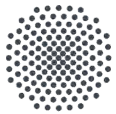


Universität Stuttgart

Metadata

In the engineering sciences

Dorothea Iglezakis

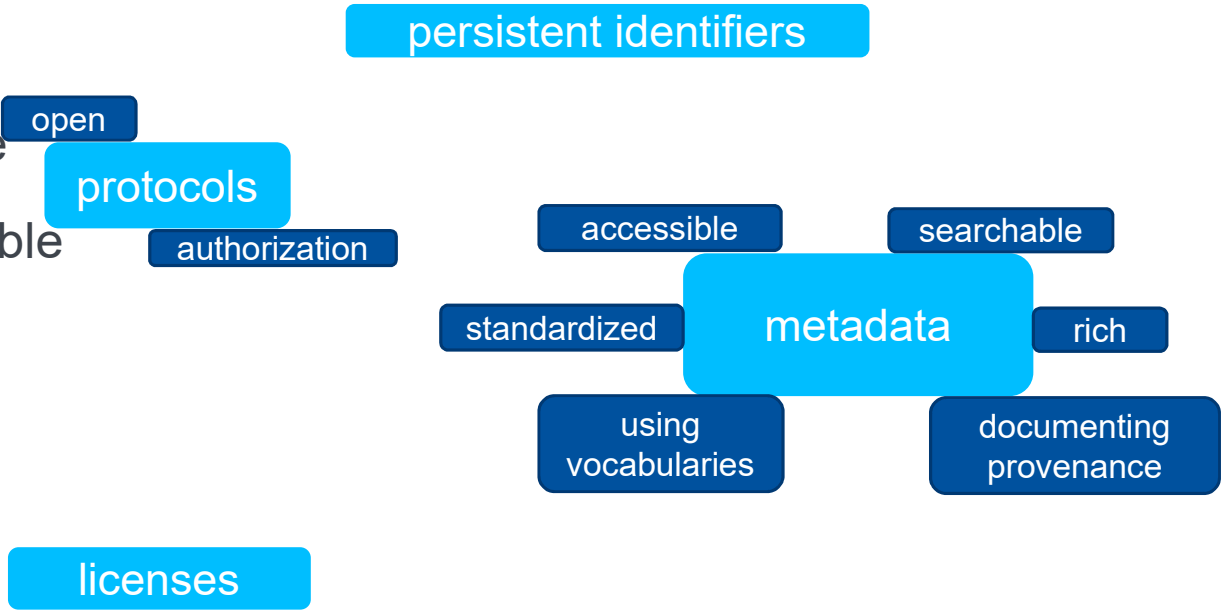
„Wouldn‘t it be great if we would be able to combine any dataset with any other dataset we would want to?“

EOSC Strategic Implementation Plan, p.4

FAIR data

Data should be:

- Findable
- Accessible
- Interoperable
- Reusable

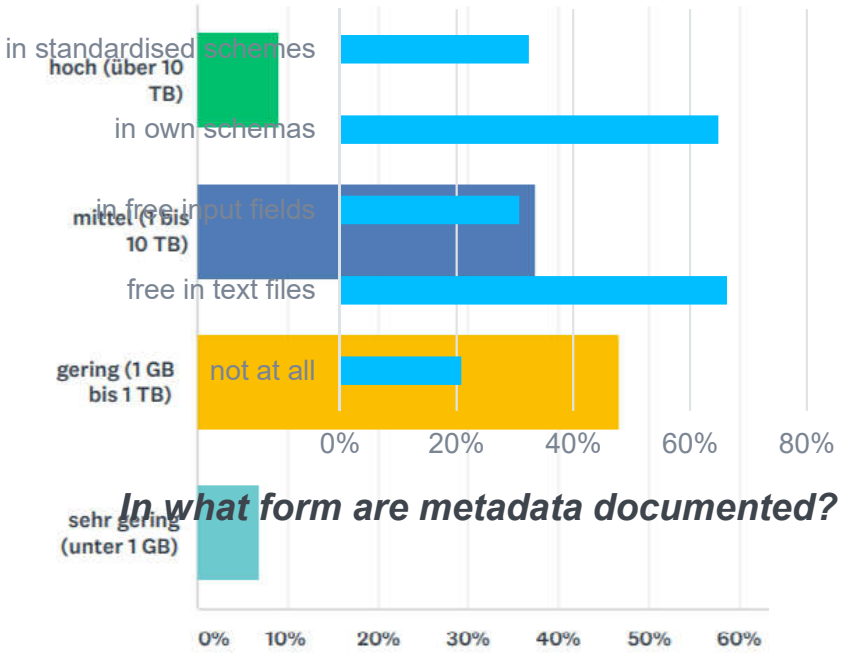


https://www.force11.org/group/fairgroup/fairprinciples

Challenges in the engineering sciences

Survey by NFDI4Ing (N = 618)

- Large amounts of data
- Great heterogeneity in objects of investigation, tools and methods
- High variability of examination setups
- Lack of schemes and standards



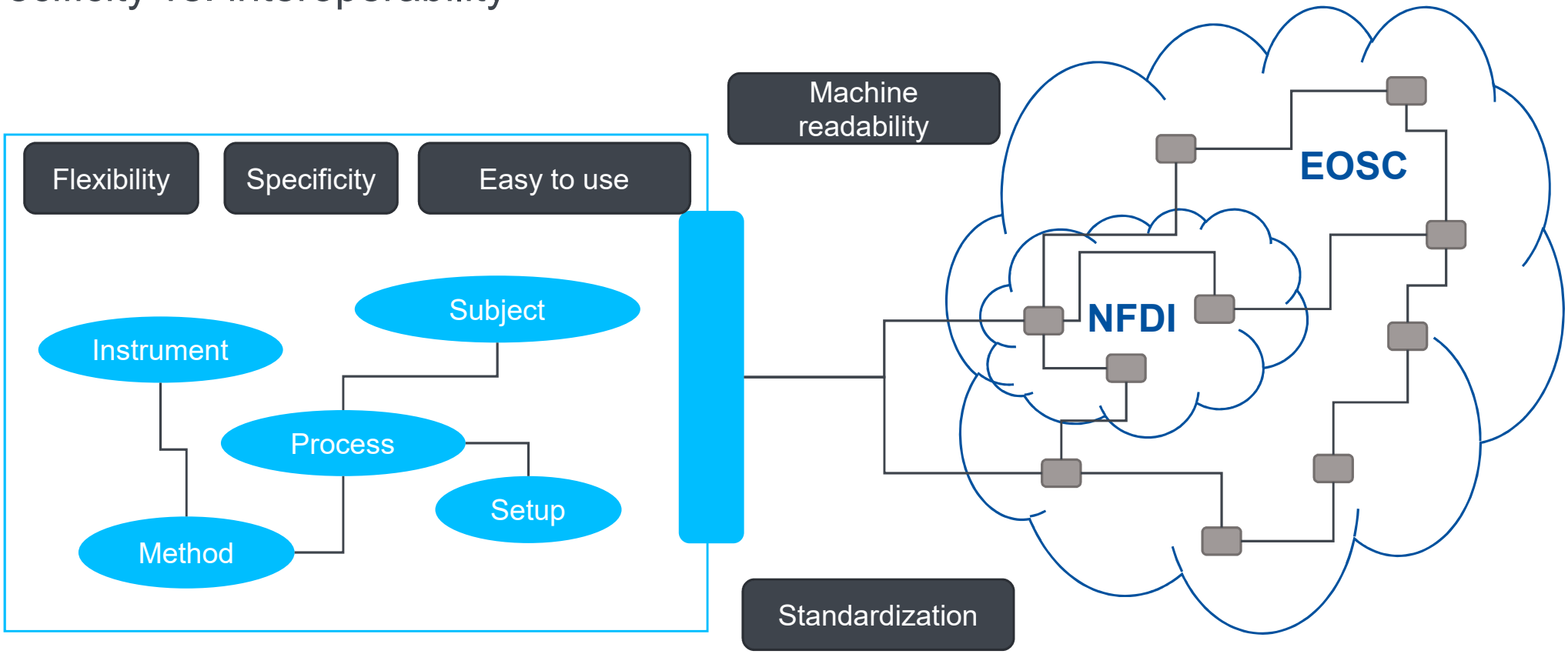
In what form are metadata documented?

Data volume per year and MA

Jagusch, G. W. & Preuß, N. (2019). *Survey data on "NFDI4Ing - Feedback from the research communities"*. doi: 10,25534/tudatalib-104

Requirements

Specificity vs. interoperability

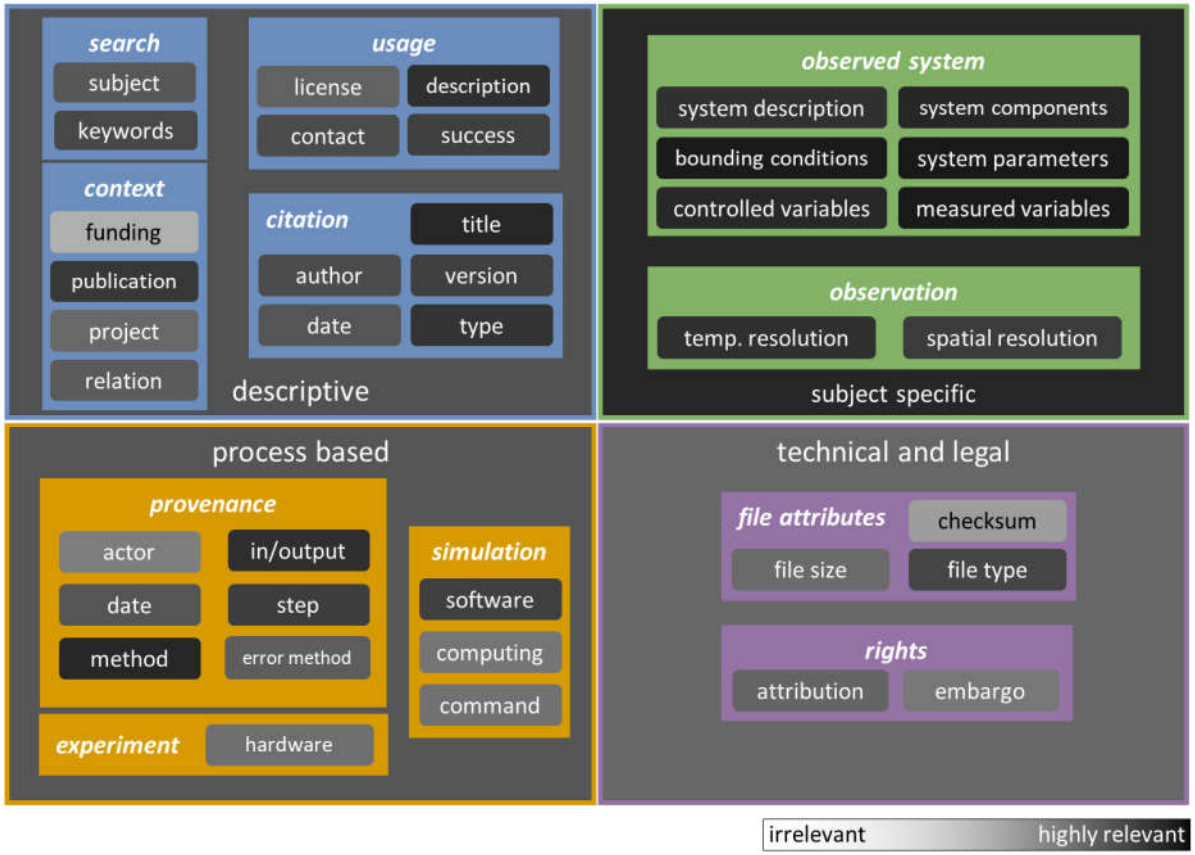


Describe your own research

global connectivity

What Information is Relevant for Engineers?

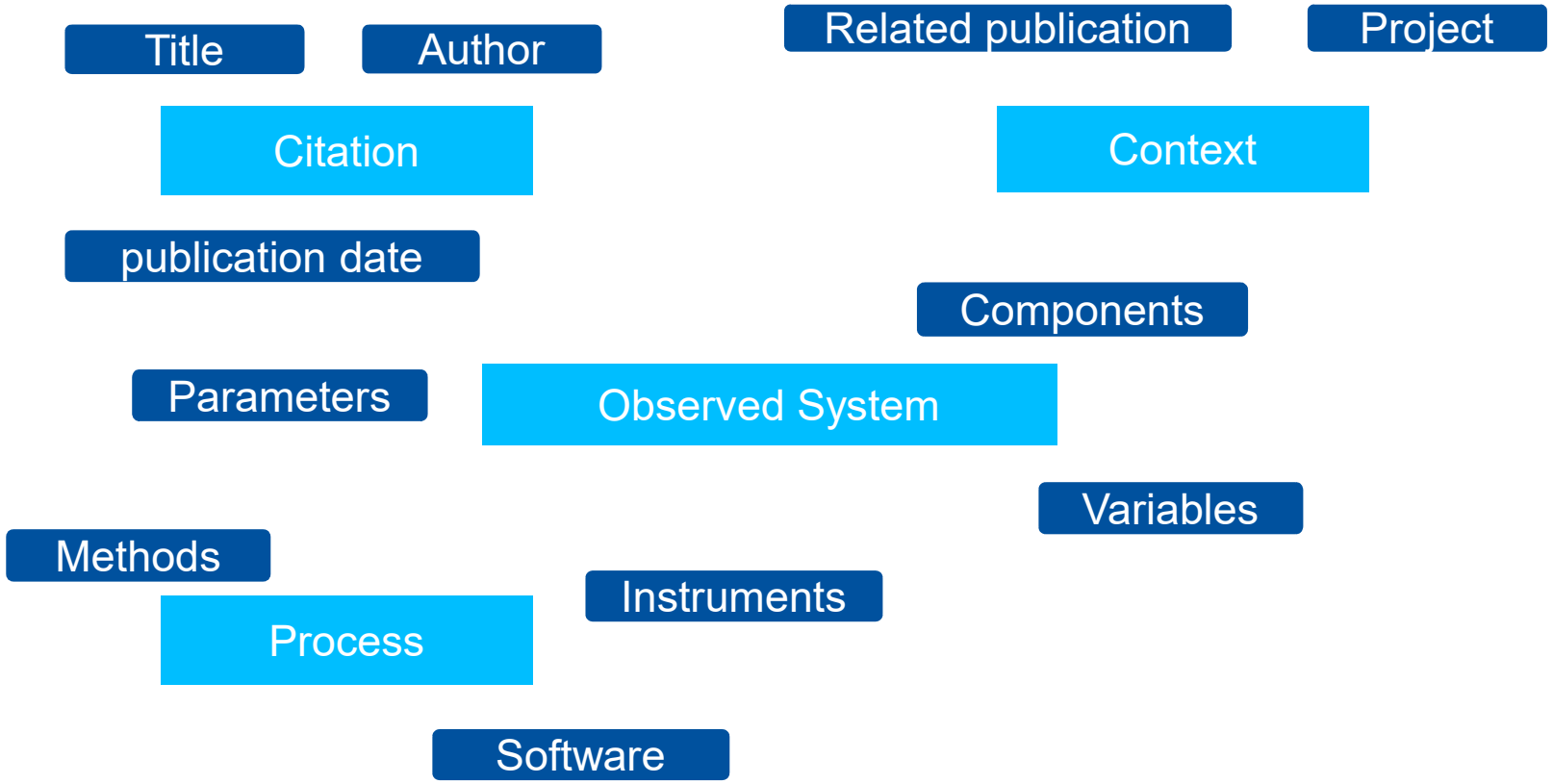
Survey at the University of Stuttgart (2019, N = 85 engineers)



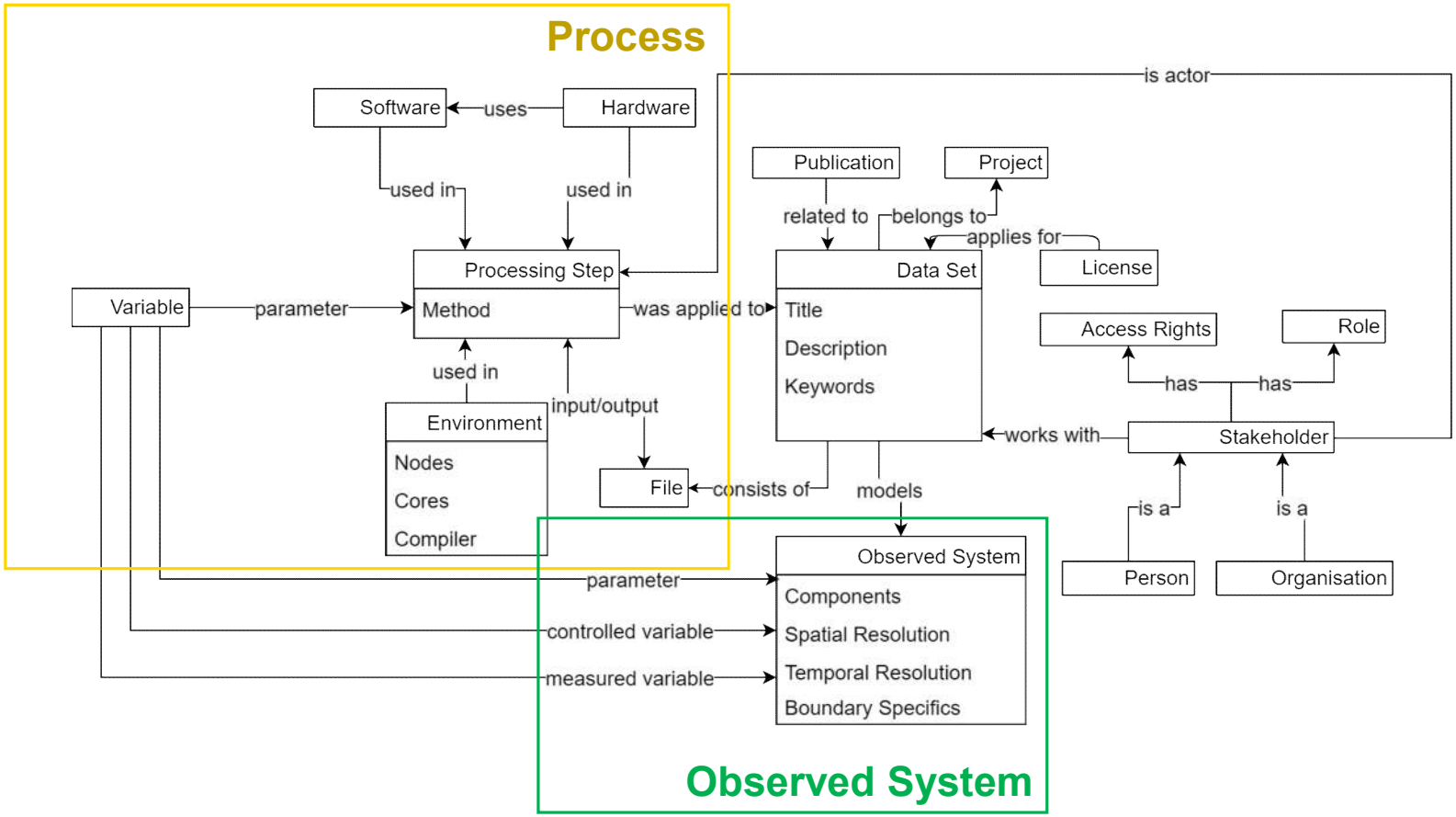
Schembera, B. & Iglezakis, D. (2020). EngMeta - Metadata for Computational Engineering. International Journal of Metadata, Semantics and Ontologies, 14, 26-38. doi: 10.1504/IJMSO.2020.107792

Metadata

Data about data

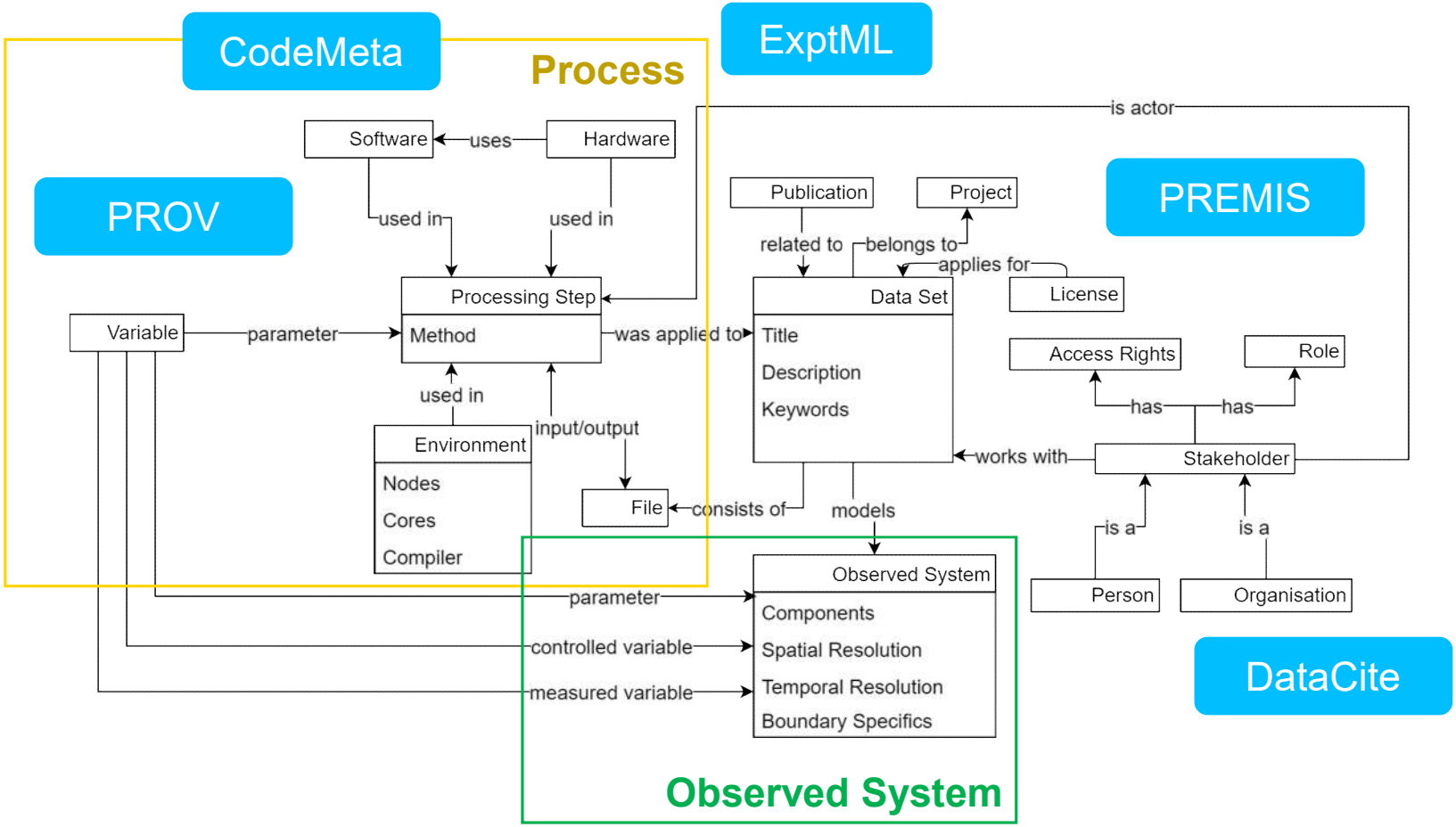


Content Model of EngMeta



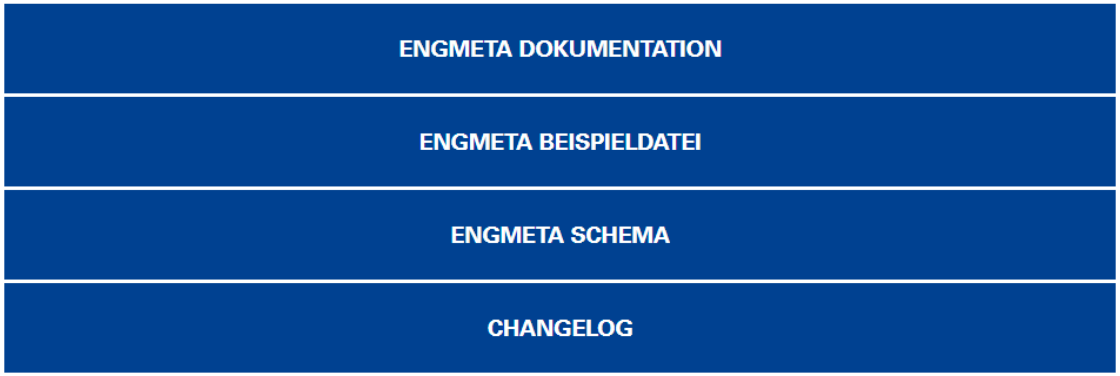
Content Model of EngMeta

Underlying Standards



EngMeta

Where to find it



Information: https://www.izus.uni-stuttgart.de/fokus/engmeta

XSD-Schema, Documentation, Examples: Iglezakis, Dorothea; Schembera, Björn, 2019, "EngMeta - a Metadata Scheme for the Engineering Sciences", https://doi.org/10.18419/darus-500, DaRUS, V1

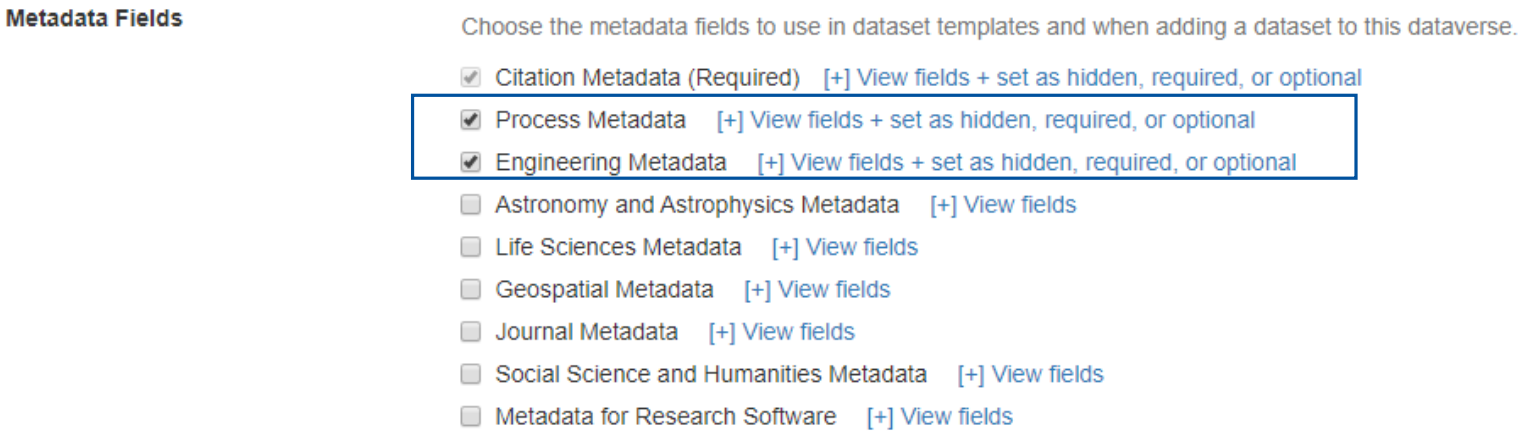
Publications: Schembera, B. & Iglezakis, D. (2020). EngMeta -- Metadata for Computational Engineering. *International Journal of Metadata, Semantics and Ontologies*, 14, 26-38.doi: 10.1504/IJMSO.2020.107792. Preprint: https://arxiv.org/abs/2005.01637

Schembera, B. & Iglezakis, D. (2019). The Genesis of EngMeta - A Metadata Model for Research Data in Computational Engineering. In E. Garoufallou, F. Sartori, R. Siatri & M. Zervas (eds.), *Metadata and Semantic Research* (p./pp. 127-132), Cham: Springer International Publishing. ISBN: 978-3-030-14401-2

EngMeta in Action

Implementation in DaRUS

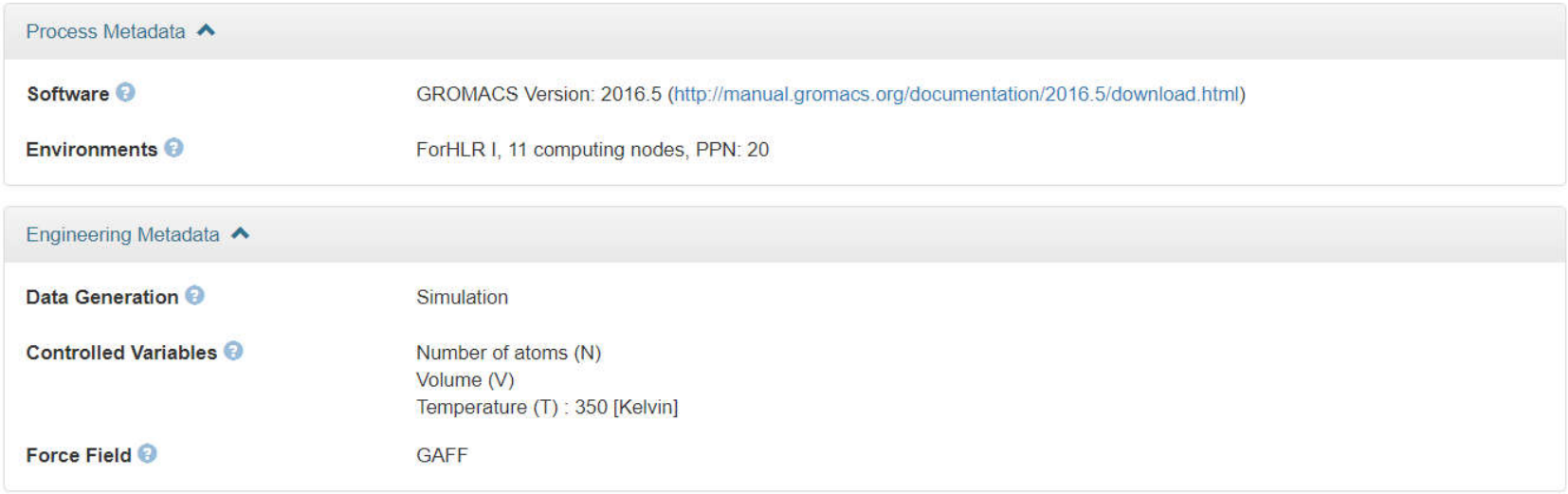
Data Repository of University of Stuttgart basing on the Open-Source-Software Dataverse with configurable metadata blocks



Seeland, Anett, 2020, "EngMeta Metadata Block Configuration for Dataverse", https://doi.org/10.18419/darus-508, DaRUS, V1

EngMeta in Action

Example: Simulation in Thermodynamics (doi:10.18419/darus-477)



EngMeta in Action

Experimental Data of Hardwood Boards (doi:10.18419/darus-863)

Process Metadata

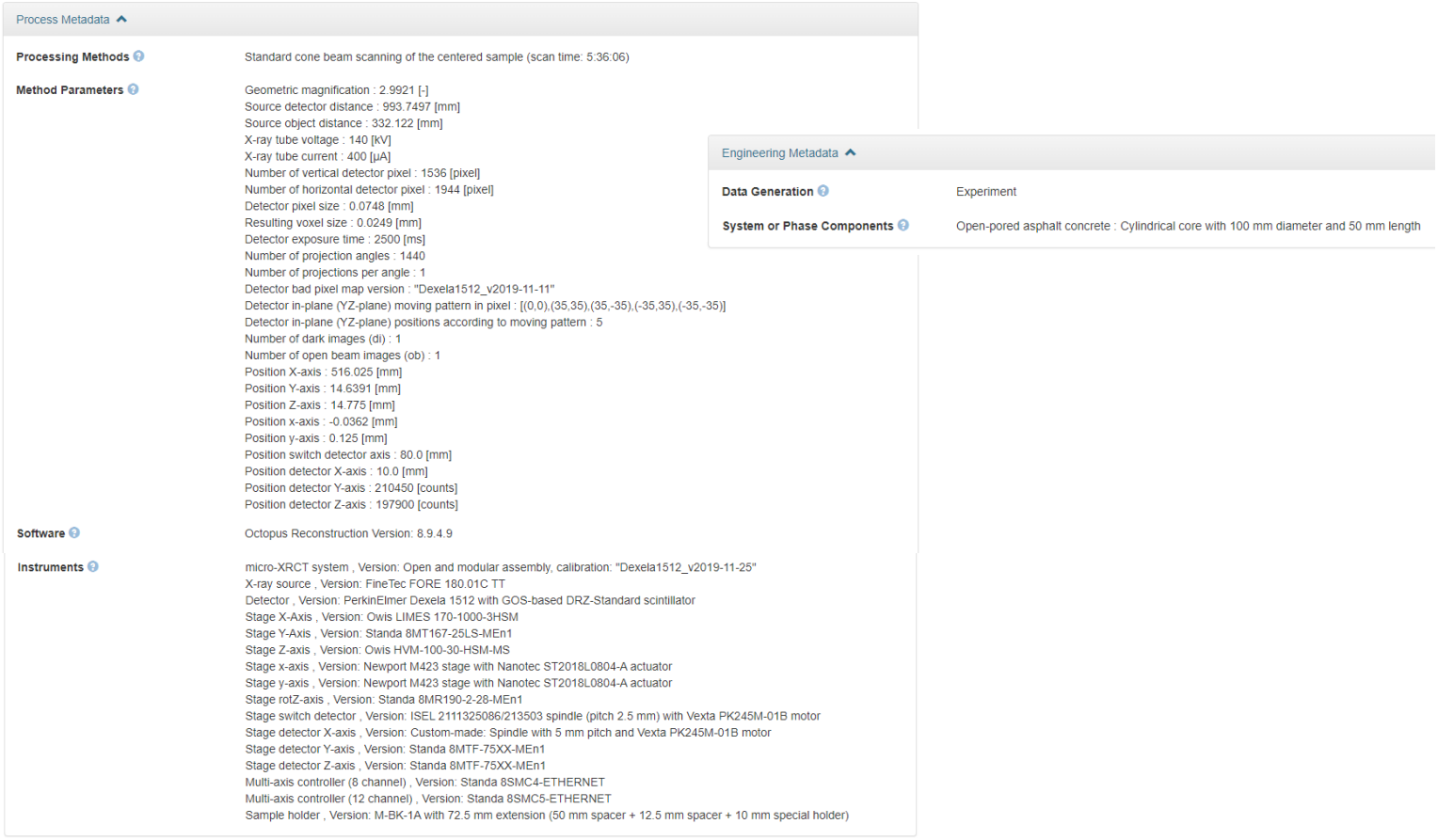
Processing Methods	Correction to 12% moisture content ; Parameters: Moisture content (The measured global and localized MOEs were corrected to a 12% moisture content according to EN 384 (2019).) Computation of MOEs (Linear regression between 10 kN and 30 kN. Mean value of both LVDTs was taken.)
Software	Python (Van Rossum, G., & Drake, F. L.. Python 3 Reference Manual. Scotts Valley, CA: CreateSpace (2009).) Version: 3.6 (https://www.python.org/) MIT NumPy (Stéfan van der Walt, S. Chris Colbert and Gaël Varoquaux. The NumPy Array: A Structure for Efficient Numerical Computation, Computing in Science & Engineering, vol. 13, no. 2, 22-30 (2011), DOI: 10.1109/MCSE.2011.37) Version: 1.17.3 (https://numpy.org/) MIT SciPy (Virtanen, P., Gommers, R., Oliphant, T.E. et al. SciPy 1.0: fundamental algorithms for scientific computing in Python. Nat Methods 17, 261–272 (2020), DOI: 10.1038/s41592-019-0686-2) Version: 1.2.1 (https://scipy.org/) MIT

Engineering Metadata

Data Generation	Experiment
Measured Variables	Modulus of elasticity parallel to the fiber (E_t,0) [MPa] Clear Wood Area Ratio (CWAR) [--] : 0 : 1 Density (ρ) [kg/m³]
Controlled Variables	Moisture content (MC) [%]
Spatial Resolution	15 cells X: 15 points, mm X: (100),

EngMeta in Action

Micro-XRCT-Data of Open-Pored Asphalt Concrete (doi:10.18419/darus-639)



Process Metadata

Processing Methods	Standard cone beam scanning of the centered sample (scan time: 5:36:06)
Method Parameters	Geometric magnification : 2.9921 [-] Source detector distance : 993.7497 [mm] Source object distance : 332.122 [mm] X-ray tube voltage : 140 [kV] X-ray tube current : 400 [µA] Number of vertical detector pixel : 1536 [pixel] Number of horizontal detector pixel : 1944 [pixel] Detector pixel size : 0.0748 [mm] Resulting voxel size : 0.0249 [mm] Detector exposure time : 2500 [ms] Number of projection angles : 1440 Number of projections per angle : 1 Detector bad pixel map version : "Dexela1512_v2019-11-11" Detector in-plane (YZ-plane) moving pattern in pixel : [(0,0),(35,35),(35,-35),(-35,35),(-35,-35)] Detector in-plane (YZ-plane) positions according to moving pattern : 5 Number of dark images (di) : 1 Number of open beam images (ob) : 1 Position X-axis : 516.025 [mm] Position Y-axis : 14.6391 [mm] Position Z-axis : 14.775 [mm] Position x-axis : -0.0362 [mm] Position y-axis : 0.125 [mm] Position switch detector axis : 80.0 [mm] Position detector X-axis : 10.0 [mm] Position detector Y-axis : 210450 [counts] Position detector Z-axis : 197900 [counts]
Software	Octopus Reconstruction Version: 8.9.4.9
Instruments	micro-XRCT system , Version: Open and modular assembly, calibration: "Dexela1512_v2019-11-25" X-ray source , Version: FineTec FORE 180.01C TT Detector , Version: PerkinElmer Dexela 1512 with GOS-based DRZ-Standard scintillator Stage X-Axis , Version: Owis LIMES 170-1000-3HSM Stage Y-Axis , Version: Standa 8MT167-25LS-MEn1 Stage Z-axis , Version: Owis HVM-100-30-HSM-MS Stage x-axis , Version: Newport M423 stage with Nanotec ST2018L0804-A actuator Stage y-axis , Version: Newport M423 stage with Nanotec ST2018L0804-A actuator Stage rotZ-axis , Version: Standa 8MR190-2-28-MEn1 Stage switch detector , Version: ISEL 2111325086/213503 spindle (pitch 2.5 mm) with Vexta PK245M-01B motor Stage detector X-axis , Version: Custom-made: Spindle with 5 mm pitch and Vexta PK245M-01B motor Stage detector Y-axis , Version: Standa 8MTF-75XX-MEn1 Stage detector Z-axis , Version: Standa 8MTF-75XX-MEn1 Multi-axis controller (8 channel) , Version: Standa 8SMC4-ETHERNET Multi-axis controller (12 channel) , Version: Standa 8SMC5-ETHERNET Sample holder , Version: M-BK-1A with 72.5 mm extension (50 mm spacer + 12.5 mm spacer + 10 mm special holder)

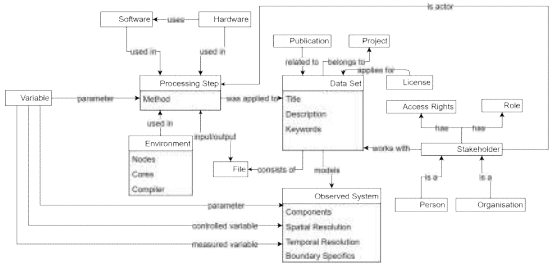
Engineering Metadata

Data Generation	Experiment
System or Phase Components	Open-pored asphalt concrete : Cylindrical core with 100 mm diameter and 50 mm length

Shortcomings of EngMeta

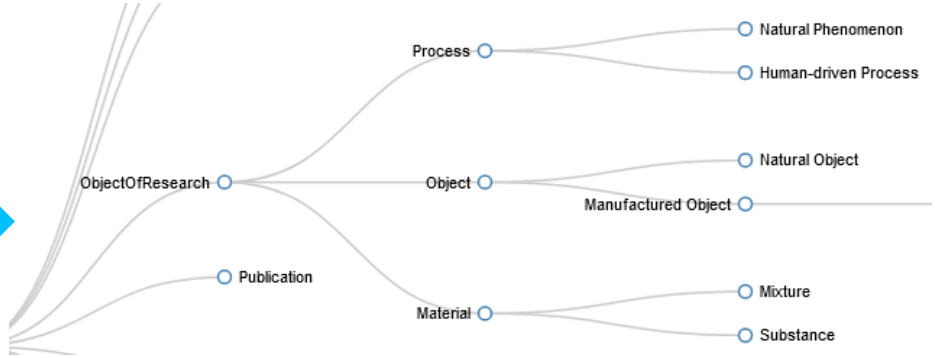
ENGMETA

- General description model
- Flexible, but not specific
- Standardizes the keys, but not the values (no controlled vocabularies)



METADATA4ING

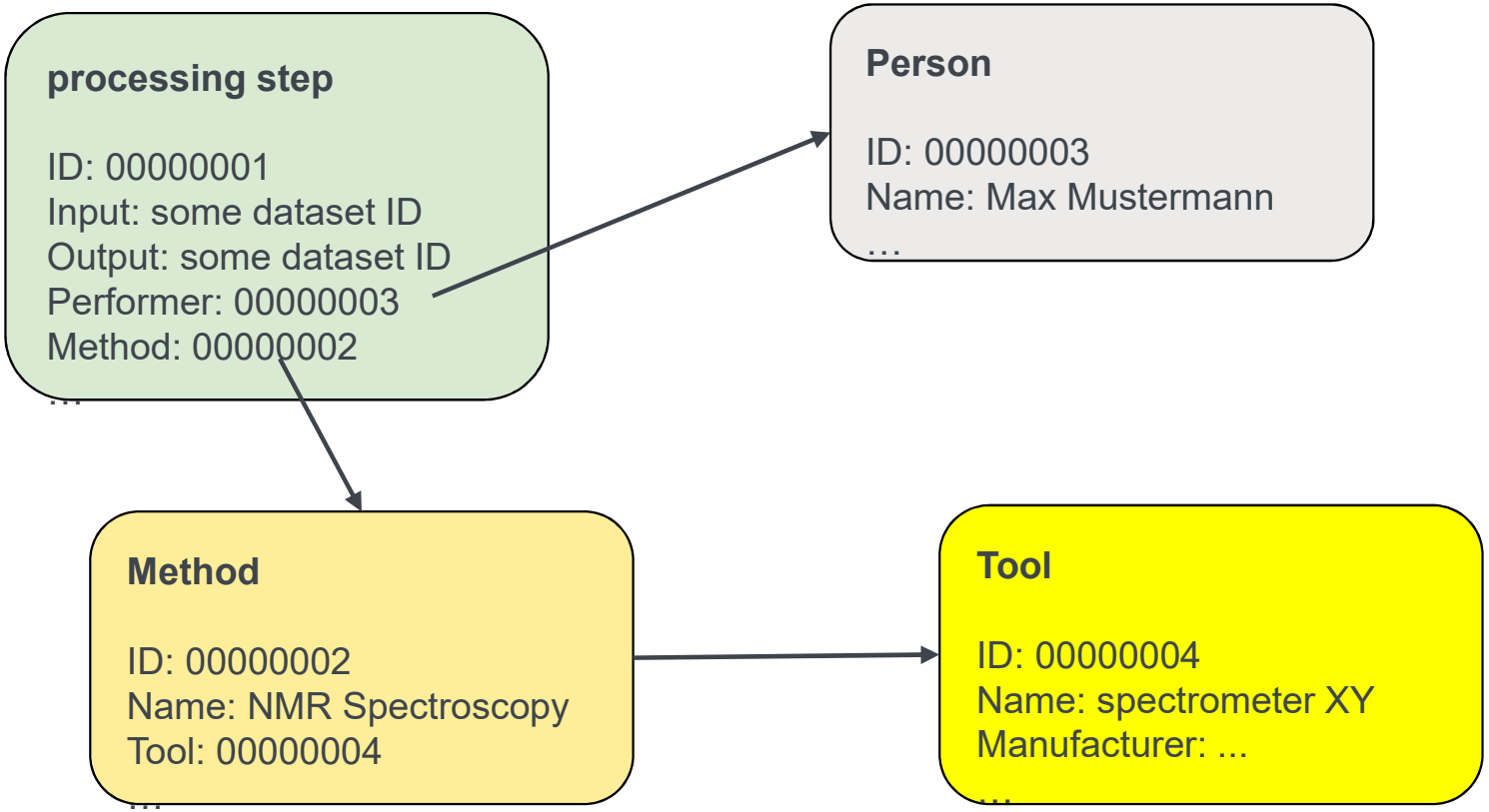
- Hierarchical Model



- Specific application profiles

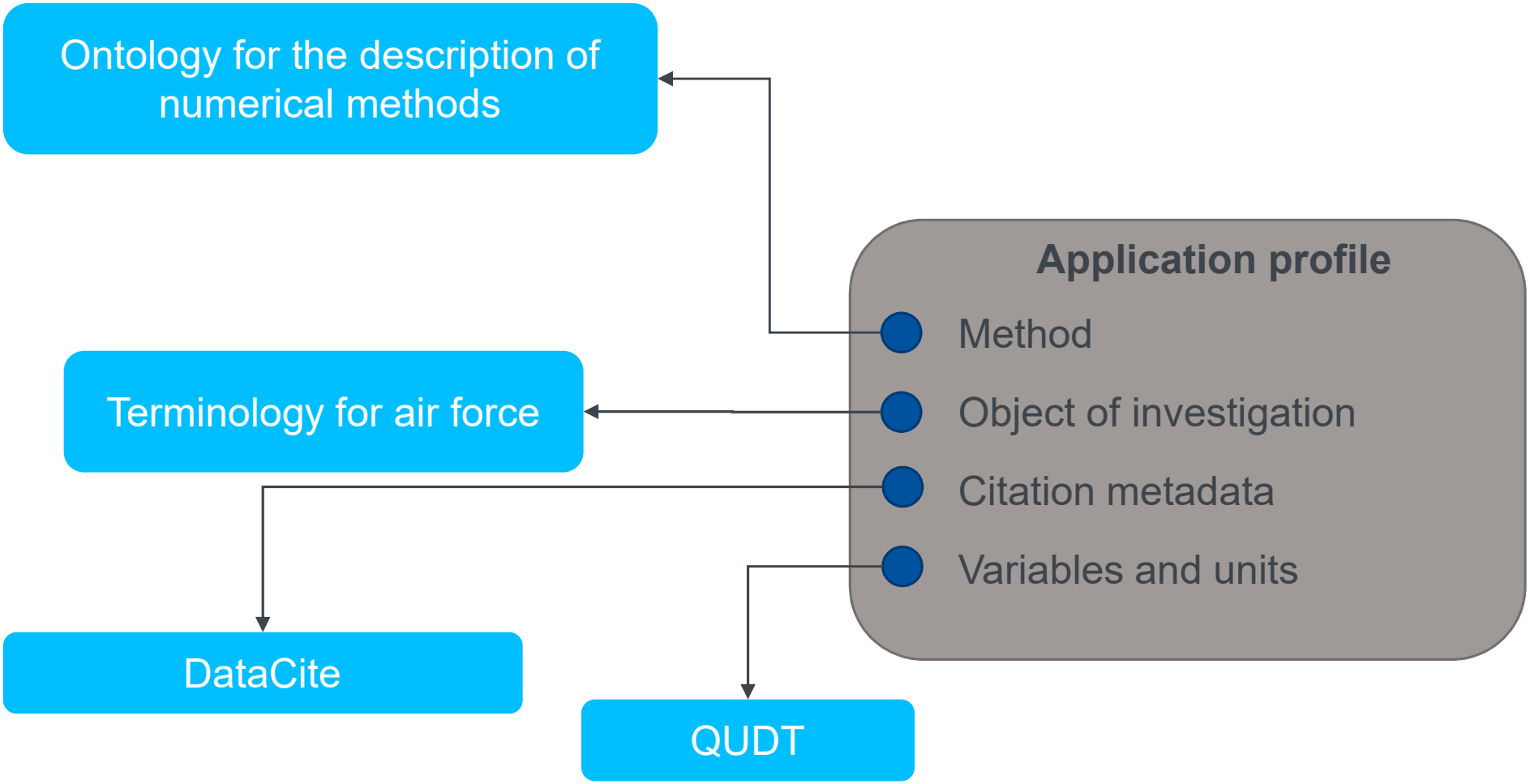
Idea (modularity, standardization)

Modular model of interconnected micro-schemes



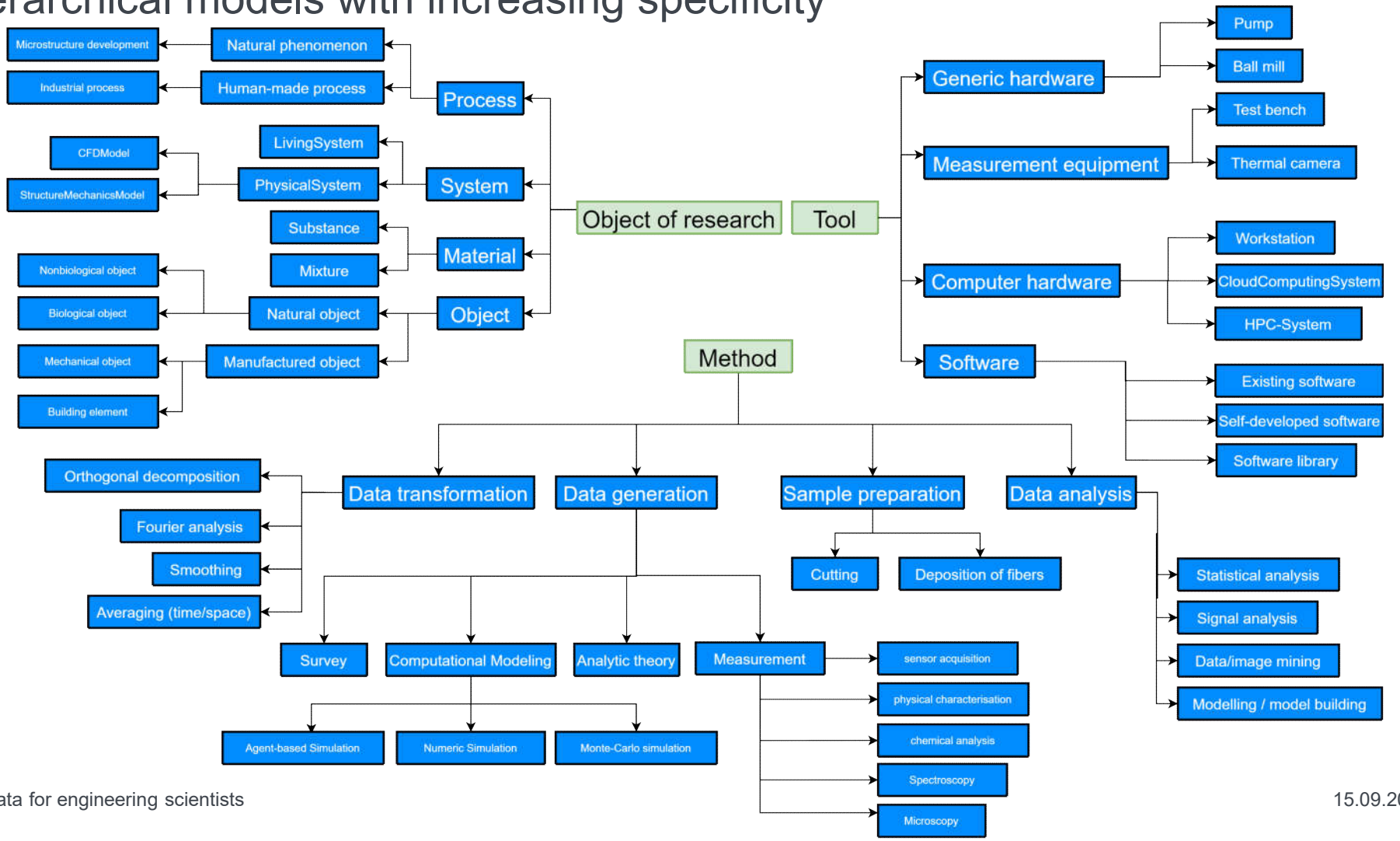
Idea (specificity, flexibility)

Individual composition of standardized components



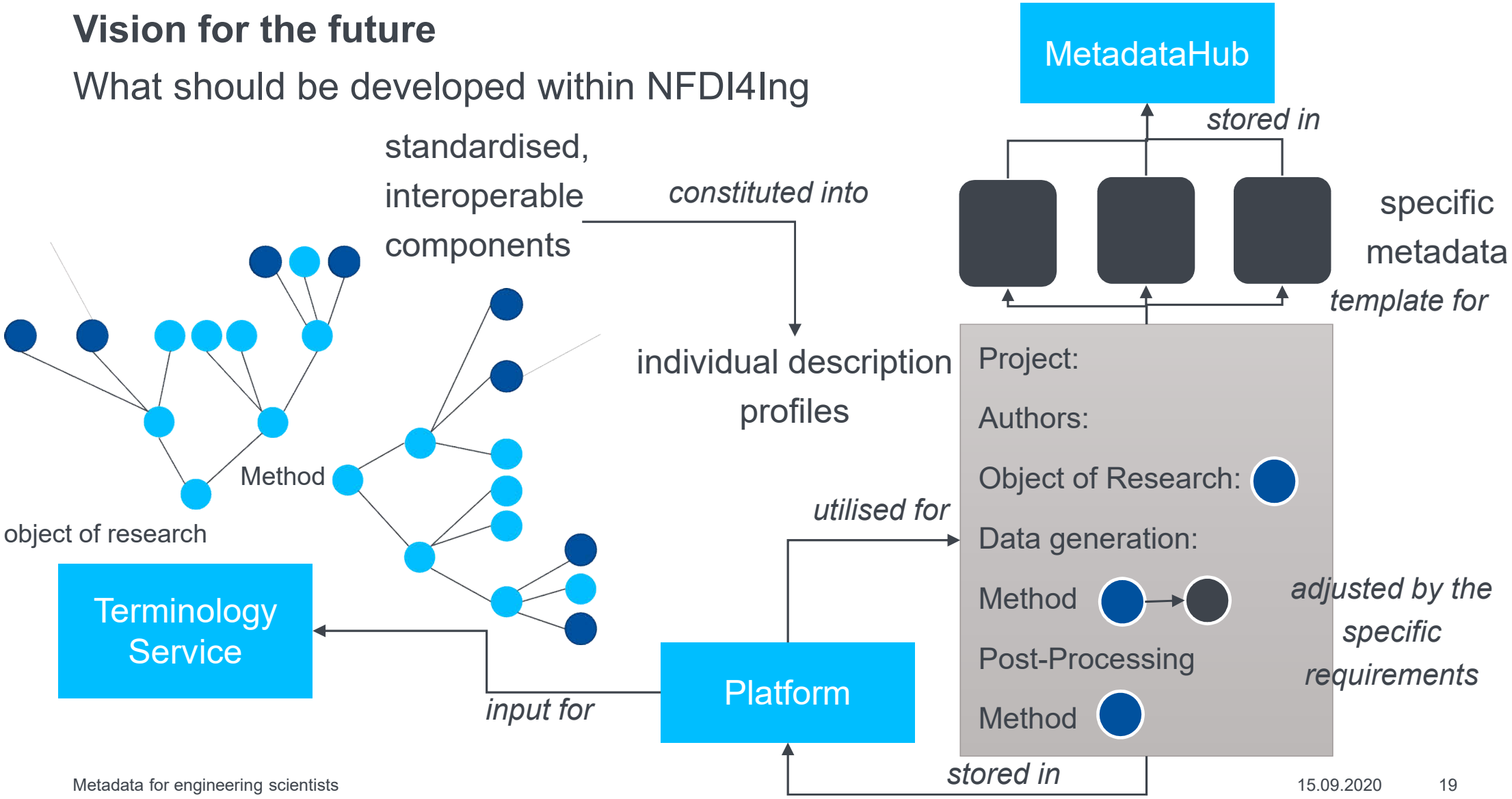
Idea (interoperability)

Hierarchical models with increasing specificity

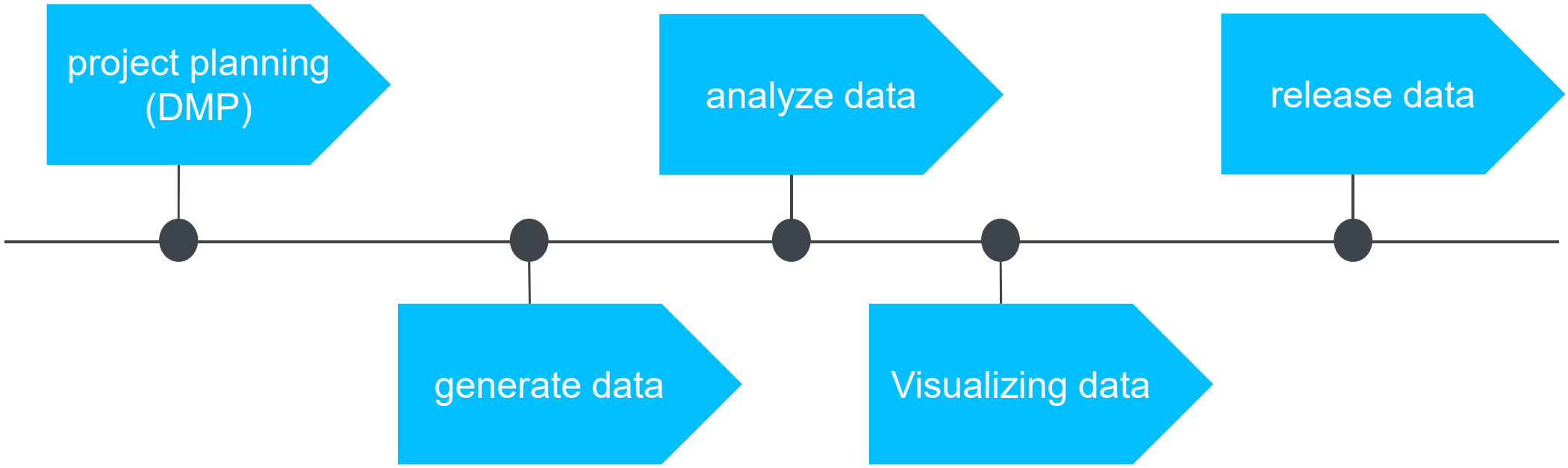


Vision for the future

What should be developed within NFDI4Ing



When do which metadata get to the data?



Contributors, project context, object of investigation

Used software and tools

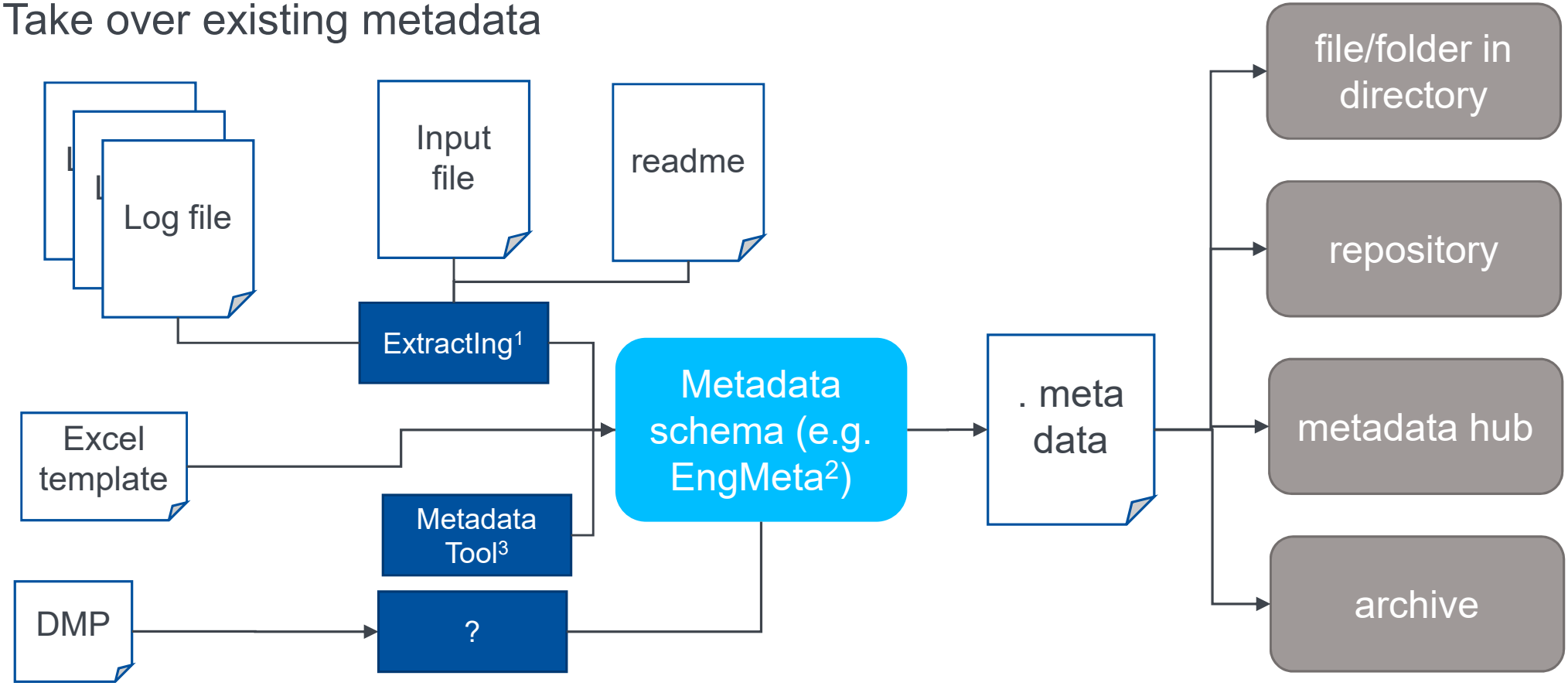
Variables collected

Used methods and parameters

License, Citation data, link to the paper

Automation of metadata collection

Take over existing metadata



1 https://github.com/bjschembera/ExtractIng

2 Iglezakis, D. & Schembera, B. (2019). EngMeta - a Metadata Scheme for the Engineering Sciences. Doi: 10.18419/darus-500

3 https://app.rwth-aachen.de/metadata/

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Vielen Dank!

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