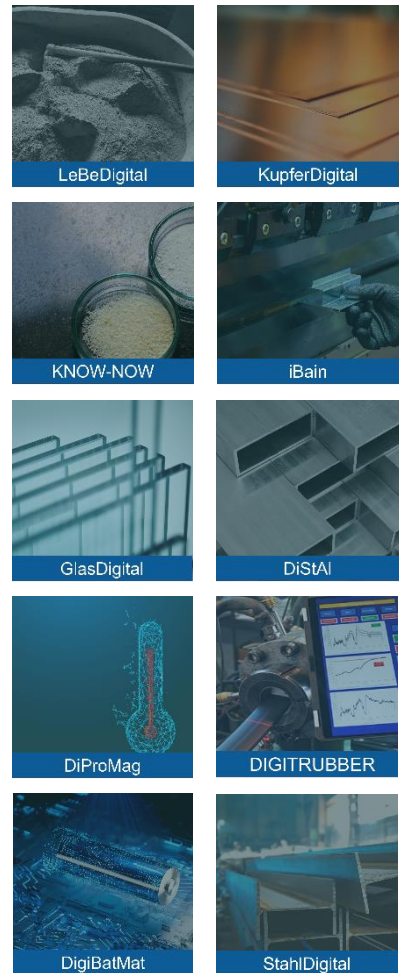


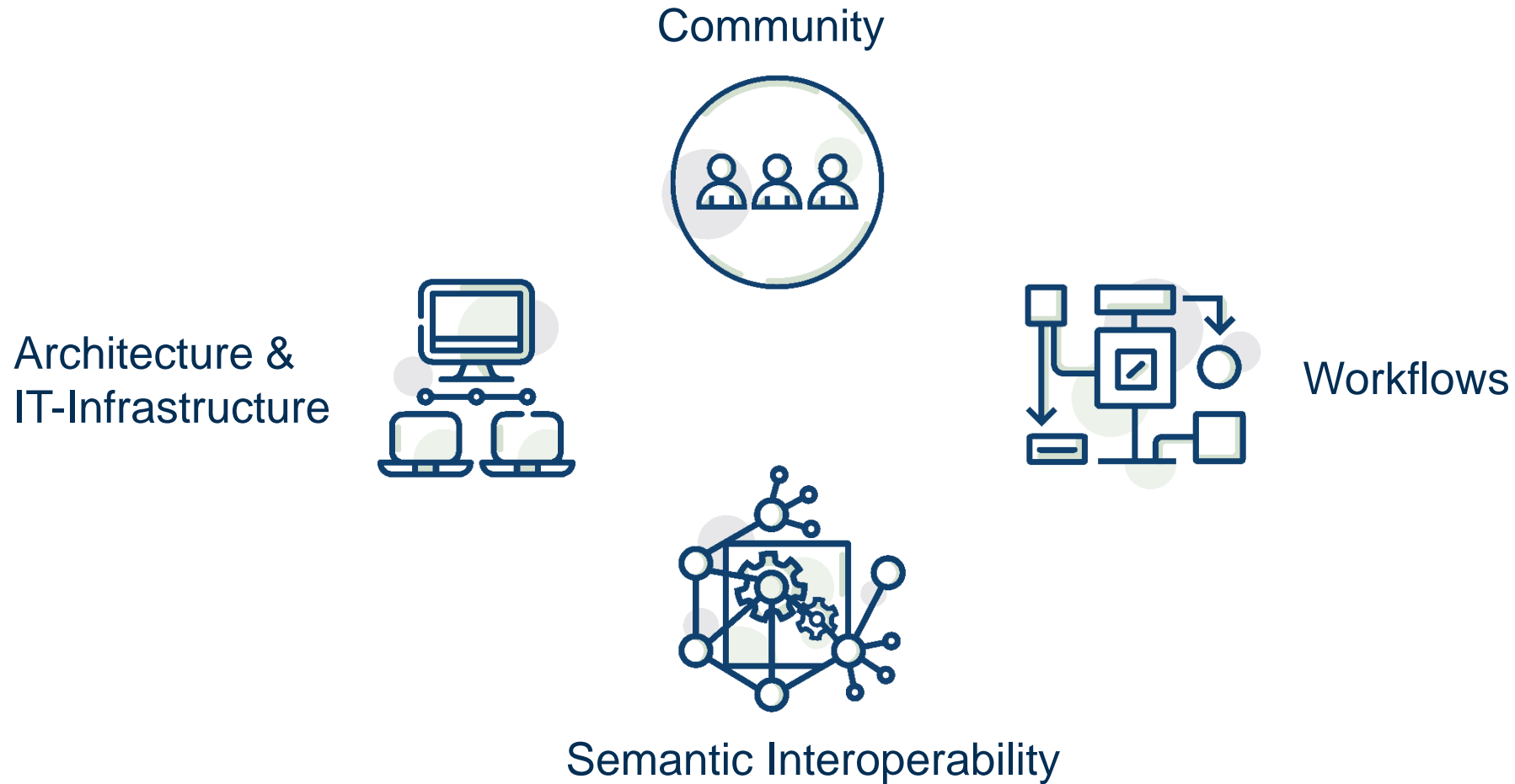
[www.materialdigital.de](http://www.materialdigital.de)





# Overview: Initiative MaterialDigital & PMD







# Team – Semantic Interoperability

**Jörg Waitelonis (FIZ)**  
Ontology Expert  
Lead

**Bernd Bayerlein (BAM)**  
MSE Expert  
Lead

**Markus Schilling (BAM)**  
MSE Expert  
Lead

**Henk Birkholz (IWT)**  
Principal Architect



**Pedro D. Portella (IWM)**  
MSE Expert

**Philipp v. Hartrott (IWM)**  
Civil Engineer

**Jannis Grundmann (IWT)**  
Software Engineer

**Matthias Jung (IWM)**  
MSE Expert

**Jehona Kryeziu (KIT)**  
Software Engineer

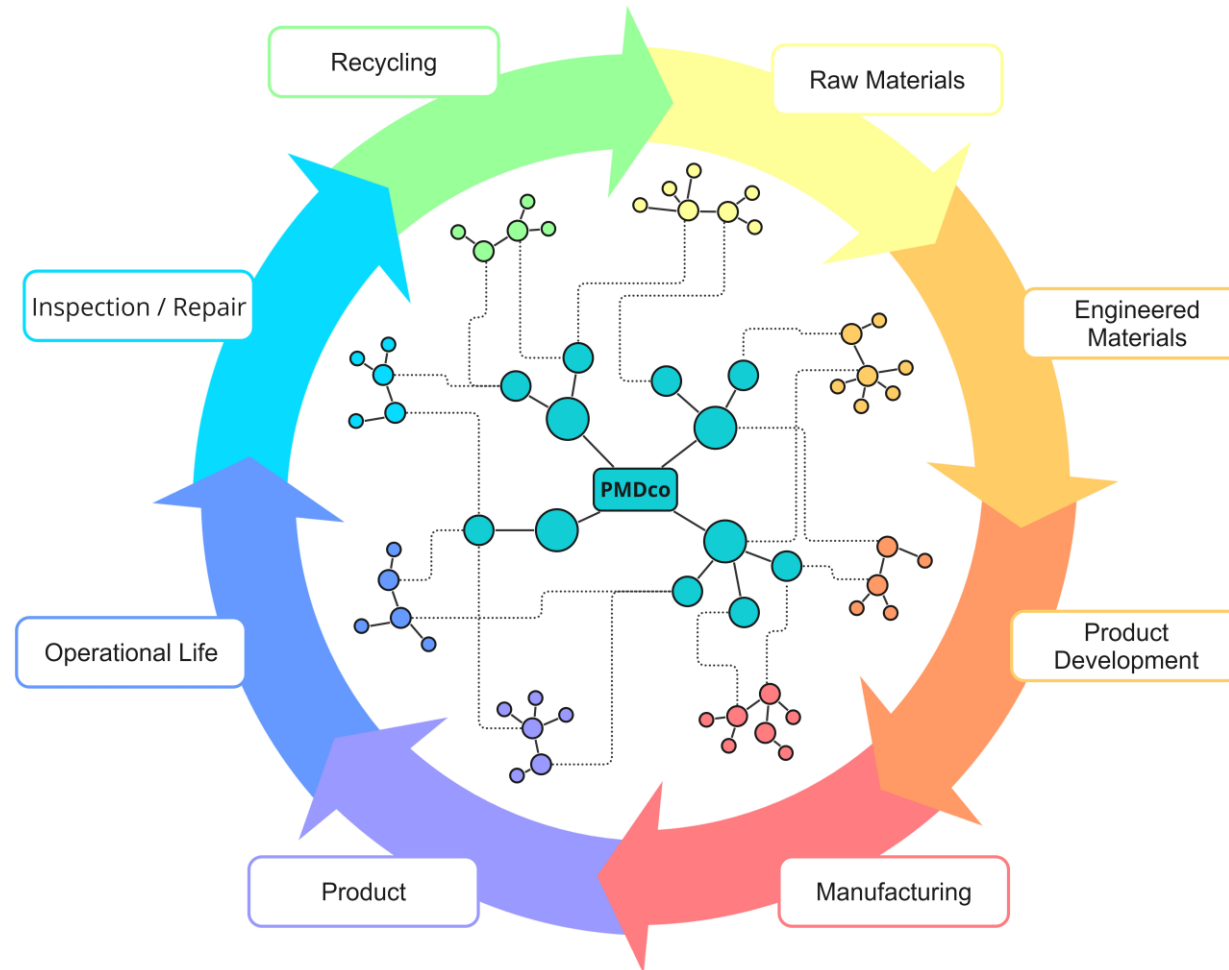
Our ongoing goal is to establish data structuring standards and agreements that facilitate technological semantic interoperability of (meta)data and services among all stakeholders, in alignment with FAIR data principles.

To achieve this, prototype ontologies are created, continuously enhanced, and shared in repositories, with ongoing engagement and collaboration within the community.






# Motivation: Interoperable Materials & Process Data

There is a focus on **achieving global-scale process interoperability** (Industry 4.0), while there is a concentration on **generating, and managing materials research data** (NFDI).





- Establishing a **shared vocabulary**
- Integrate **invariant and variant knowledge**
- **Enhancing interoperability** with existing approaches
- **Fostering reproducibility**
- **Reducing costs, saving resources**
- **Accelerate development and discovery**

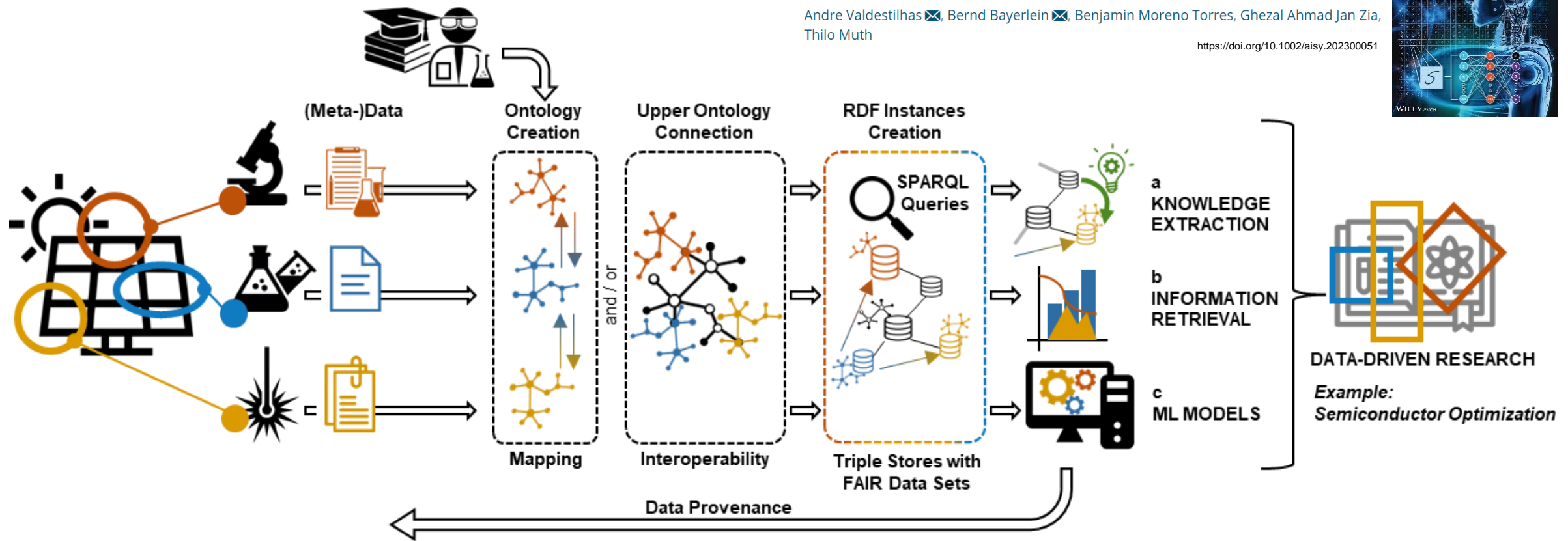
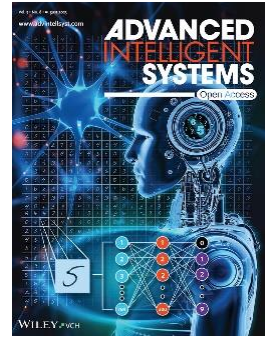
# Motivation – (Meta)Data Transformation in MSE

Perspective |  Open Access |  

## The Intersection Between Semantic Web and Materials Science

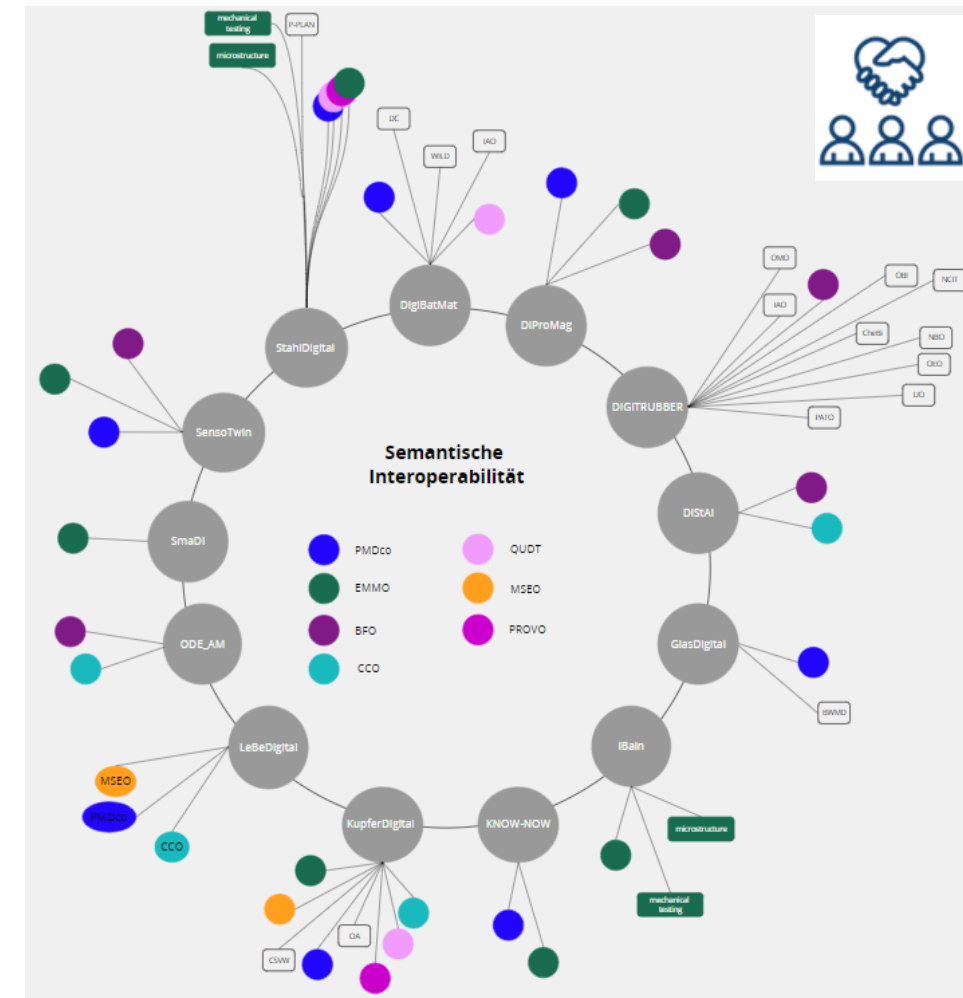
Andre Valdestilhas , Bernd Bayerlein , Benjamin Moreno Torres, Ghezal Ahmad Jan Zia, Thilo Muth

<https://doi.org/10.1002/aisy.202300051>



# Existing MSE Ontologies

- Numerous ontologies for the MSE domain, but:
  - unknown,
  - inaccessible,
  - poorly curated and maintained,
  - inadequately documented,
  - tailored for specific niches,
  - lacking precise and domain-appropriate term definitions for effective application and reuse.





# Bridging the Gap via the PMD Core Ontology

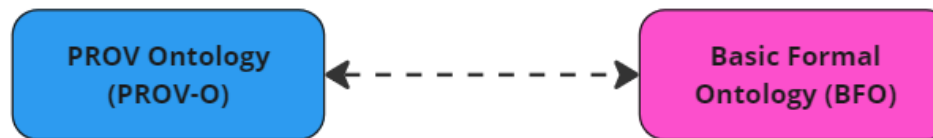


- Mid-level Ontology for Materials Science and Engineering (MSE)
- Maintained and curated by the **Platform MaterialDigital**
- Based on continuous MSE community interactions
- Semantic intermediate layer to connect domain-specific application ontologies
- Common framework for describing and organizing (meta)data

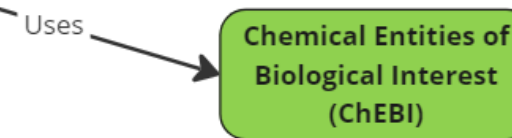
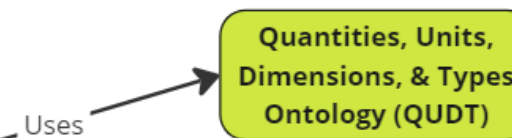
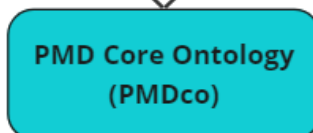


# Ontology Layers

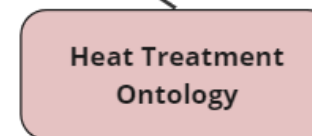
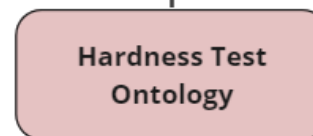
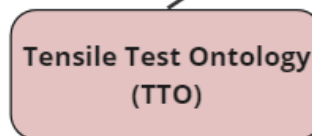
**Top-level**  
foundational, universal concepts



**Mid-level**  
intermediate, connecting concepts

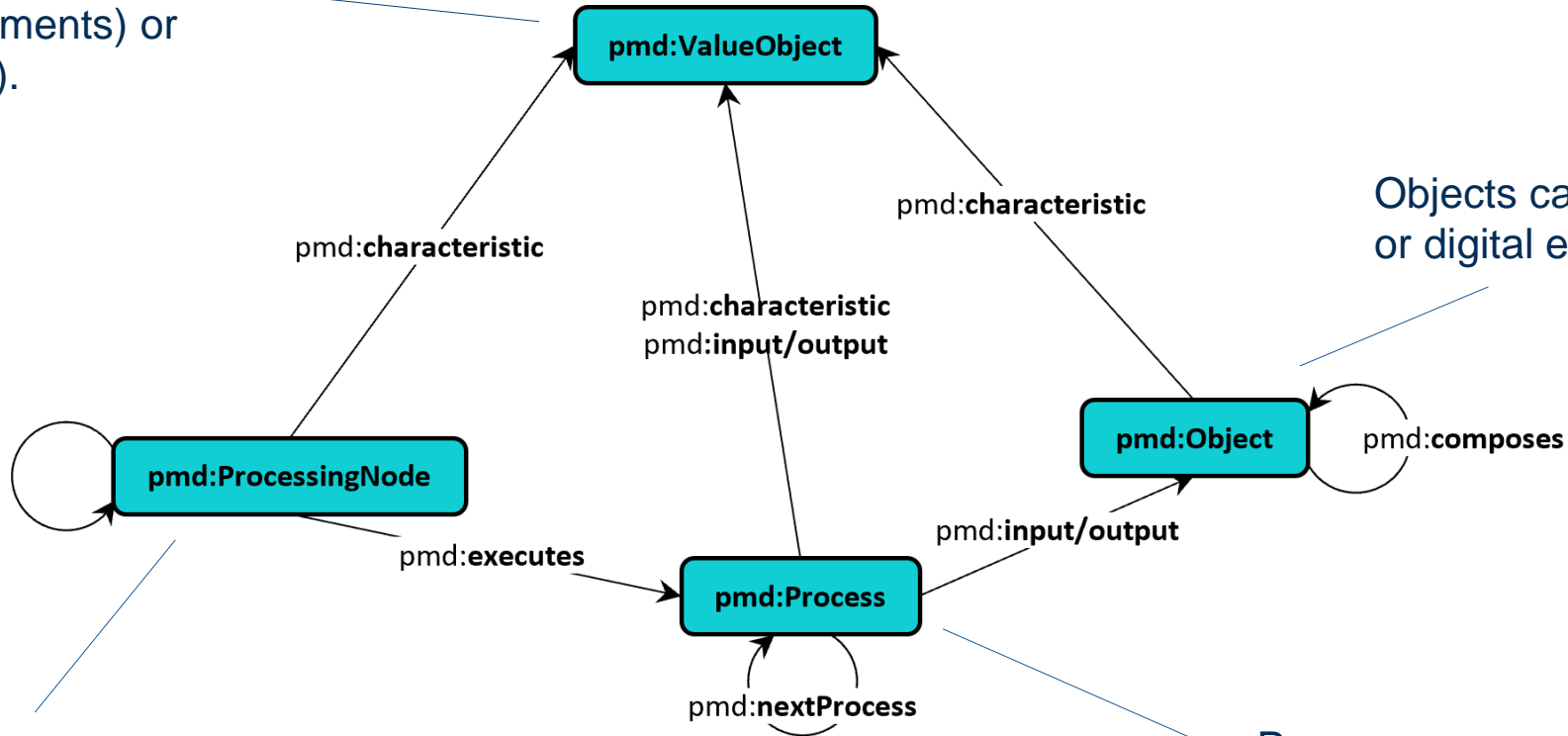


**Domain level**  
specific domain concepts



# PMDco - Essential Classes and Relations

Instances can be classified as Meta-, Primary or Secondary Data as well as Outputs (e.g., Measurements) or Inputs (e.g., Set Points).



Objects can be physical or digital entities.

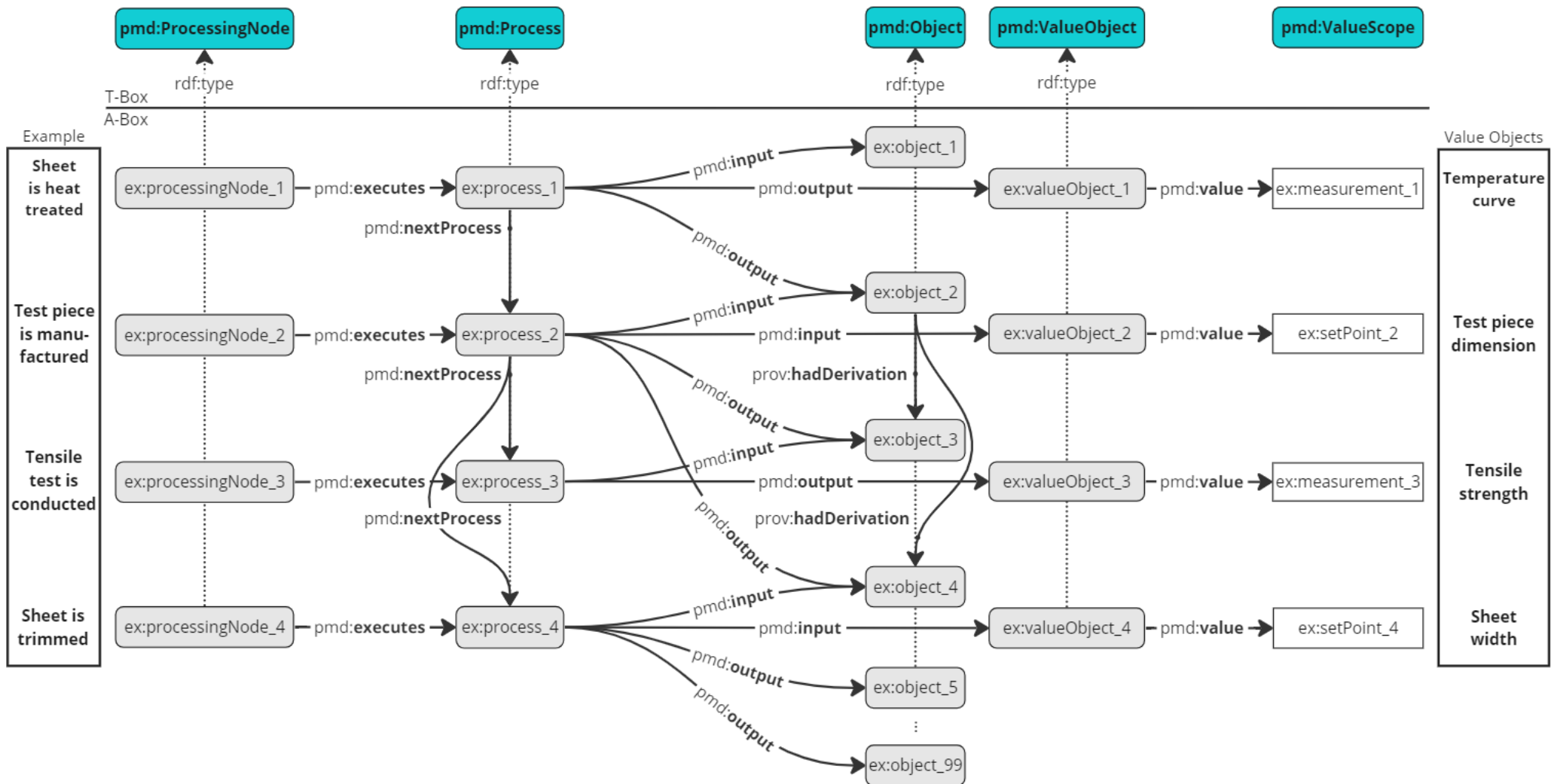
Processing nodes are facilitating components, such as machines, equipment, tools, accessories, ...

Processes are activities such as experiments, test methods, workflows, ...

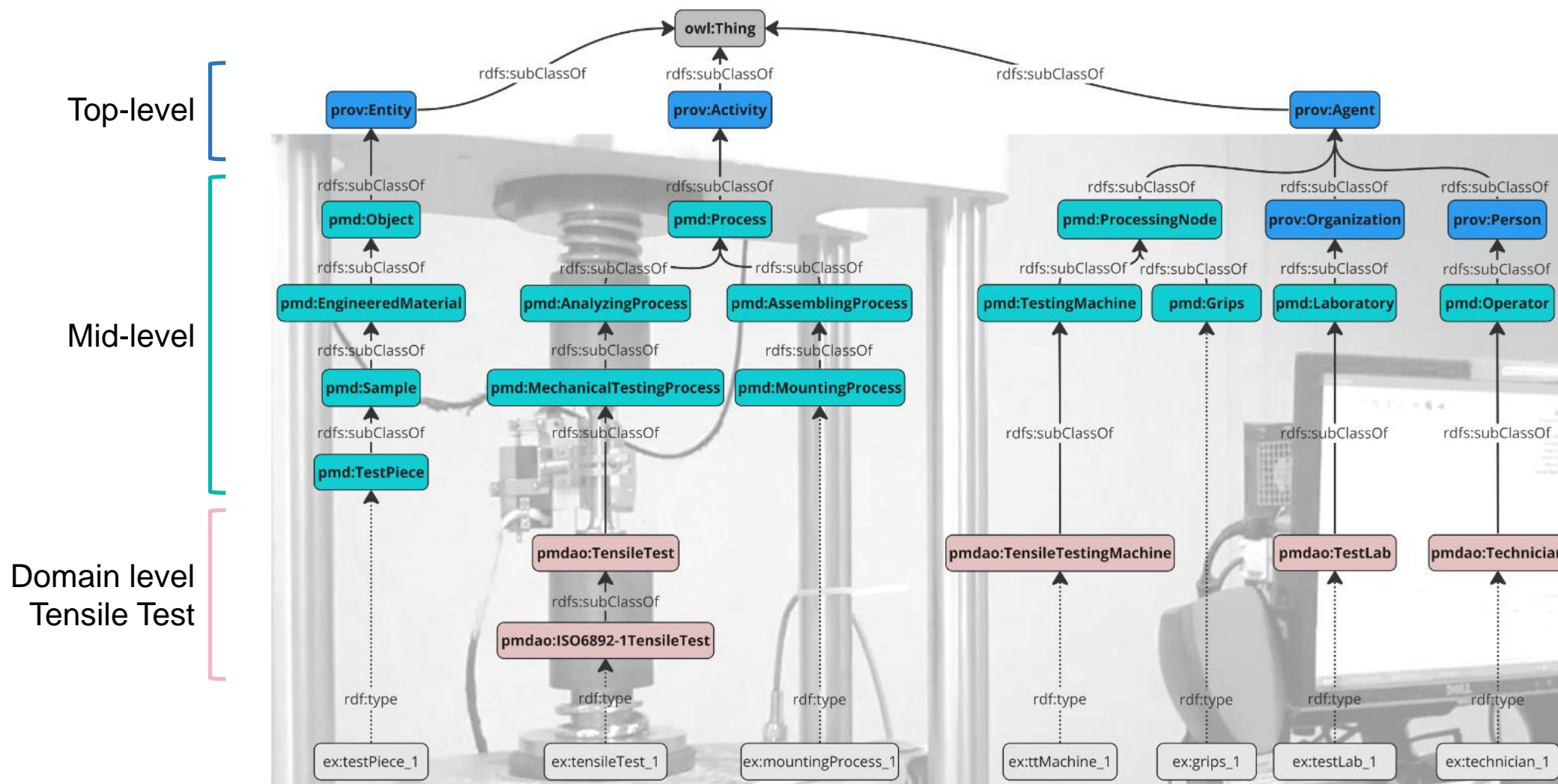




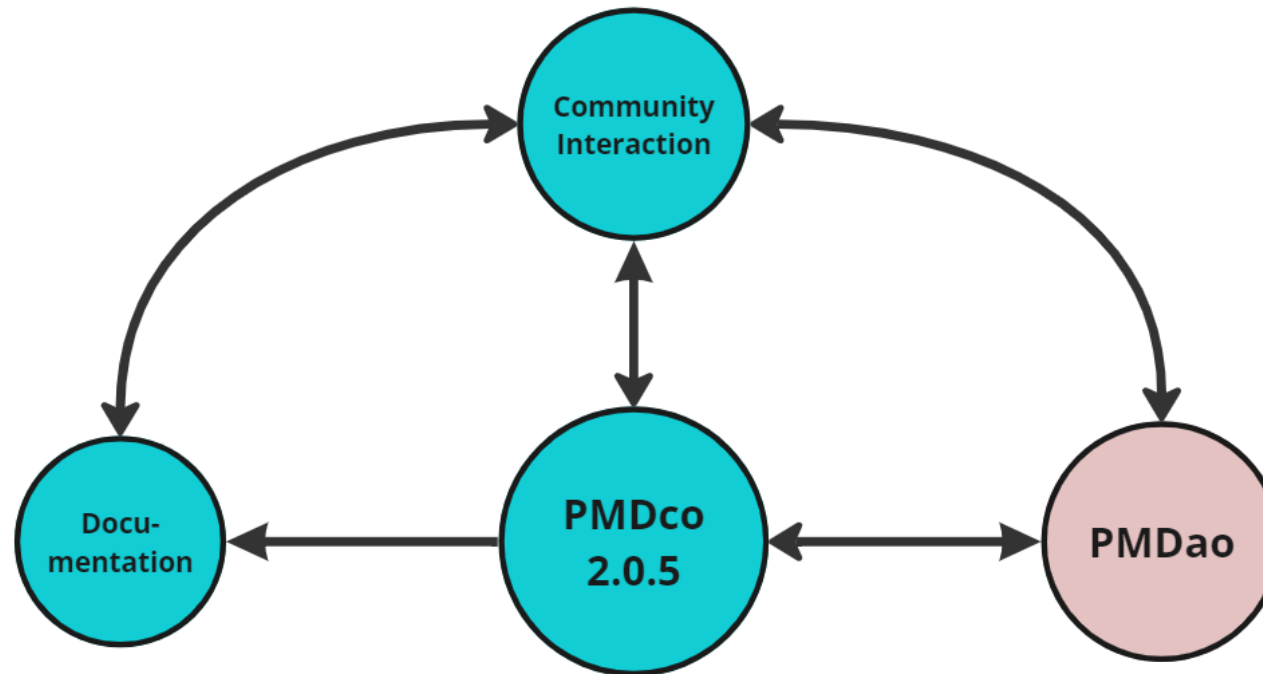
# PMDco – MSE Process Chain Modelling



# PMDao – Tensile Test Ontology



# Location: PMDco and PMDao



<https://github.com/materialdigital/core-ontology>



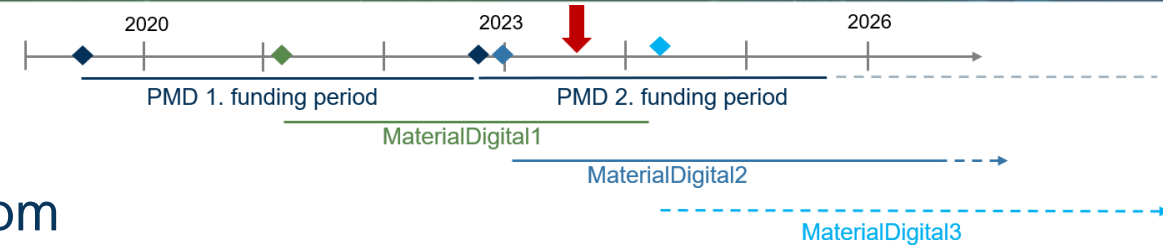
<https://github.com/materialdigital/application-ontologies>

## Tensile Test Ontology (TTO)





# PMD Ontology Playground



## Session format:

- Bi-weekly sessions, open to public, Fridays from 1-2 pm

## Target audience:

- Ontology practitioners and MSE domain experts

## Session activities:

- Currently: **Phase 1** projects "Show & Tell"
- Knowledge transfer
- Sharing PMDco user experiences
- Discussing modeling challenges
- Enhancing PMDco and extending its documentation via collaborative curation process



- **Achieve Semantic Interoperability**

*Ensure seamless data exchange and integration within MSE.*

- **Enhance Data and Process Quality**

*Improve data reliability and process, experiment, and digital workflow efficiency.*

- **Unify Knowledge Representation**

*Create a cohesive framework for organizing domain-specific information.*

- **Support Data Sharing and Data-driven Research**

*Facilitate collaborative research and access to valuable data resources.*

- **Foster Collaborations**

*Encourage partnerships with other research projects for collective progress.*





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[www.materialdigital.de](http://www.materialdigital.de)

Join in!



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