

Cluster of Excellence (Internet of Production): Proposed Ontology for Digital Shadows from Theory to Practice

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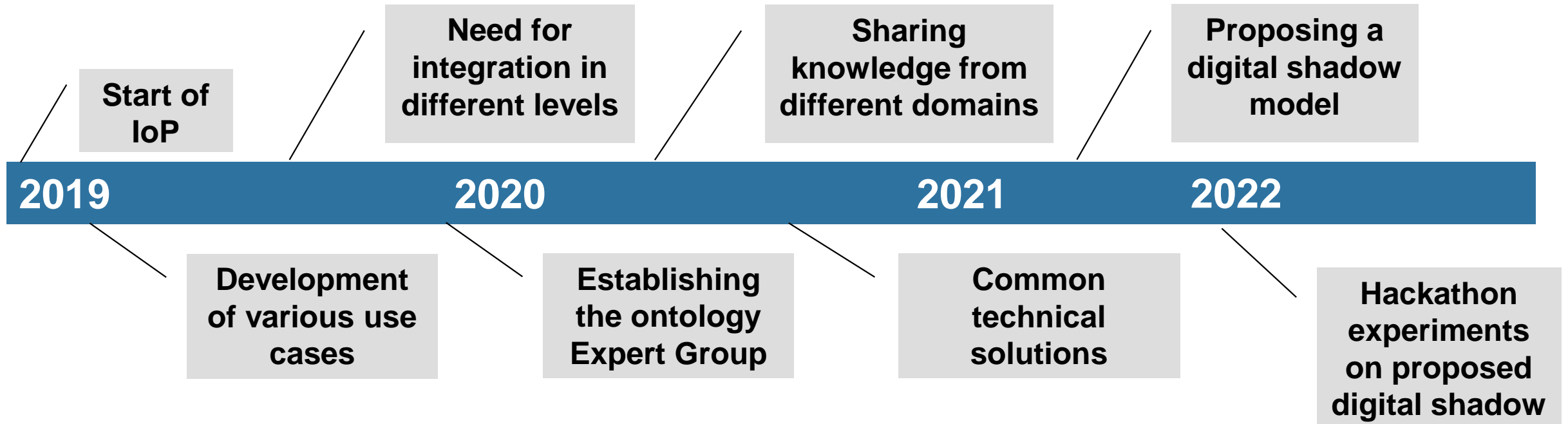
Agenda

- 1** General information
- 2** Digital shadow
- 3** Hackathon activities
- 4** Conclusion and next steps

Ontology Expert Group: General Information

- Established ~2 year ago
- ~30 members from Cluster of Excellence Project
- Main activities:
 - Providing infrastructure for the digital shadow in internet of production
 - Published in ER 2021
 - Application of the provided infrastructure in different use cases
 - Production planning and control in injection molding
 - Shop floor use case
 - Process mining (use cases extracted from SAP systems)
 - Textile domain
 - Laser manufacturing
 - Hackathon activities:
 - Data lifting
 - Querying
 - Validation
 - Knowledge graphs

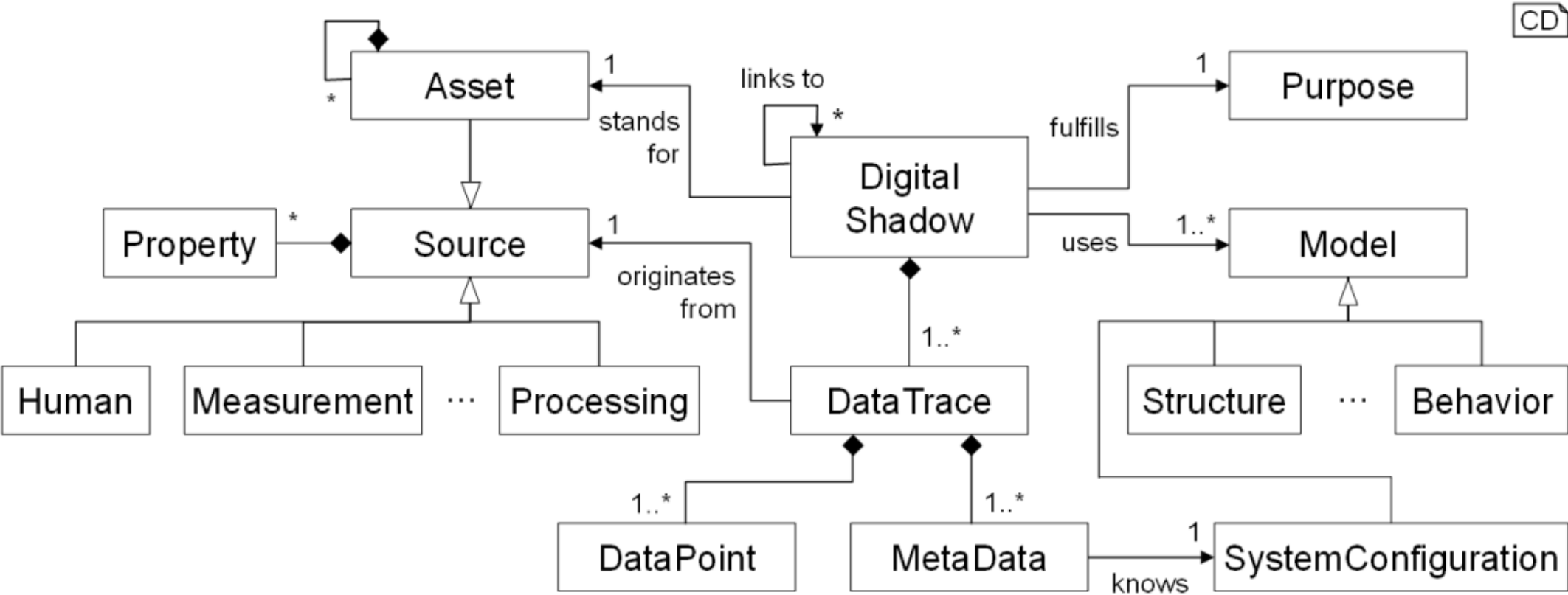
Ontology Expert Group: General Information



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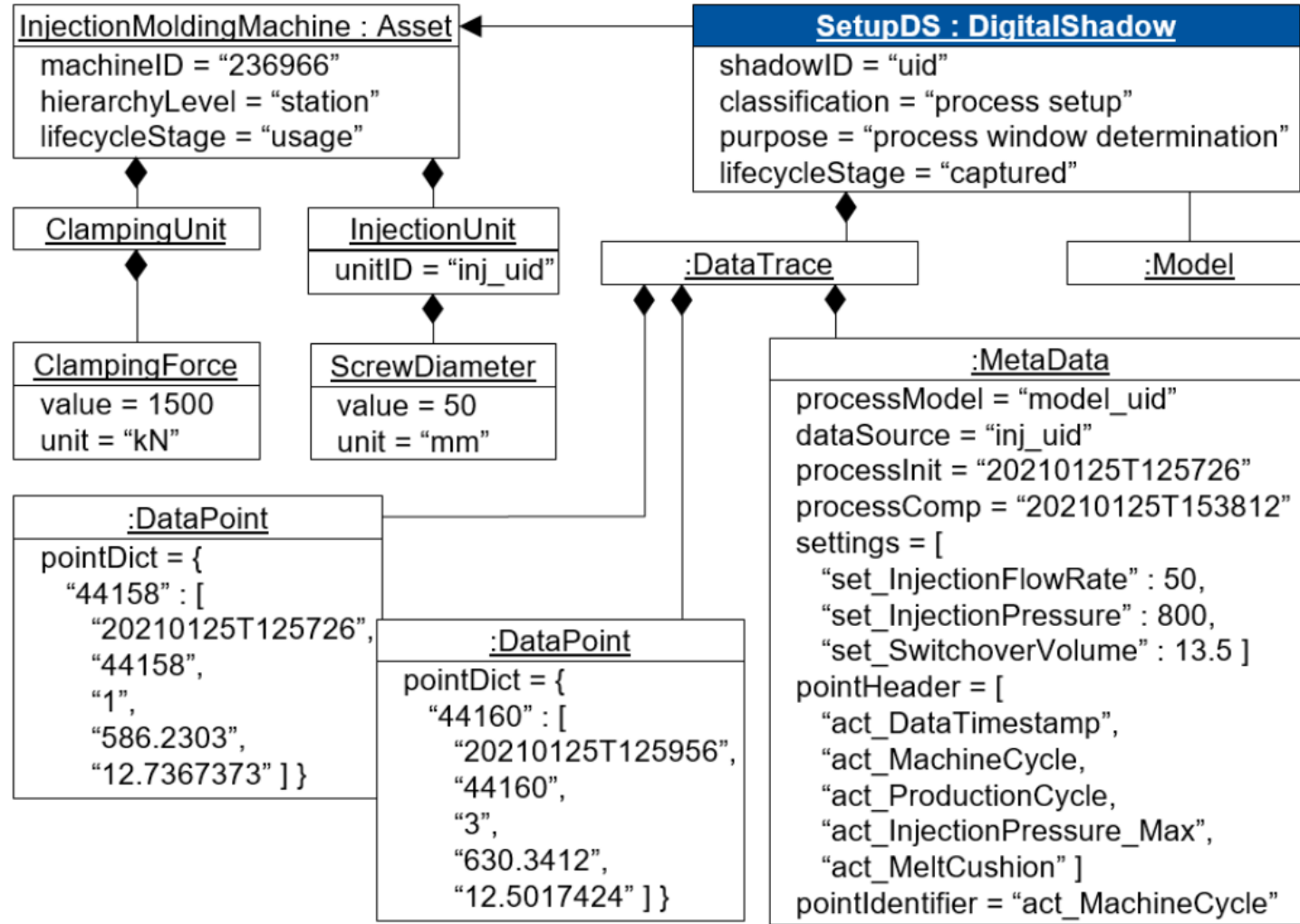
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Proposed Digital Shadow



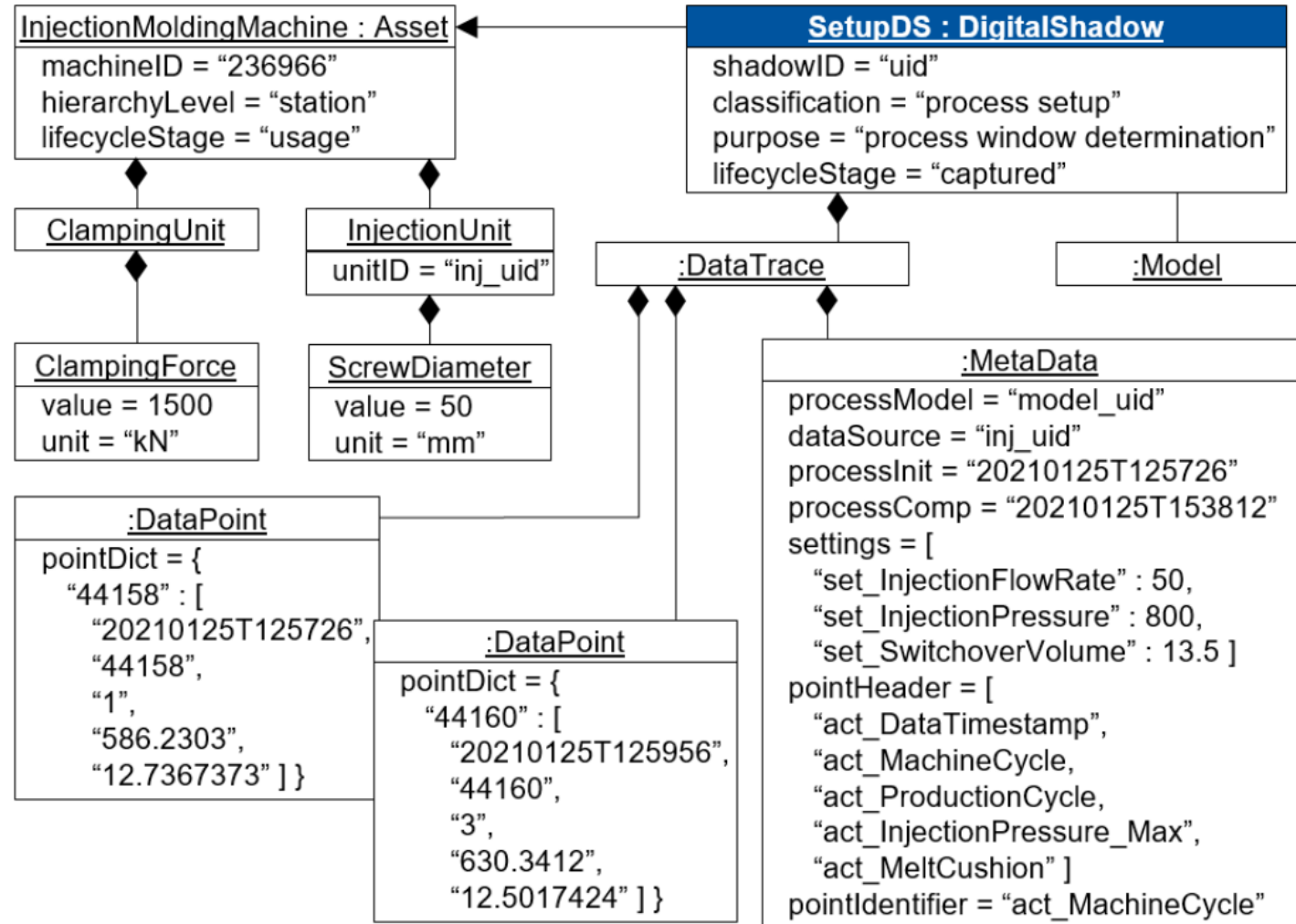
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Structure of an Instantiated DS Object in Injection Molding



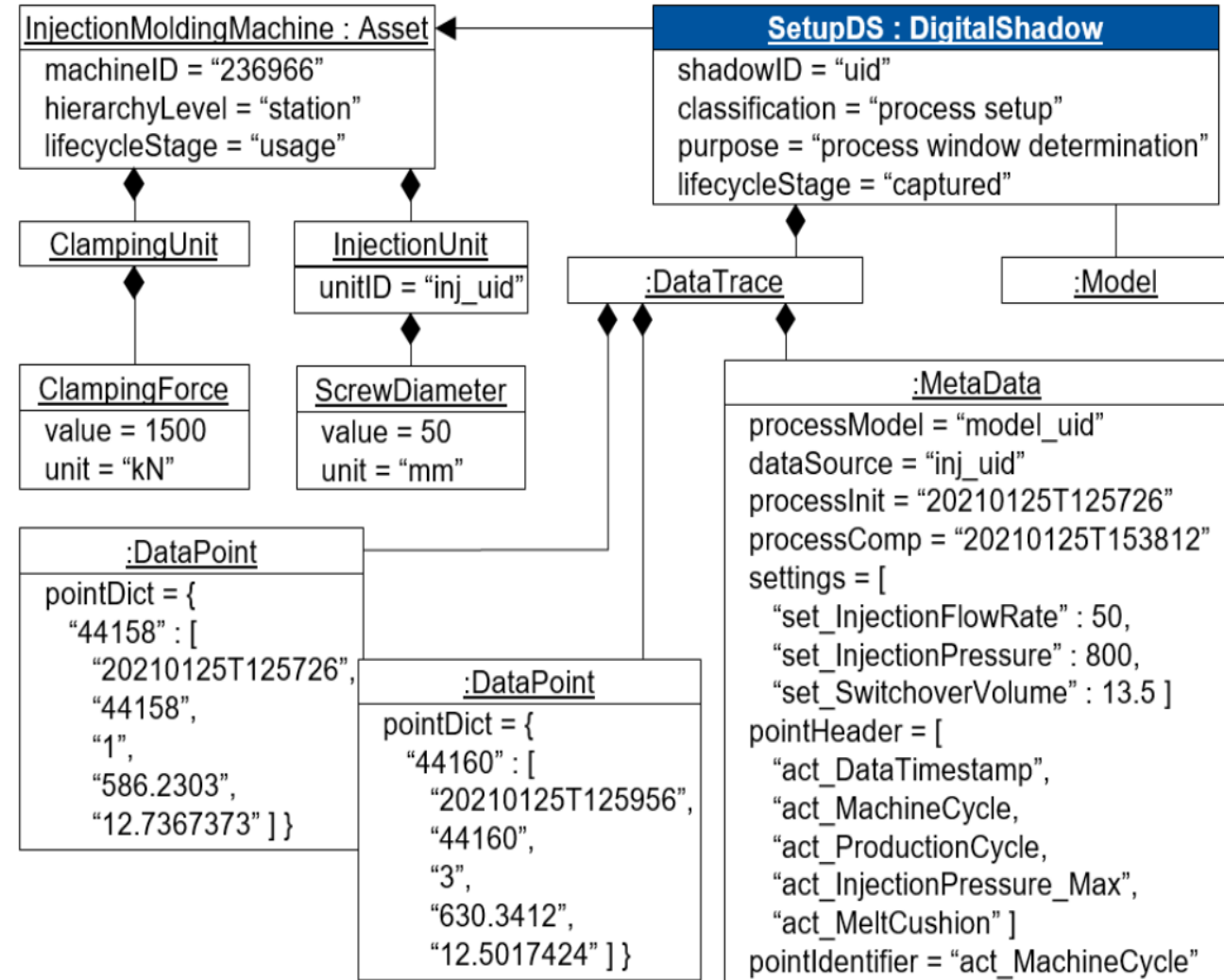
Structure of an Instantiated DS Object in Injection Molding

- **Asset:** An asset is an item, thing or entity that has potential or actual value to an organization. Each DS is associated with exactly one asset which represents the described system.
- **Source:** Each DataTrace must be associated with one distinct Source. A Source is composed of any number of defined properties. In our meta-model, the Asset is a Source.



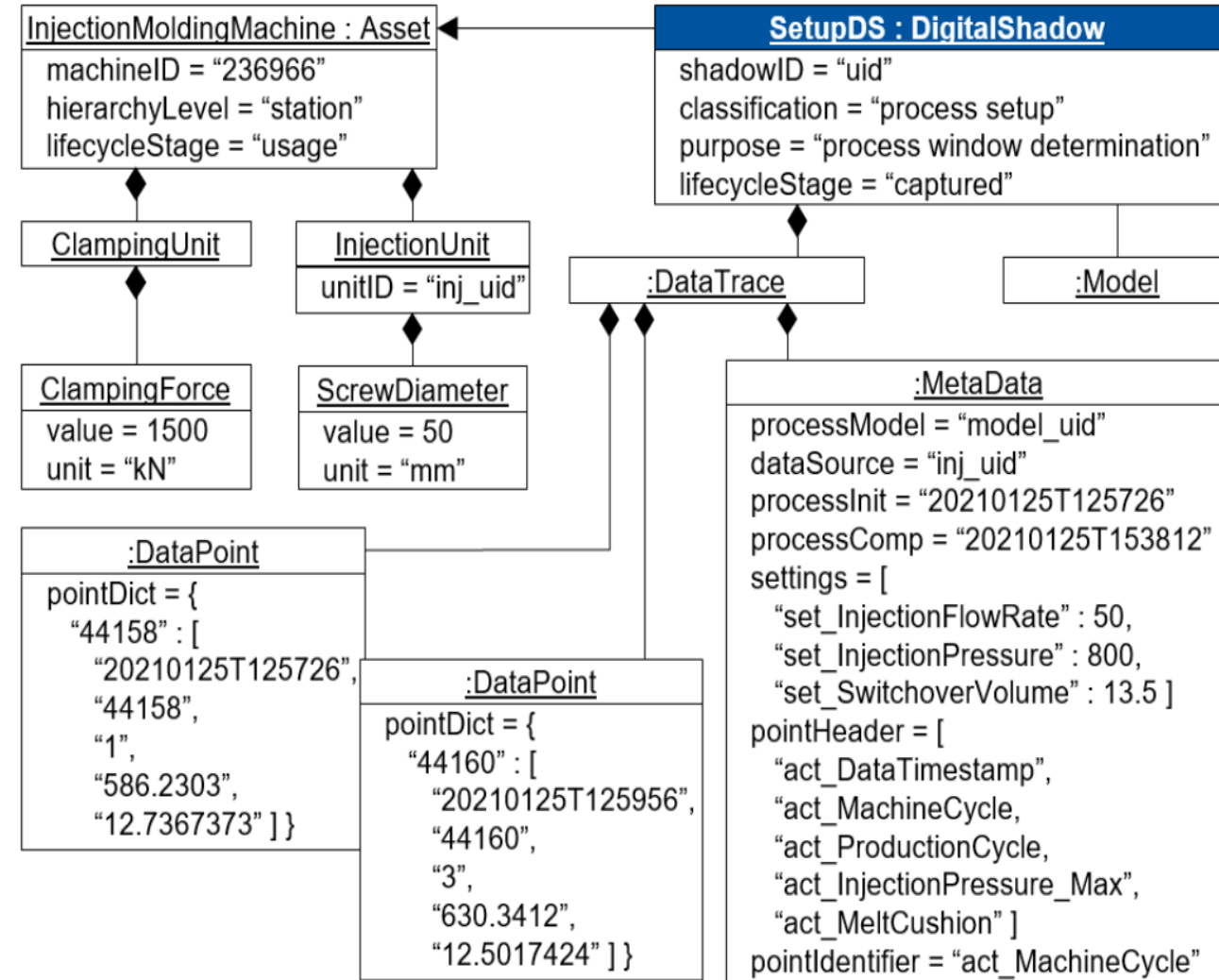
Structure of an Instantiated DS Object in Injection Molding

- **Data Trace.** The core element of the DS is data that describes the matter of concern about the given asset. The DS consists of contextualized Data Traces as a subset of accessible data consisting of one or more Data Points.
- **Data Point.** As elaborated above, the DS may consist of multiple Data Traces and subsequently, a multitude of Data Points that originate from several Sources.
- **Meta Data.** To enable contextualizing and interpreting the actual data of concern that describe a system's behavior, the DS itself as well as the Data Traces hold Meta Data.



Structure of an Instantiated DS Object in Injection Molding

- **Models.** Models are a central constituent of Digital Shadows. According to Stachowiak, models are reduced to the relevant aspects and abstract details of the original that have a pragmatism that lets them replace the original in certain scenarios.
- **Purpose.** Purpose in a general understanding is what the DS is supposed to do". DSs must be tailored to a specific Purpose.



Digital Shadow

The conceptual model can be used to reproduce digital shadows for a very wide range of practical use cases



Purpose

- Data and knowledge exchange
- Analysis and optimization



Main asset

- The product / the material / the machine
- Production system and its properties
- ERP and other IT systems
- Unique IoP-wide IDs for assets desired
- ...



Sources

- Often still manual access
- Databases, sensors, simulations, ...



Available data

- Heterogenous data formats
- Special programmes, software or tools required
- Data ownership so far often undefined



Behaviour of a DS

- Classification or event-notification capabilities in real-time monitoring, calculation, prediction
- Data-based reaction like a controller
- Learning shadow used for offline recommendations



Next steps: iterative refinements of meta model, technical implementation to enable queries and cross-use-case integration

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Hackathon Activities

- Data lifting:
 - Semantic mapping (per RML) of classical Data (e.g., JSON) to RDF output.
- Querying:
 - We will use Graph DB to do SPARQL queries to answer the questions that the data provider has.
- Validation:
 - The tool that we will work with is Shapes Constraint Language (SHACL) and its handy online validation tool. We can apply different constraints such as temperature range are applicable.
- Knowledge graphs

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Conclusion and Next Steps



- The ontology expert group is active for two year with ~ 30 participants
- The Digital Shadow meta model was published in ?
- Digital Shadow ontology to integrate all use cases



- Continuous improvement and further evaluation of DS meta model
- Technical implementation and use cases integration
- How can we model processes with multiple case notions?