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REMOTE
KONFERENZ

Hoai My Van

Framework for Data and AI Life Cycle

Research Project REMORA

#ittage

Framework for Data and AI Life Cycle

Flexible and Continuous Operation of Artificial Intelligence in Industrie 4.0

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Framework for Data and AI Life Cycle

Agenda

- I. Introduction to Industrie 4.0
- II. REMORA project
- III. Framework for data and AI life cycle
- IV. Exemplification on predictive maintenance use case
- V. Findings from research prototype
- VI. Outlook

The Rise of Industrie 4.0

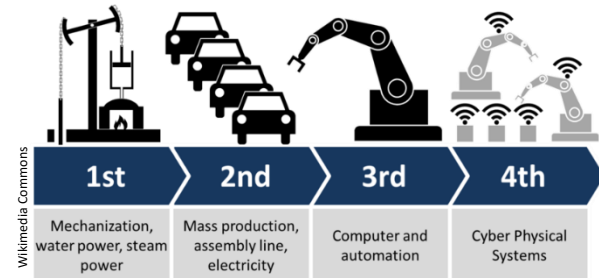
Improve Production and Services

Goal

- Improve **operation quality, productivity, resource usage,** and **flexibility**
- Make production **highly automated** and **adaptable**

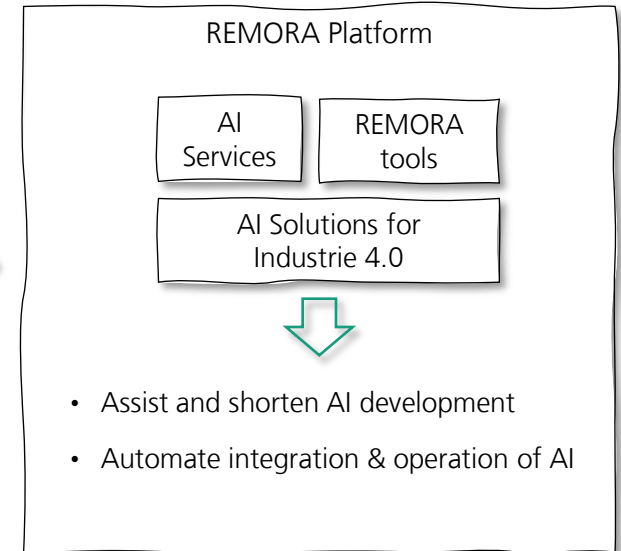
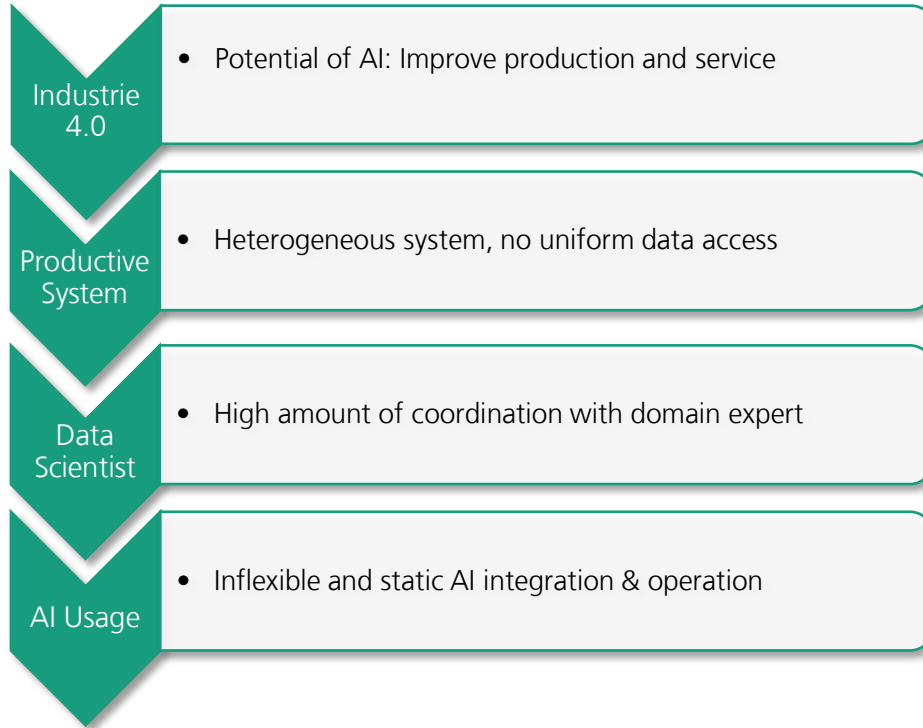
Industrie 4.0

Focuses on digitalization of processes and on leveraging the resulting data to achieve this goal.



REMORA Project

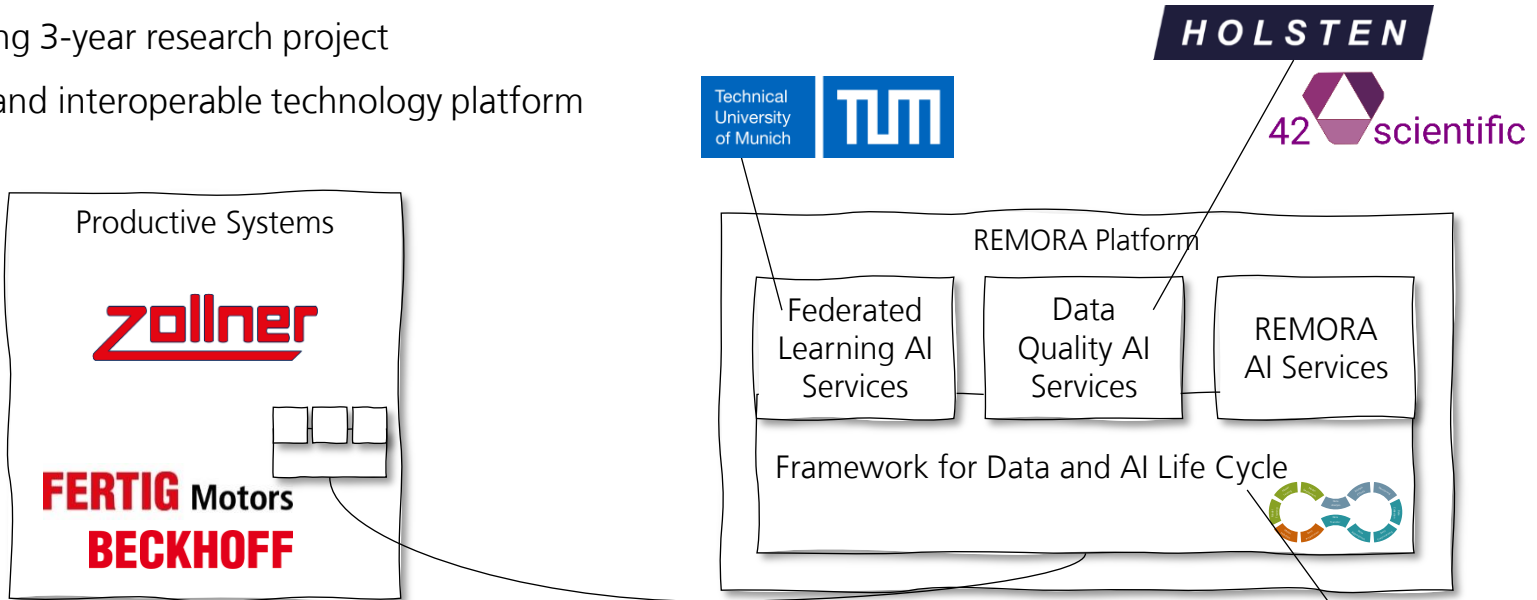
Challenge: Heterogeneous Systems



REMORA Platform

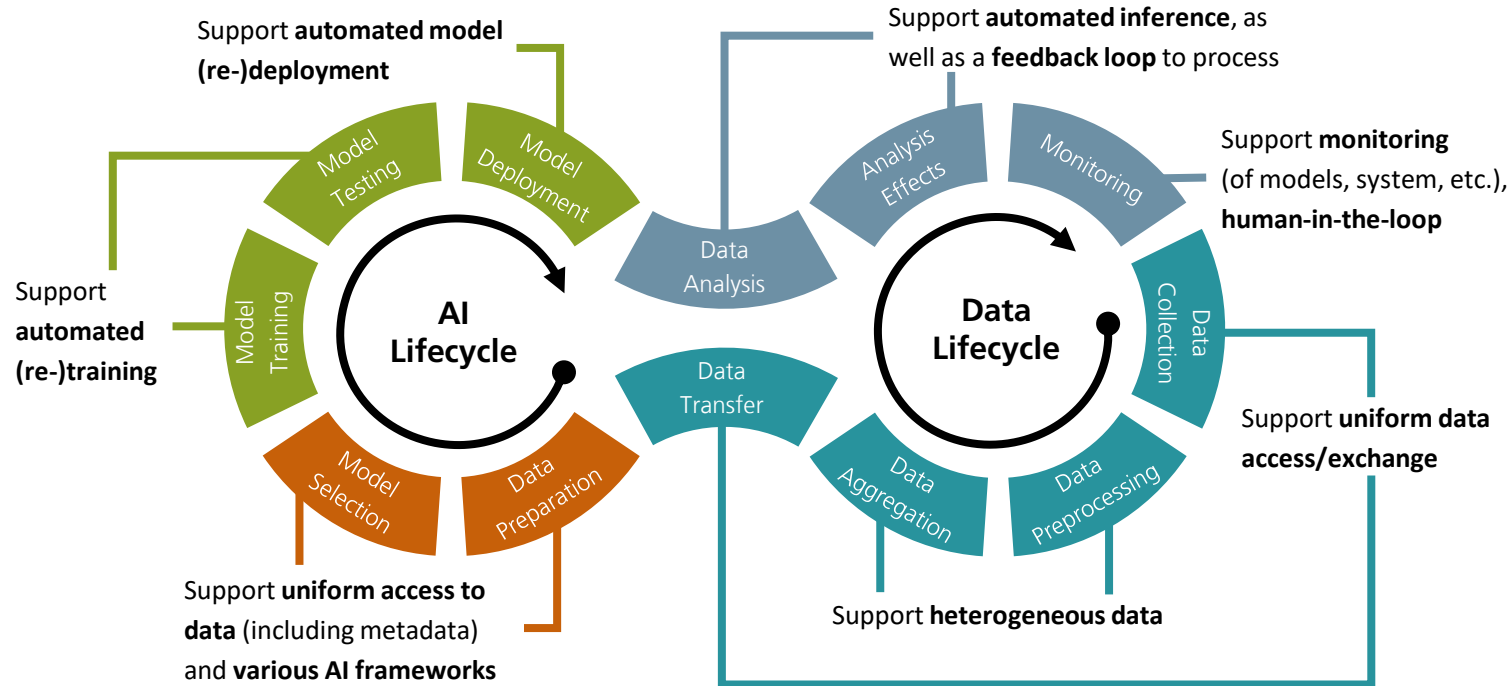
AI Solutions for Industry 4.0

- Ongoing 3-year research project
- Open and interoperable technology platform



Framework for Data and AI Life Cycle

Automated, Continuous and Dynamic Data and AI Life Cycle



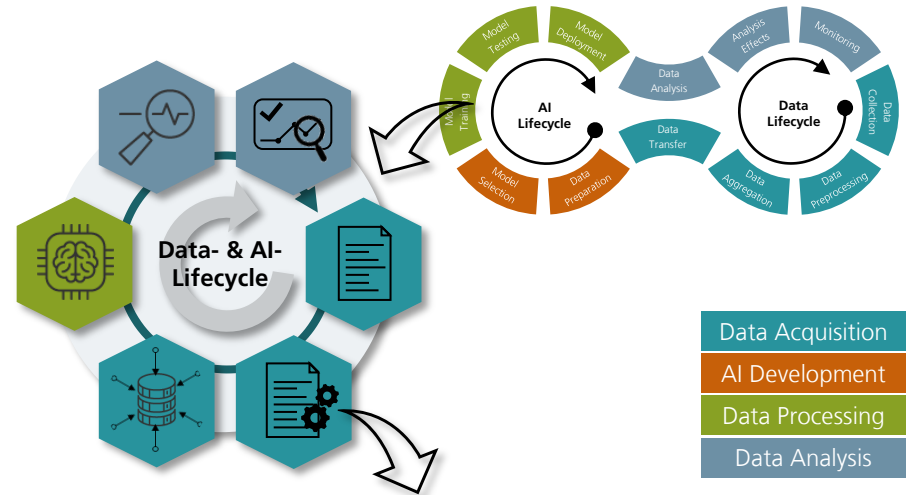
Framework for Data and AI Life Cycle

Coordination and Management of Flexible Services

Framework for Data and AI Life Cycle

- Support for all life cycle stages (realized as AI Services)
- Adaptive architecture for AI, incl. DevOps/MLOps and service management
- Support for a variety of hardware/software technologies

→ Holistic, technology-independent solution for continuous and flexible AI applications

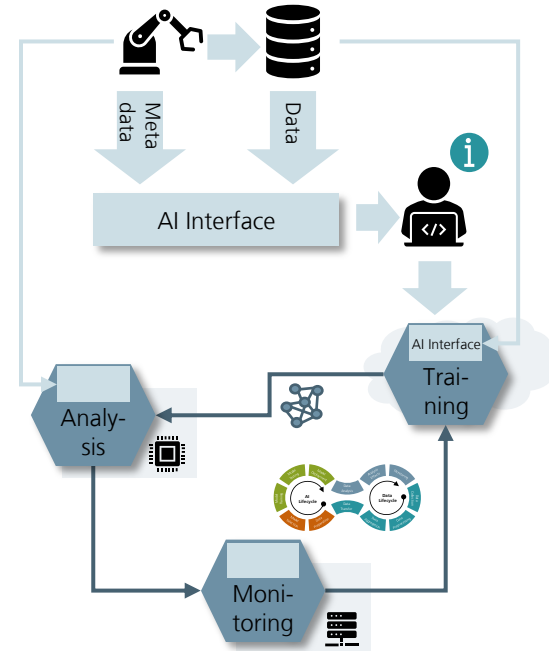
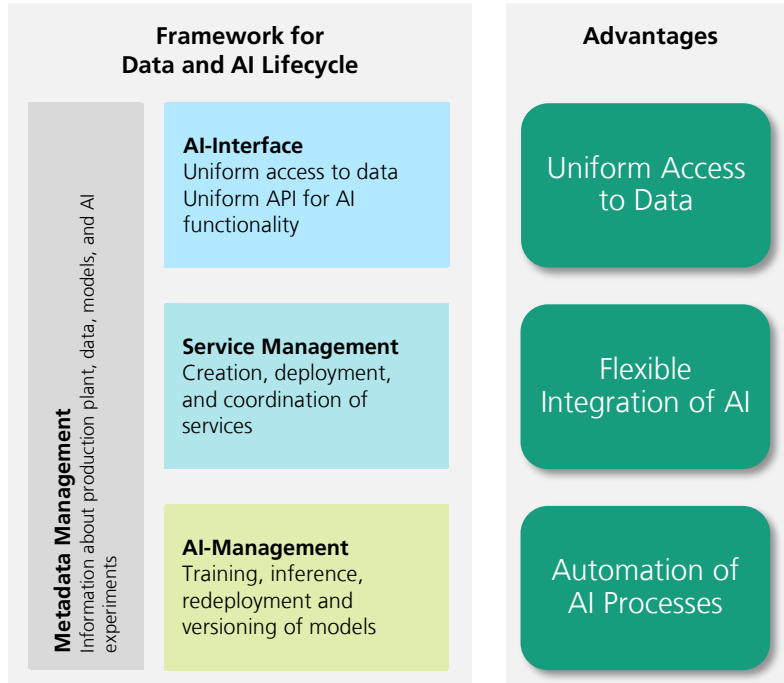


AI Service

- Microservices for Data and AI Life Cycle
- Variations: container, executable, VM, etc.

Framework for Data and AI Life Cycle

Three Big Advantages

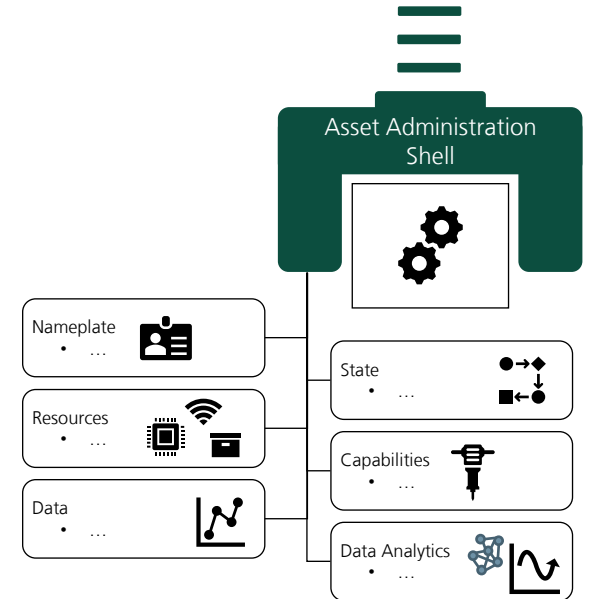


Framework for Data and AI Life Cycle

Metadata Management

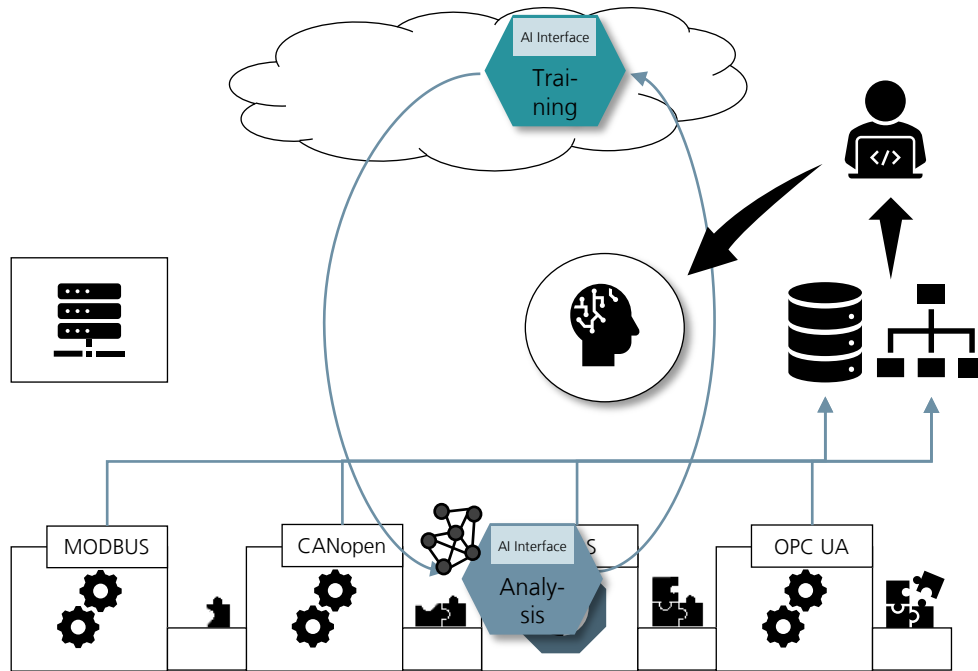
Asset Administration Shell

- Implementation of a Digital Twin for Industrie 4.0
- Static sub models for documentation
- Dynamic sub models for run-time information



Example – Predictive Maintenance

Overview



Objective

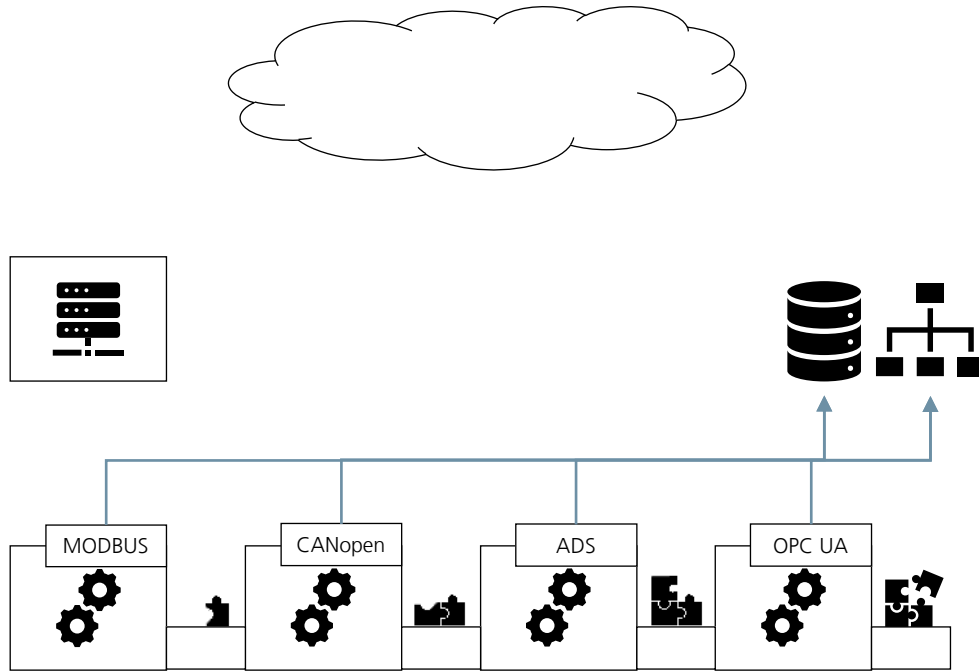
- Standstill reduction
- AI to predict standstill/measures

Steps

1. Data Collection
2. AI Development
3. Service Deployment & Management
4. Retraining management

Example – Predictive Maintenance

Data Collection



Objective

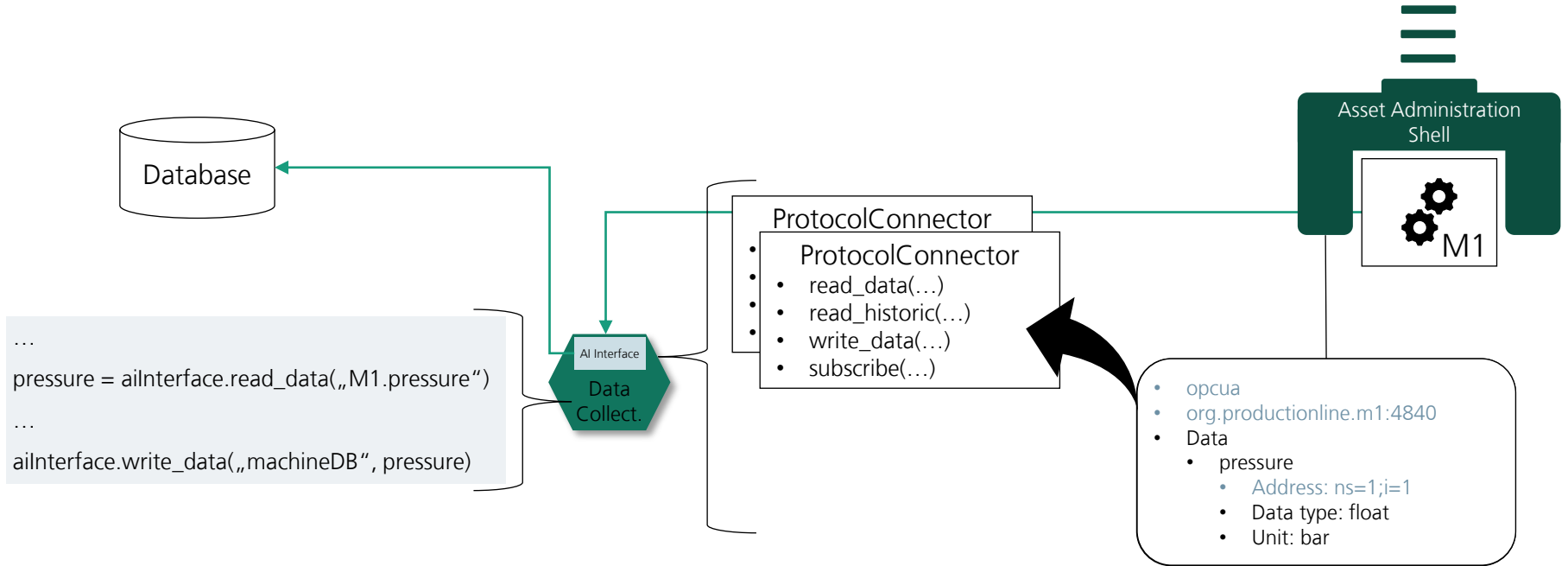
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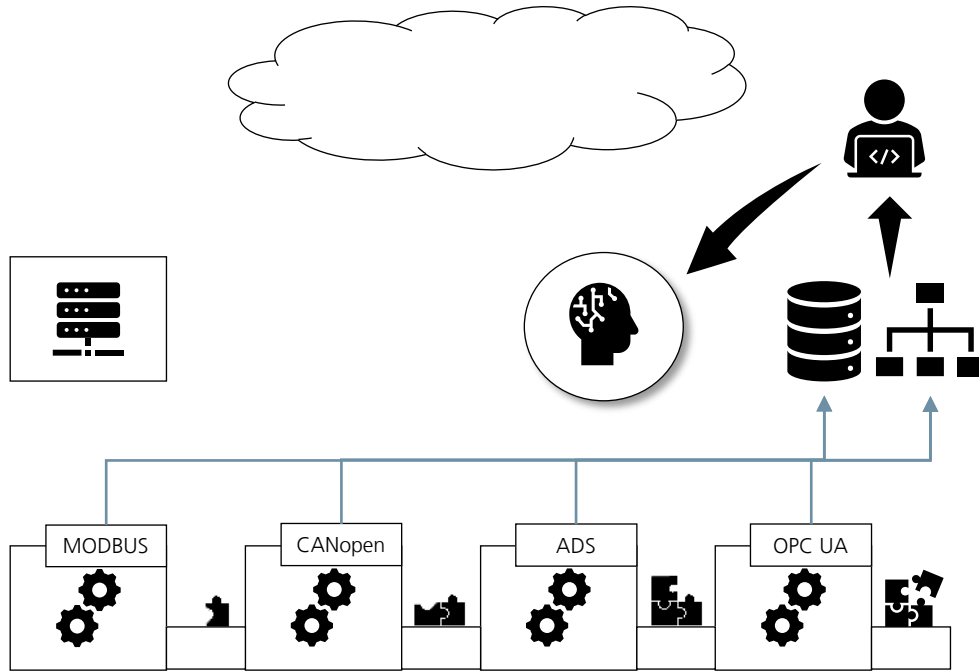
Data Collection

AI-Interface for Data Access



Example – Predictive Maintenance

AI Development



Objective

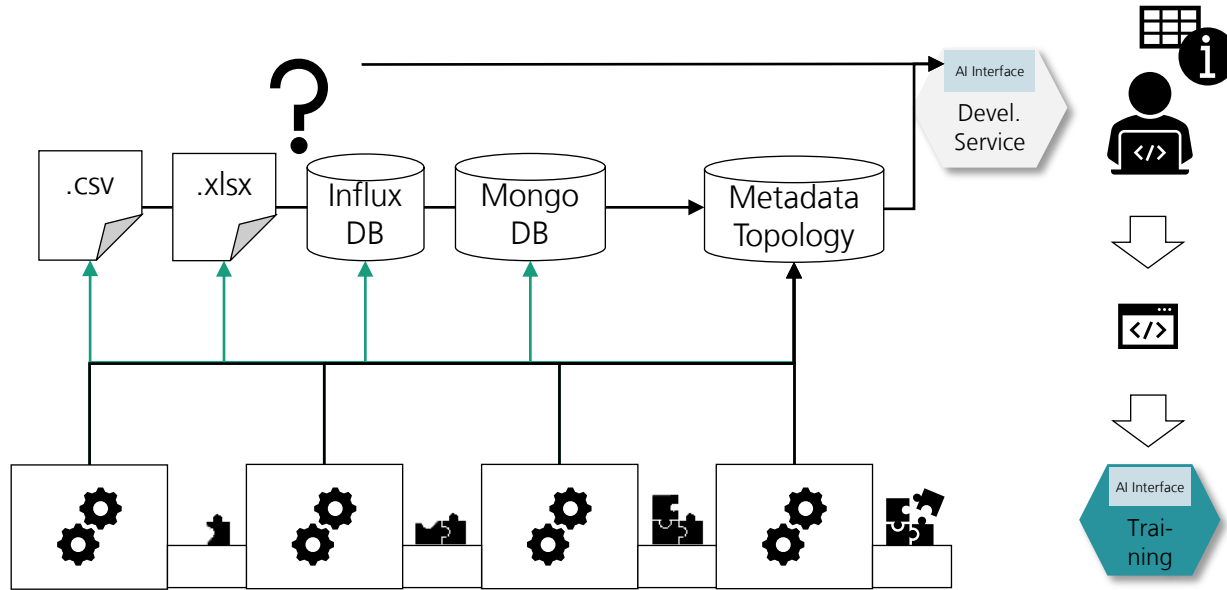
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AI Development

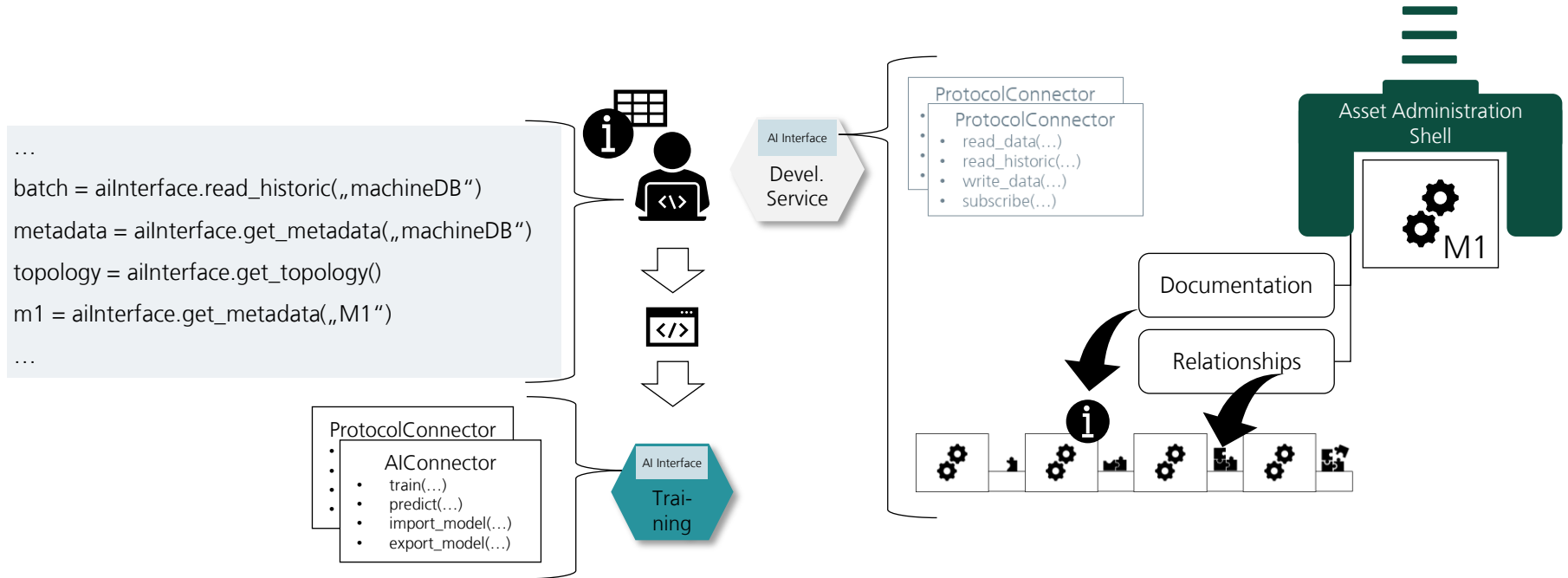
General Idea



- Data inspection independent of used technology
- Metadata/topology overview to get better understanding
- Development, e.g., of training code

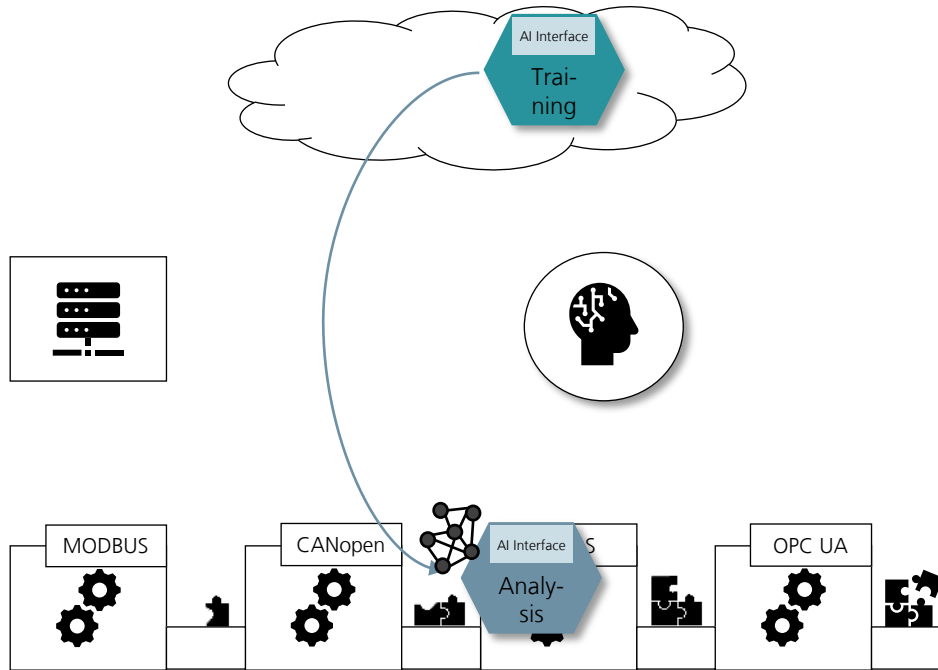
AI Development

Assistant for Data Scientist



Example – Predictive Maintenance

Service Deployment & Management



Objective

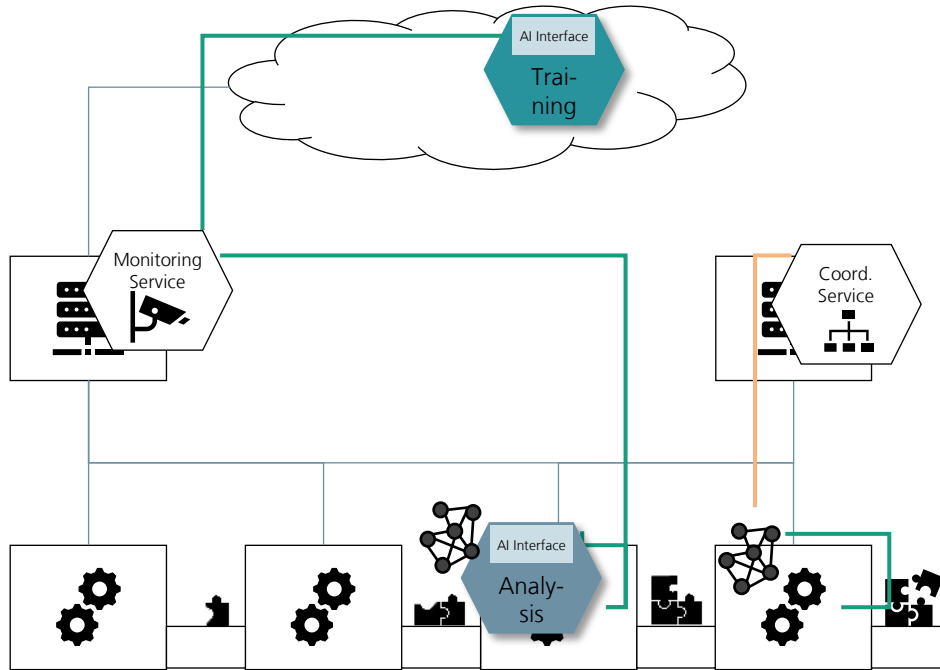
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Steps

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Service Deployment & Management

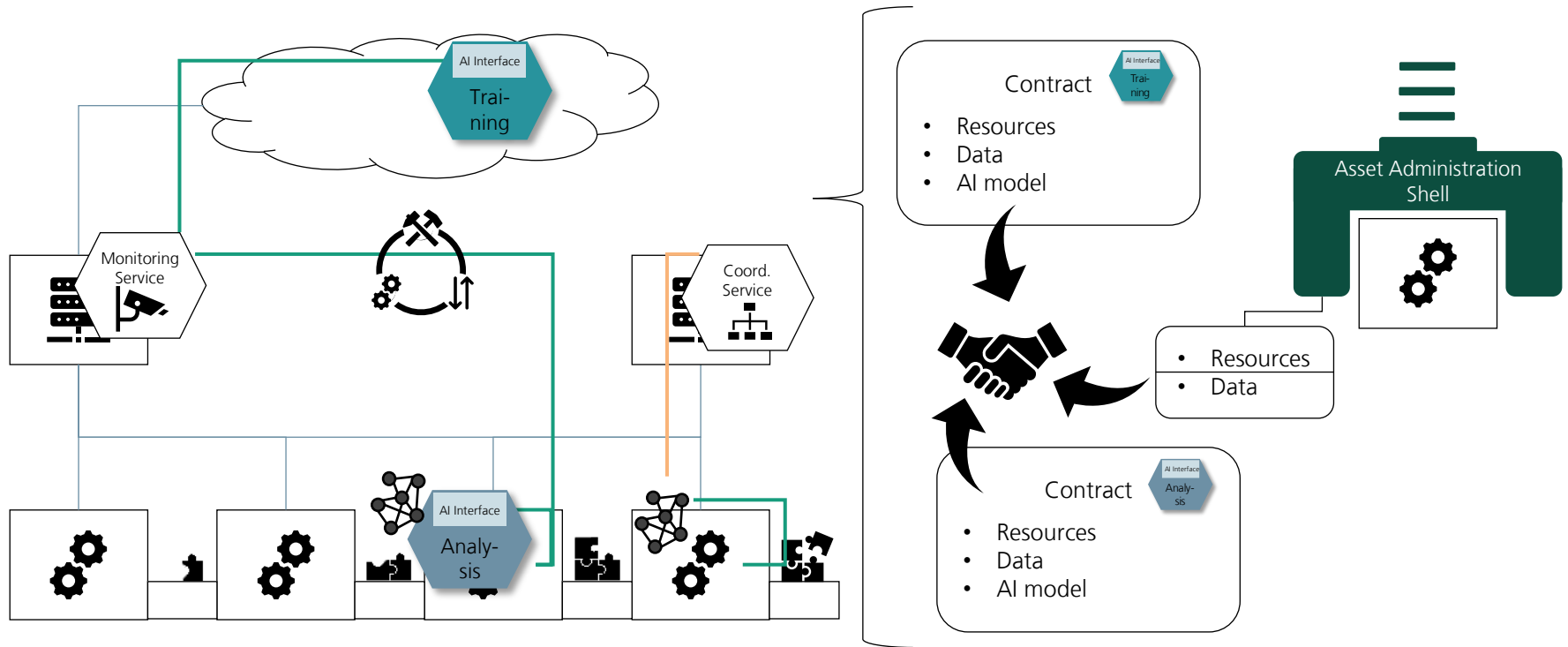
General Idea



- Flexible deployment of services to where it makes the most sense
 - Consideration of available resources and optimization goals
 - E.g., training in cloud, real-time critical analysis close to data
- AI models
 - Deployed to respective services, or
 - Integrated AI model directly into component with parallel coordination instance
- Service coordination and data flow control

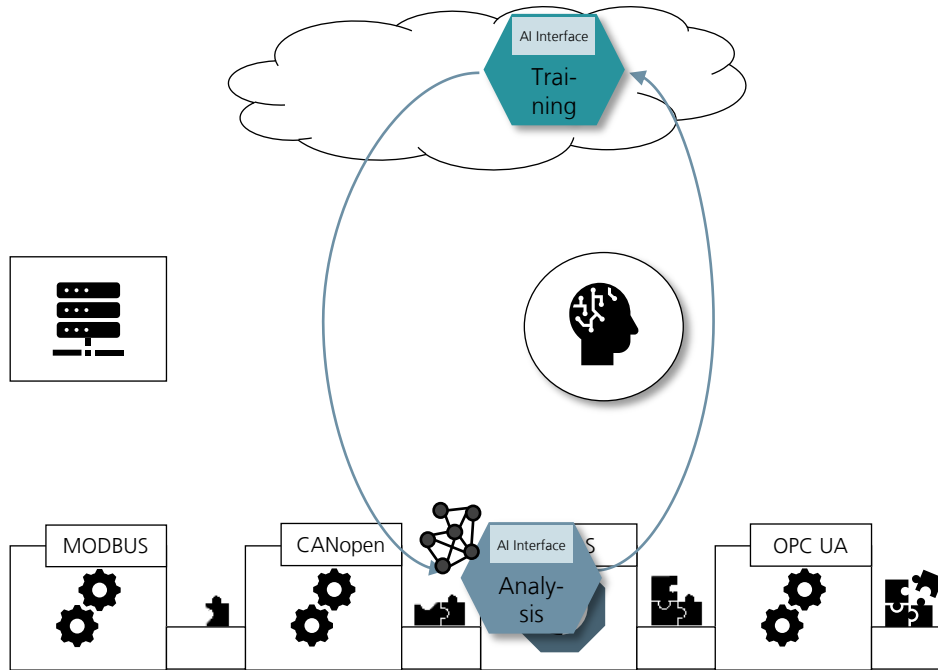
Service Deployment & Management

Flexible Integration of AI



Example – Predictive Maintenance

Retraining Management



Objective

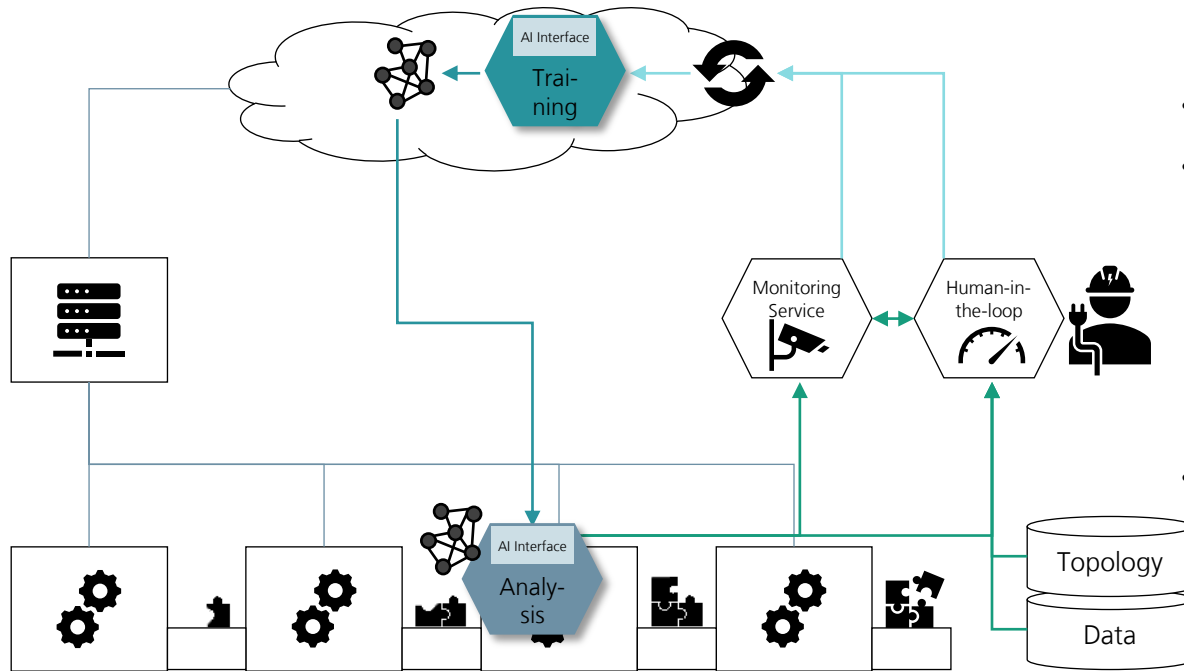
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Steps

1. Data Collection
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4. Retraining management

Retraining Management

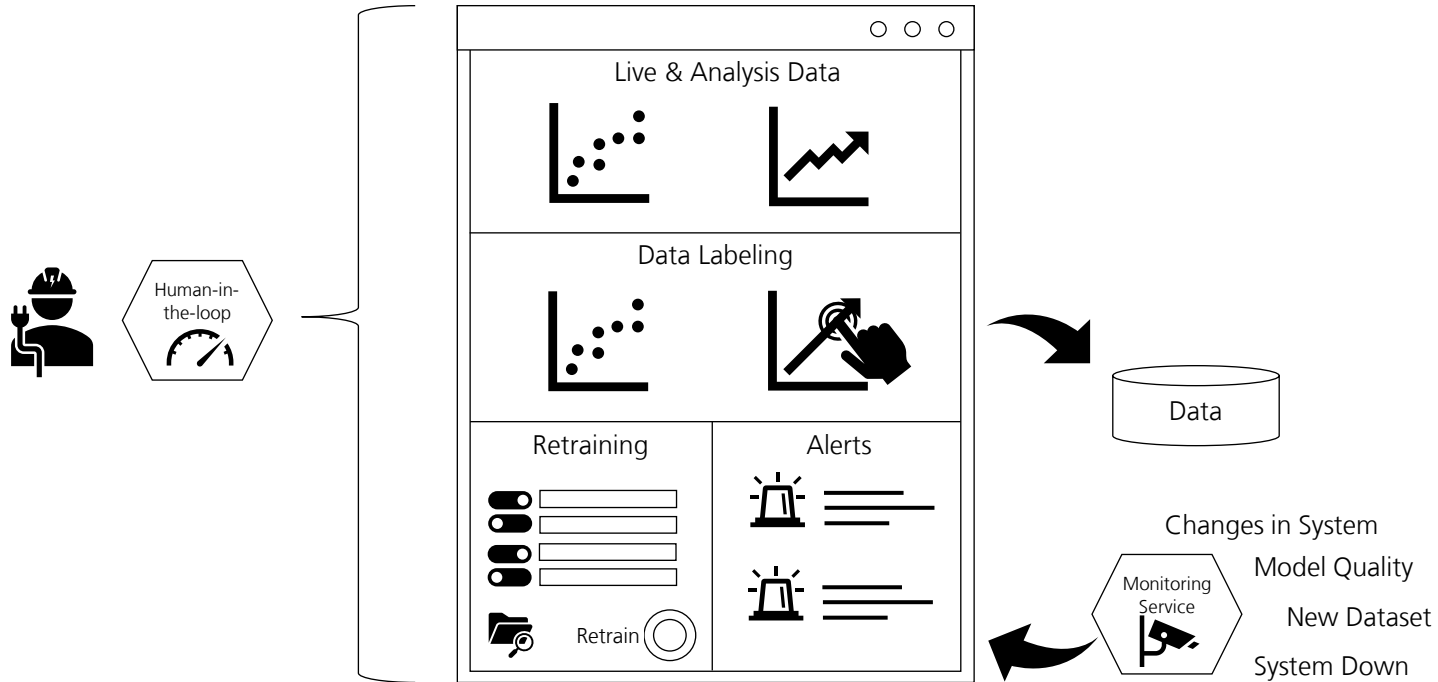
General Idea



- Human-in-the-loop: integrate user and expert knowledge into AI process
- Automatic monitoring
- Retraining triggers
 - Manual retraining
 - Bad model quality
 - Changes in topology
 - New data
- Automatic retraining and deployment of new model

Retraining Management

Human-in-the-Loop

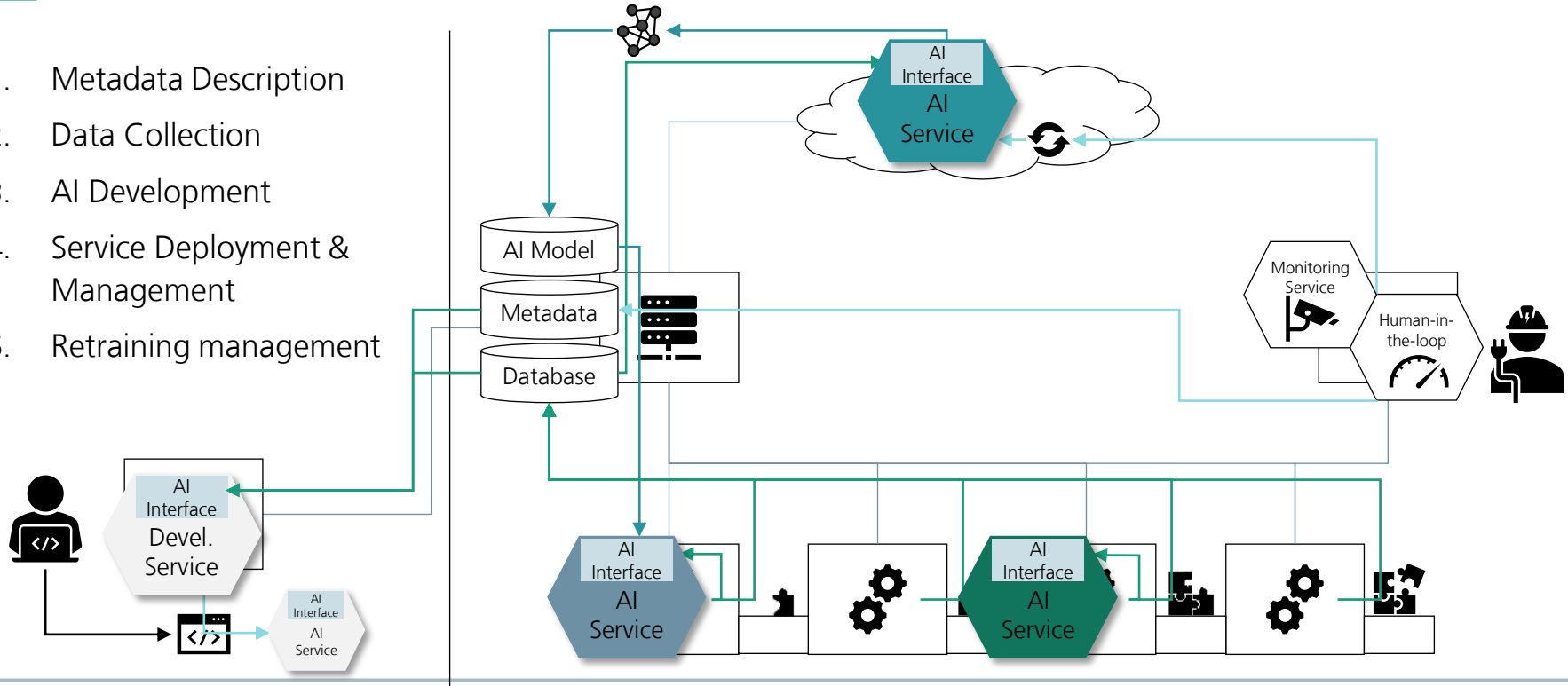


Framework for Data and AI Life Cycle

Holistic Framework for Flexible AI Applications

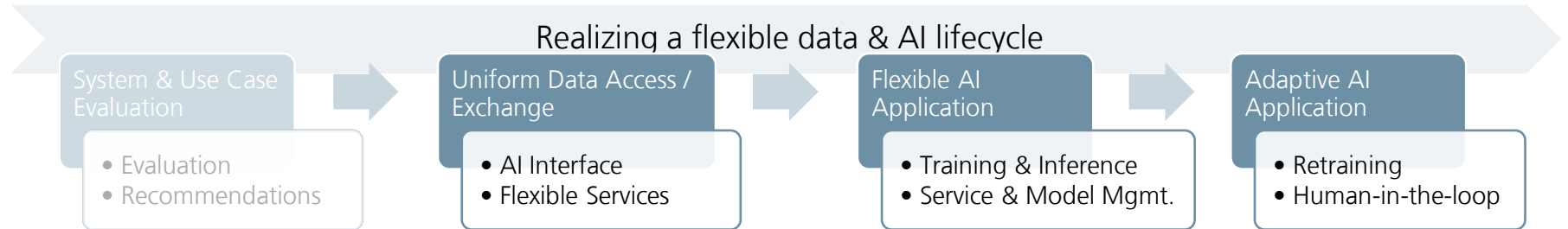
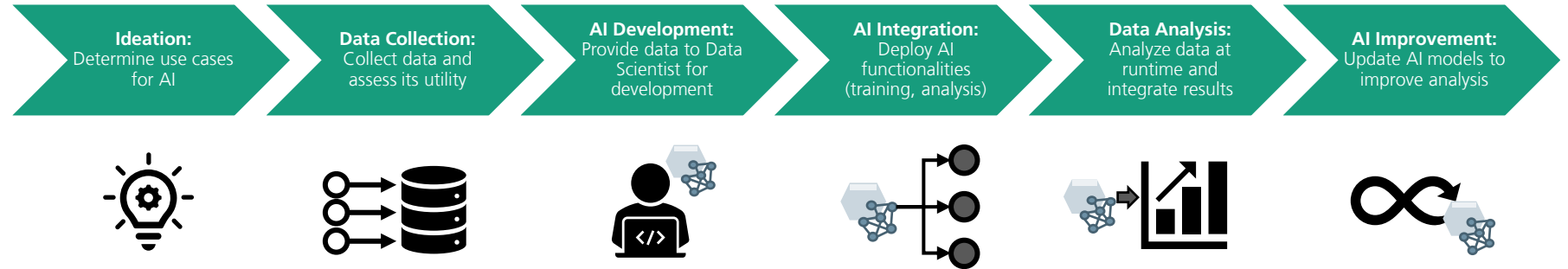


1. Metadata Description
2. Data Collection
3. AI Development
4. Service Deployment & Management
5. Retraining management



Framework for Data and AI Life Cycle

Modular Framework Fitted to AI Maturity Level

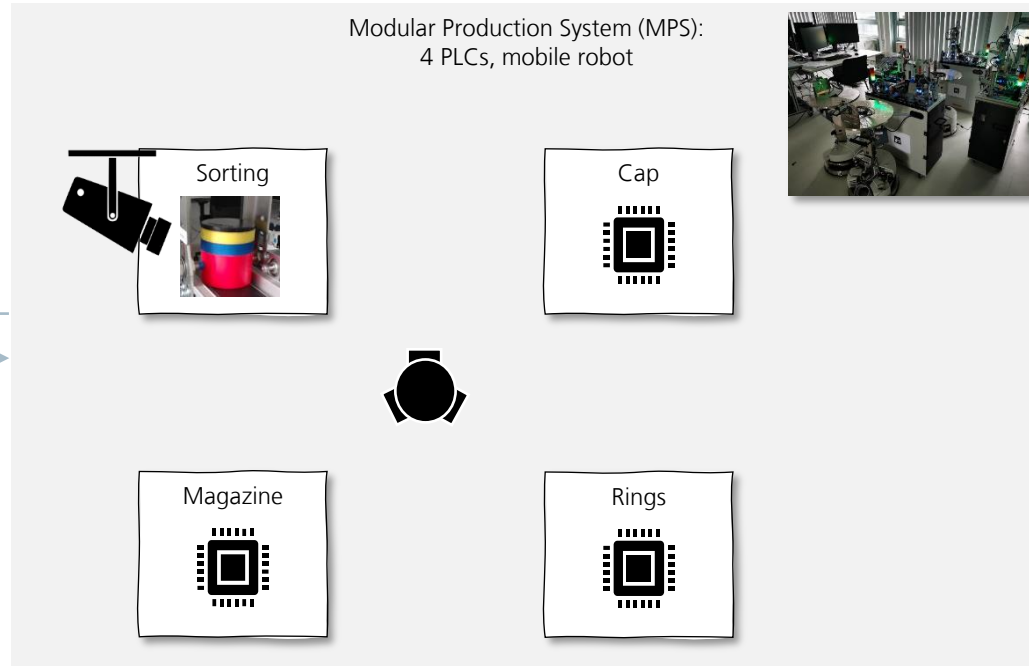
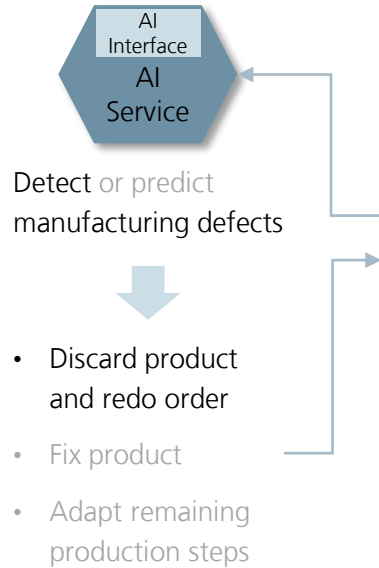




Research Prototype

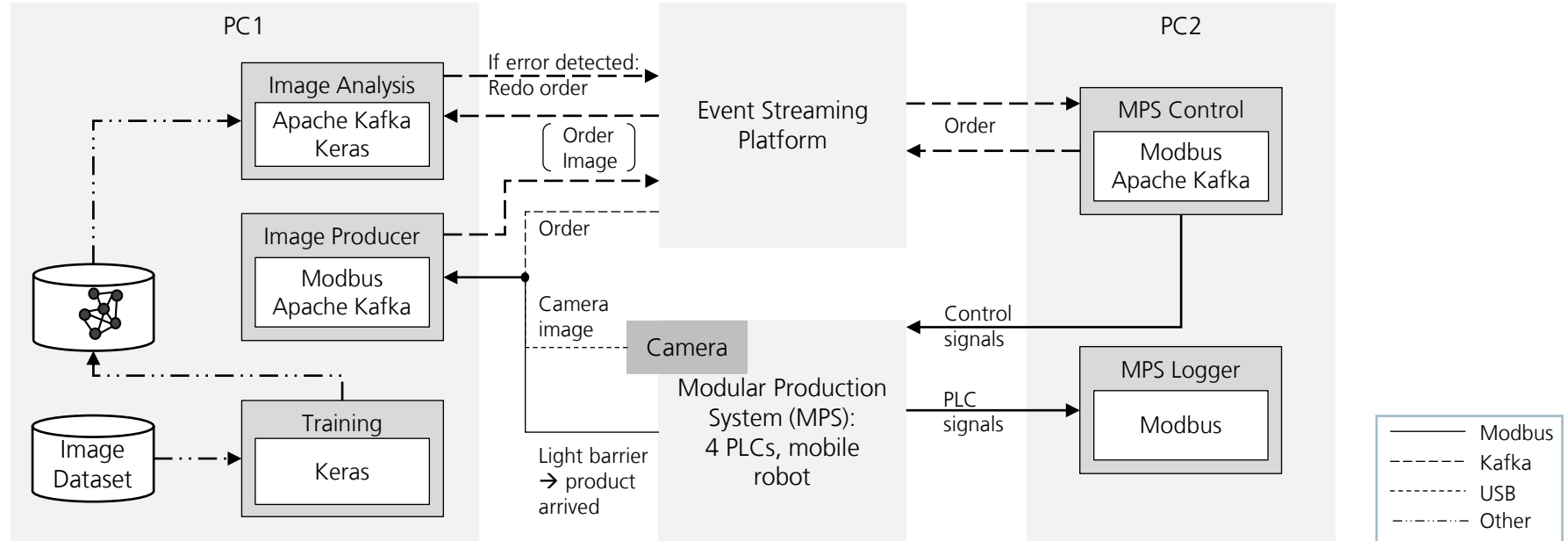
Research Prototype

Modular Production System



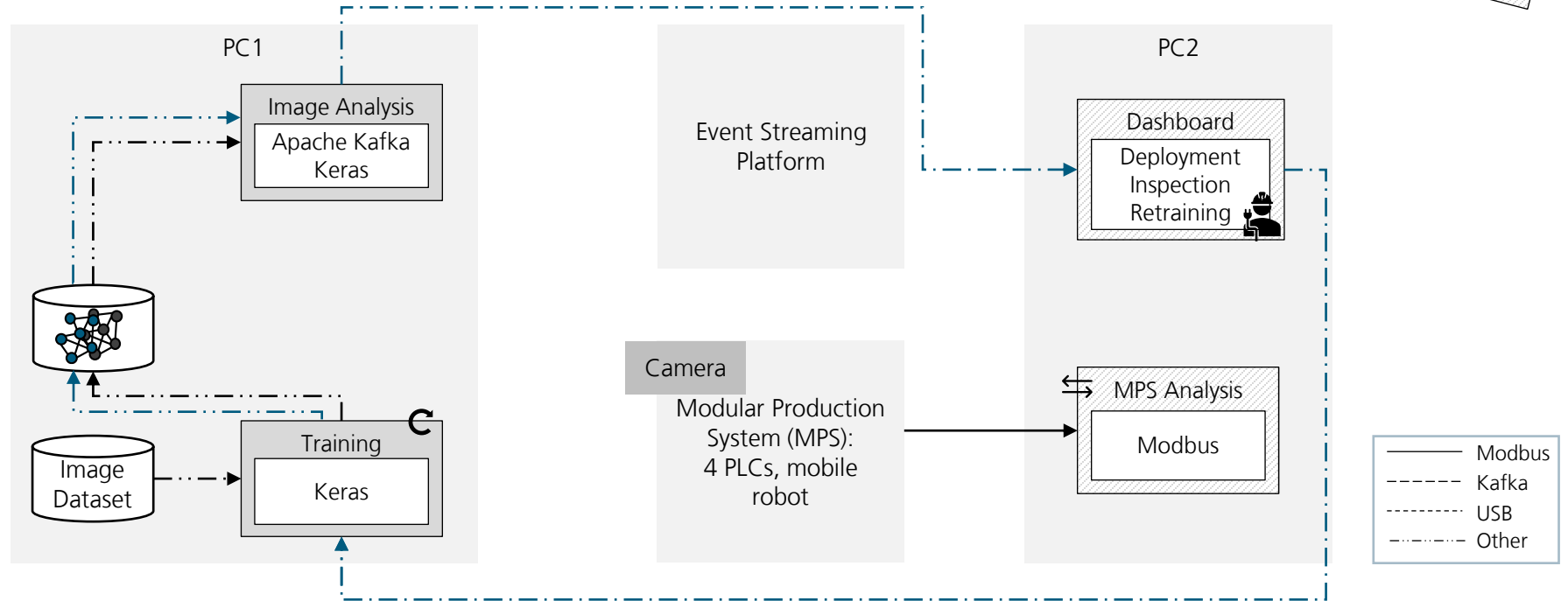
Research Prototype

Initial AI Integration – Manufacturing Fault Detection



Research Prototype

Next Steps – Holistic Data and AI Life Cycle

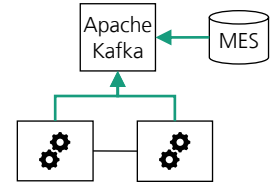


Framework for Data and AI Life Cycle

Additional Use Cases

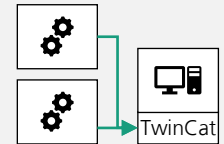
Predictive maintenance

- Brown-field production line
- Centralized Apache Kafka system: live data, historic data, MES data, AI models



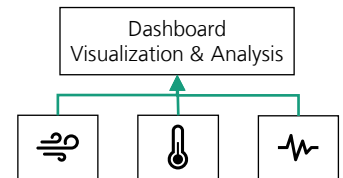
Development of state model for virtual commissioning

- Green-field test station
- TwinCat-based system: live data via ads, historic data via csv



Assessment of worker's safety

- Distributed sensor system: body-worn sensors, environment sensors
- Combine mixed data sets: csv, mdf

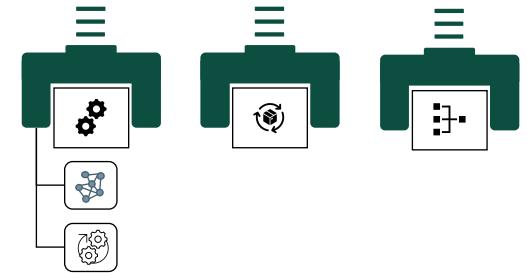


Outlook

Future Research Direction

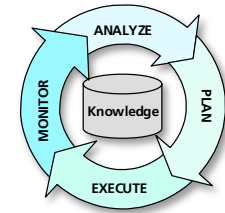
Asset Administration Shell

- Description of products & production processes (for tracking relations)
- Integration and tracking of AI
- Simulation (for testing or data generation)



Increase self-adaptive capabilities and safety

- Adaptive data source selection (based on changes in environment or goals)
- Plug-and-produce (by deploying matching services)
- Safe & optimized configurations (by describing non-functional requirements)



Outlook

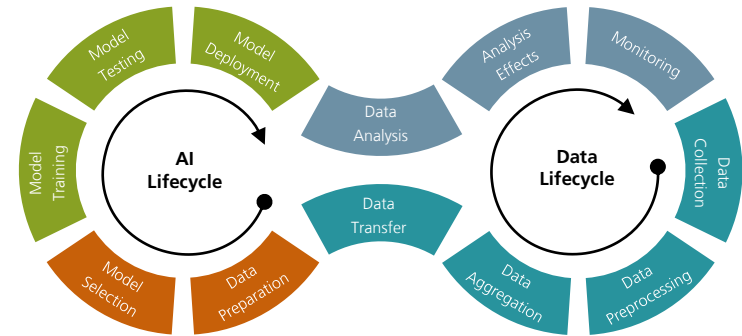
Vision: One Framework for All

Framework for data & AI lifecycle

- Uniform access to data, metadata, topology
- Open, interoperable, technology-neutral
- Automated, continuous, dynamic data & AI lifecycle

Potential

- Support for AI newbie
- Usage beyond Industrie 4.0
- Additional data sources: MES, ERP, logs, etc.



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Dieses Vorhaben wird im Rahmen des Projektes „REMORA – Multi-Stage Automated Continuous Delivery for AI-based Software & Services Development in Industry 4.0“ durch das Bayerische Staatsministerium für Wirtschaft, Landesentwicklung und Energie gefördert und durch die Bayern Innovativ – Bayerische Gesellschaft für Innovation und Wissenstransfer mbH unterstützt.

Publications

Further Reading Material

- [Simple AI integration for Industry 4.0 - Fraunhofer IKS](#) (Website)
- [Implementing a Metadata Manager for Machine Learning with the Asset Administration Shell](#) (ImplAAS@ETFA Workshop Paper)
- [Framework für Daten- und KI-Lebenszyklus](#) (Computer&Automation Article)
- [Ein Turbo für Künstliche Intelligenz in der Produktion](#) (Blog Post)
- [Framework for data and AI life cycle](#) (Presentation)