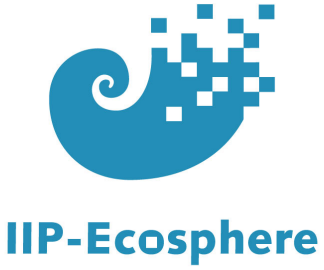

explAIn

Towards Explainability in Cyber-Physical Production Systems

(Touching on AI, MLOps, etc. along the way)

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Software Systems Engineering
University of Hildesheim

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Intelligent CPPS

In Industry 4.0 machine intelligence is a basic assumption.

We need:

- Foundations that are able to support AI applications for Industry 4.0 (IIP-Ecosphere ➔ Oktoflow platform)
- Deal with common problems that come together with AI
  ➔ Explain-project (MLOps, explainability)

Oktoflow-Platform

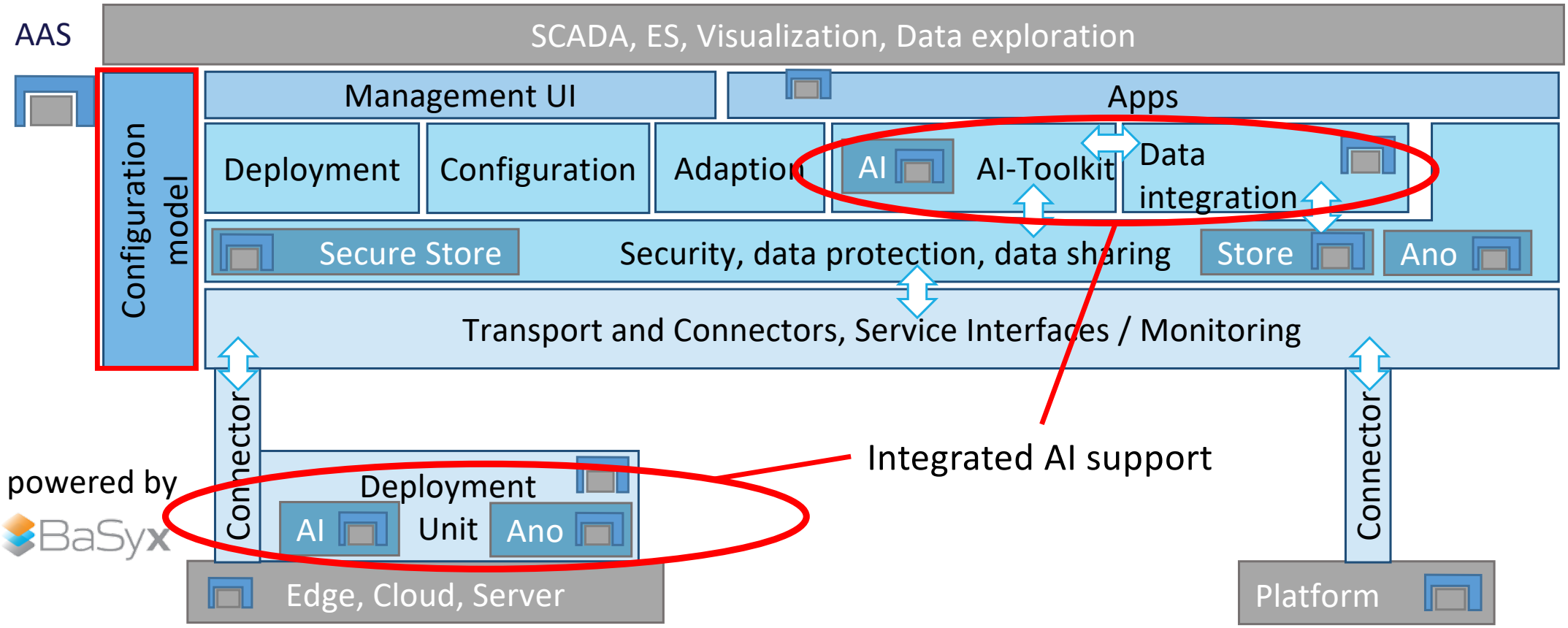
- Result of the IIP-Ecosphere project
- Model-driven I4.0 platforms
- AI-enabled I4.0 / IIoT

Oktoflow platform

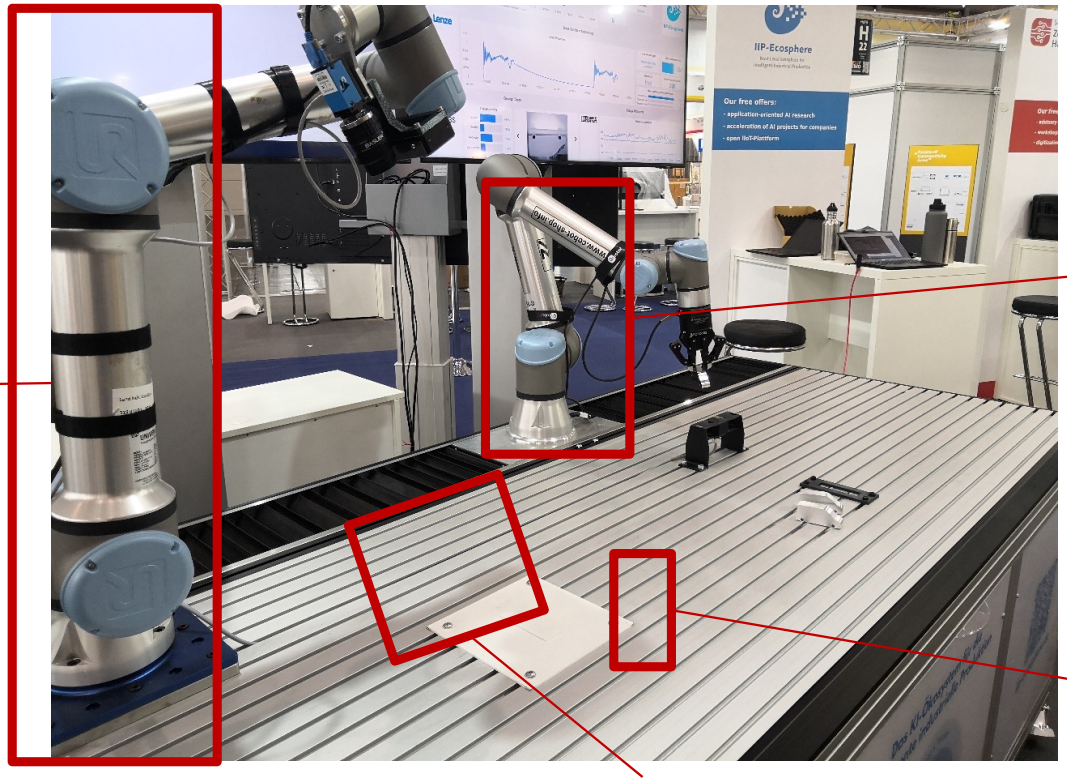
- Vertical AAS integration (from device to application)
- Model-driven approach / Low-code
- Massive code generation (up to 86% in demonstrators)
- Heterogeneous Edge devices
- AI integration (Python, RapidMiner, FLower)
- Standard-based (OPC-UA, AAS, MQTT, …)
- Open for extensions

H. Eichelberger und C. Niederée: *Asset Administration Shells, Configuration, Code Generation: A power trio for Industry 4.0 Platforms*. In: ETFA'23, S.1-8.

Oktoflow Architecture



Coordinated activity + Federated Learning



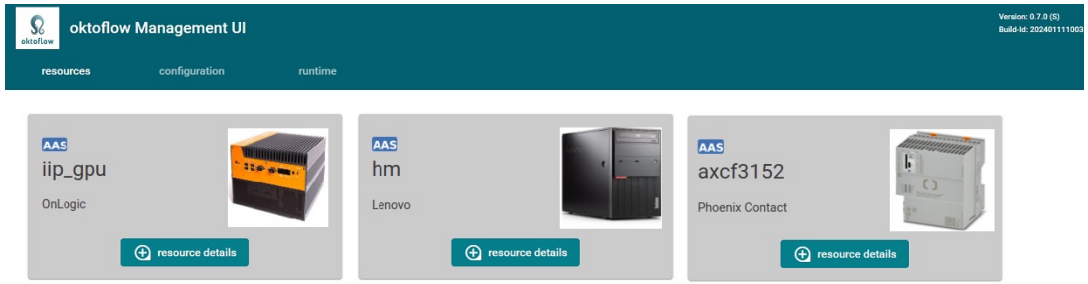
Cobot 2 (visual quality inspection)

Cobot 1 (gripping)

Product identification (MIP magnetic sensor)

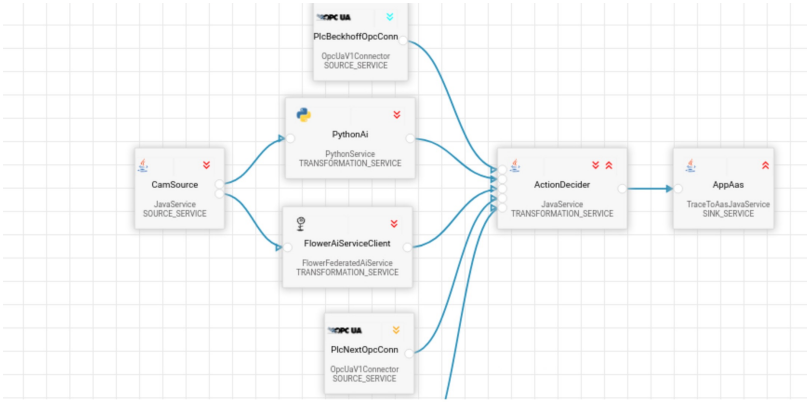
Lenze linear drive (condition monitoring on forward path)

Status of oktoflow



Current work

- Consolidation
- Integration of IDTA AAS standards
- Continued / new collaborations
- Evaluation in further demonstrators



It‘s open source: *Use it, extend it and collaborate!*

AI needs Explainability

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Foundation of the Explain project

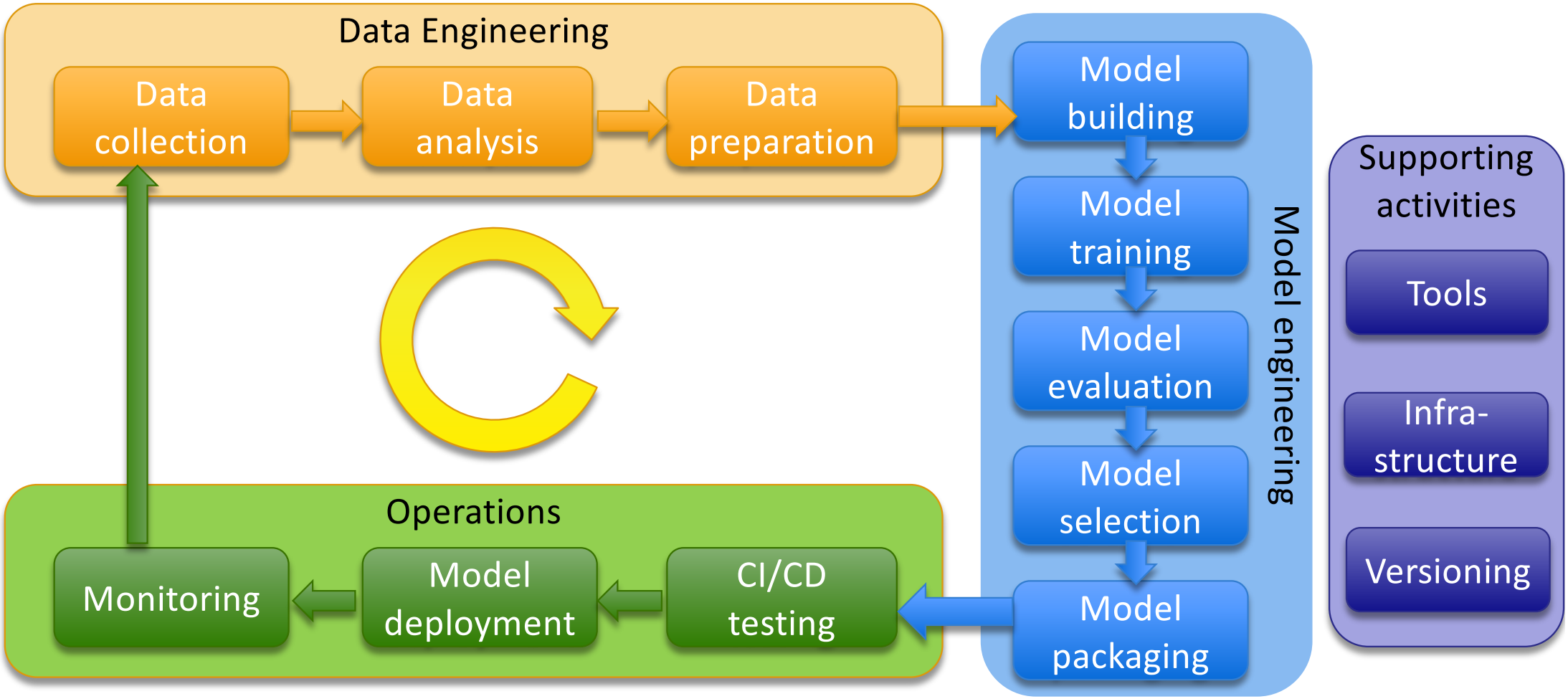
- Machine Learning in the context of CPPS requires a perspective of the whole life-cycle

  ➔ MLOps

- As CPPS systems are typically critical, we need operators and others to understand

  ➔ Explainability

The MLOps Lifecycle



Need and benefits of explainability

Core goal: output explanations = result of deployed models

Explain machine learning outputs:

- why is the current product broken?
- why should modify the operation parameters for the power plant (now)?

Need and benefits of explainability

Additional explanation options:

- During trainings:
  - for identifying potential issues when trying to improve models
  - for review (model acceptance)
- During operations:
  - Additional information on when explanations are wrong

Challenges

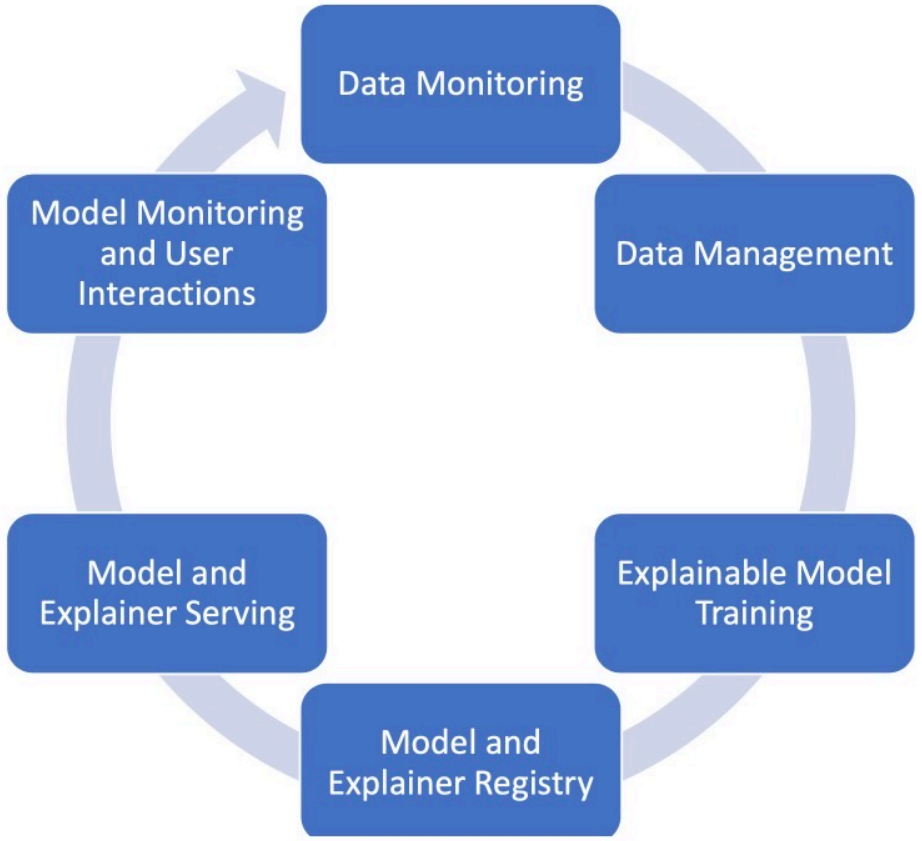
MLOps related challenges

- Data-related:
  - Drift (sensor, environment (e.g., lighting)
  - Data annotation (sufficient and ongoing in production)
  - Manufacturer-specific interfaces
  - Data-volume
  - …
- Model-related:
  - Importance of domain knowledge
  - Identifying appropriate models
  - Model update
  - …
- Operations-related:
  - Operations environment (cloud,server,edge)
  - Edge-processing of AI
  - …

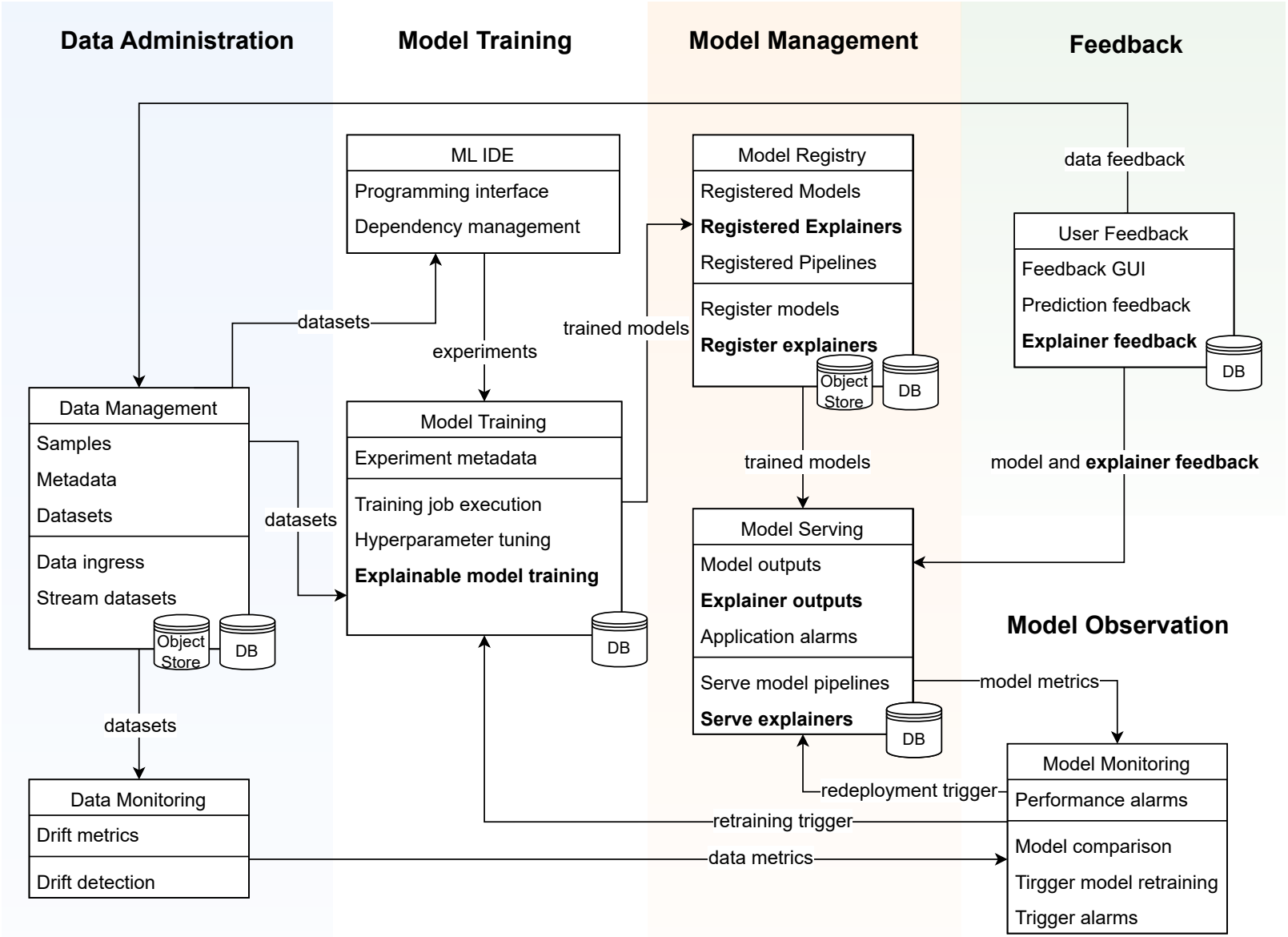
Challenges: Explainability

Explainability in MLOps

- Diversity of explanation problems
- Systematic integration in the MLOps life-cycle
- User-interaction for explainability
- Deployment and registries for explainers



Explain MLOps-Architecture *(with explanation support)*



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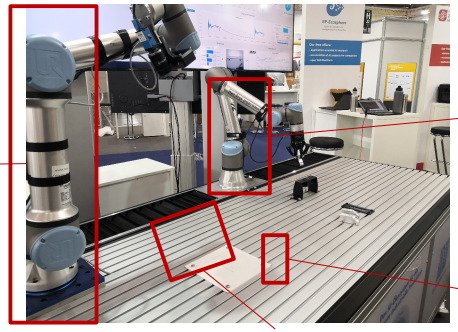
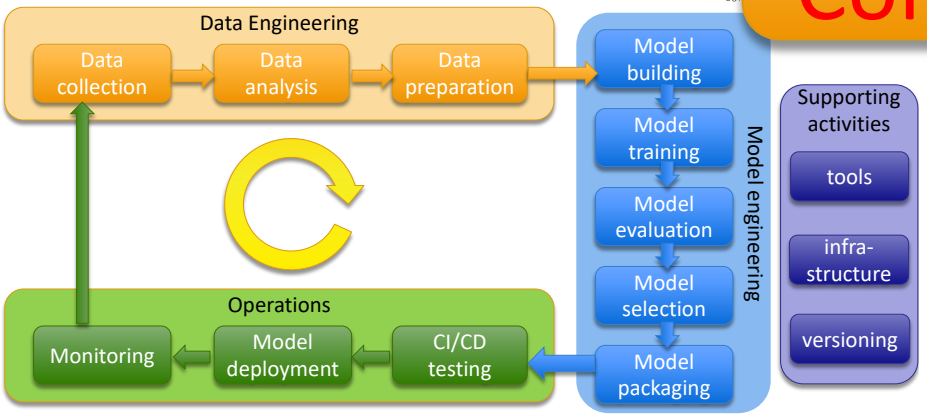
IIP-Ecosphere

Coordinated activity + Federated Learning



Questions/ Comments

The MLOps Lifecycle



Architecture (with explanation support)