

Towards Collaborative Predictive Maintenance with Blockchain and Federated Learning

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Christian Becker

Working Student @ inovex

- › Team Data Management and Analytics
- › Bachelorthesis “Evaluation of Federated Learning in Deep Learning” @ inovex

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- › Faculty of Computer Science
- › Specialized in Federated and Machine Learning





Marisa Mohr

Senior Machine Learning Engineer @ inovex

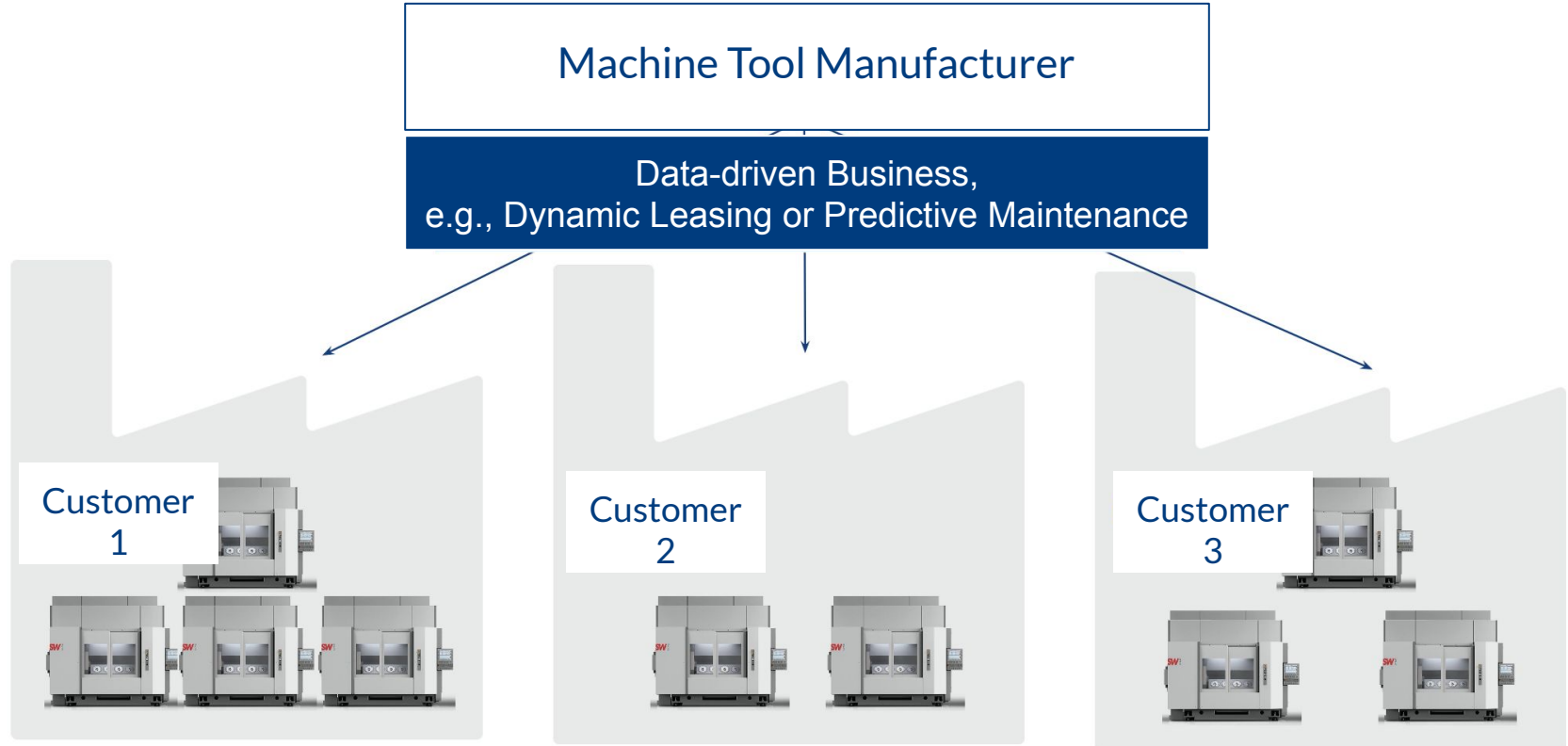
- › Team Data Management and Analytics, Artificial Intelligence
- › IIoT and Predictive Maintenance

External Doctoral Student @ University of Lübeck

- › Institute of Information Systems, Prof. Dr. Ralf Möller
- › Learning from Up and Downs: Multivariate Ordinal Pattern Representations for Time Series



Data-Driven Business in IIoT



Collaborative Smart Contracting Platform for Digital Value Networks

Machine Manufacturer



Enabler



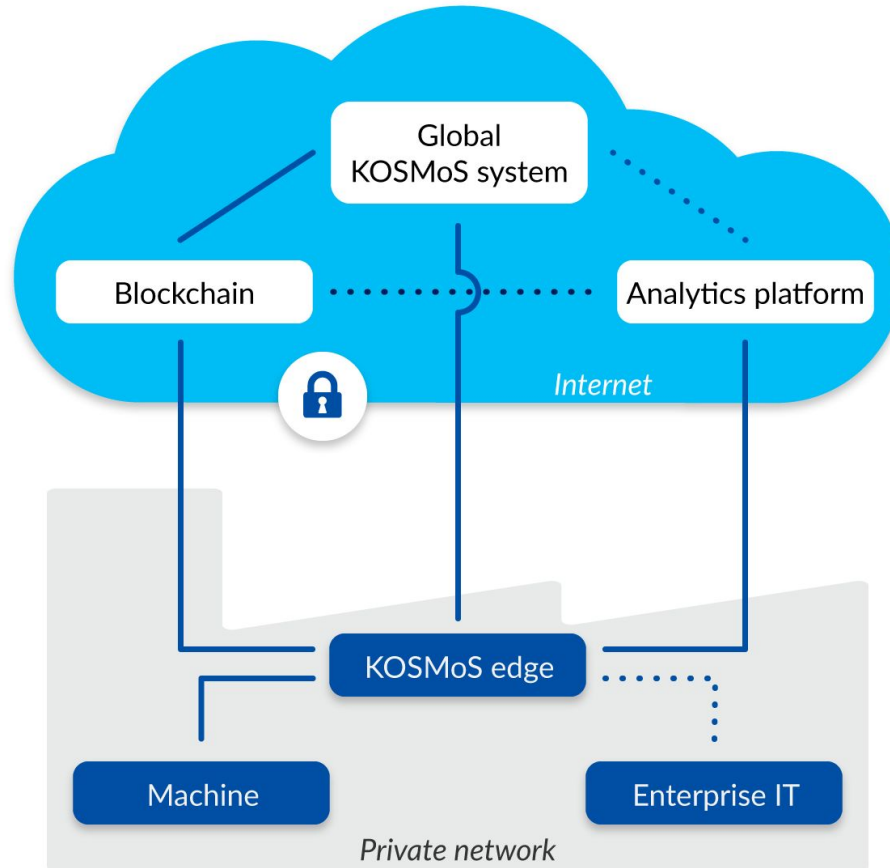
Research Institutions



KOSMoS is an **ecosystem** that enables the realisation of cross-company data-driven business models based on secure infrastructures, in particular with the help of a **blockchain** and **federated learning**.



KOSMoS Architecture



Blockchain: Protection against manipulation

- Installation of microcontrollers in between sensor and the following systems component (Korb et al., ISW Stuttgart)
- Implementation of a blockchain with a suitable signing procedure so that data is signed at the place where it is recorded
- **Consensus:** All participants are synchronised and validate transactions
- Authenticity of entries, unauthorised manipulation and confidentiality

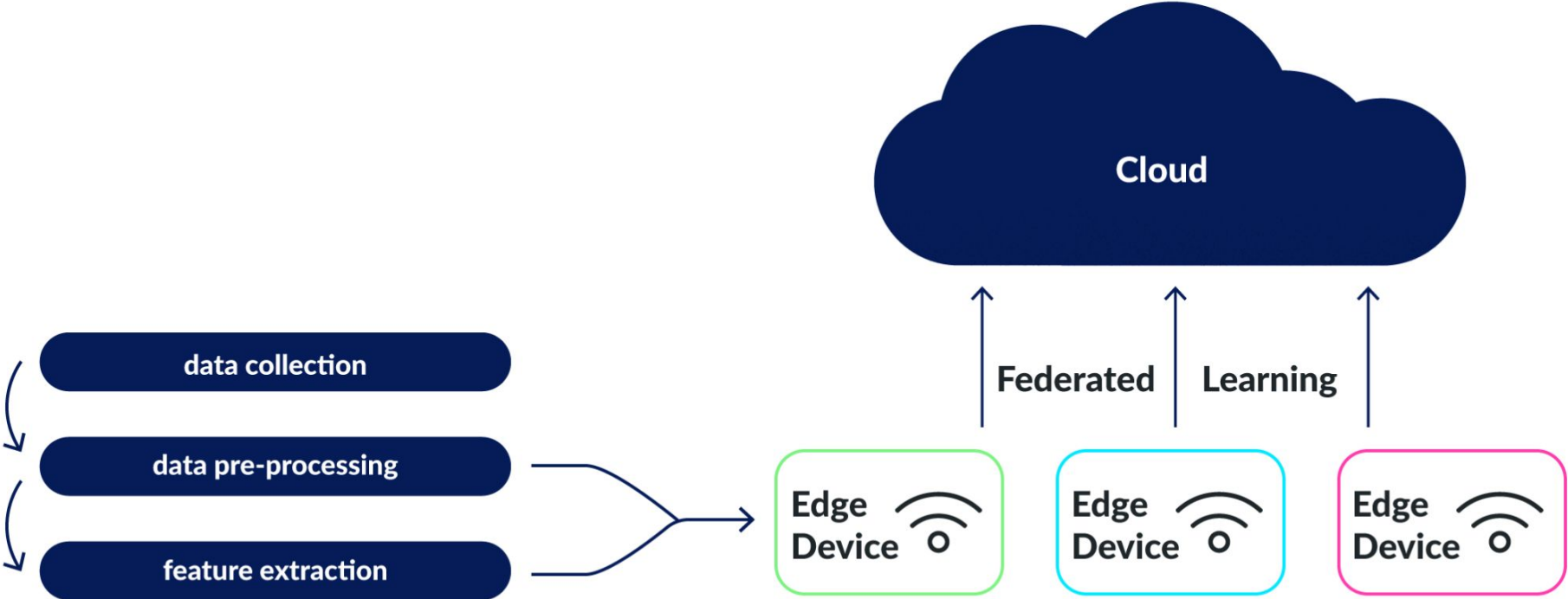


Challenges in KOSMoS

- › Close collaboration with machine manufacturers to develop the **KOSMoS ecosystem**
- › **Only available data is recorded at test machines** in a laboratory environment and operators are not willing to contribute their data
- › No suitable data to train a predictive maintenance model
- › **Bearing data** is used as a baseline to design and develop a **generic federated learning framework**.

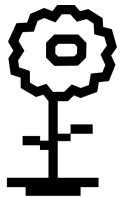


Connecting Machine Operators

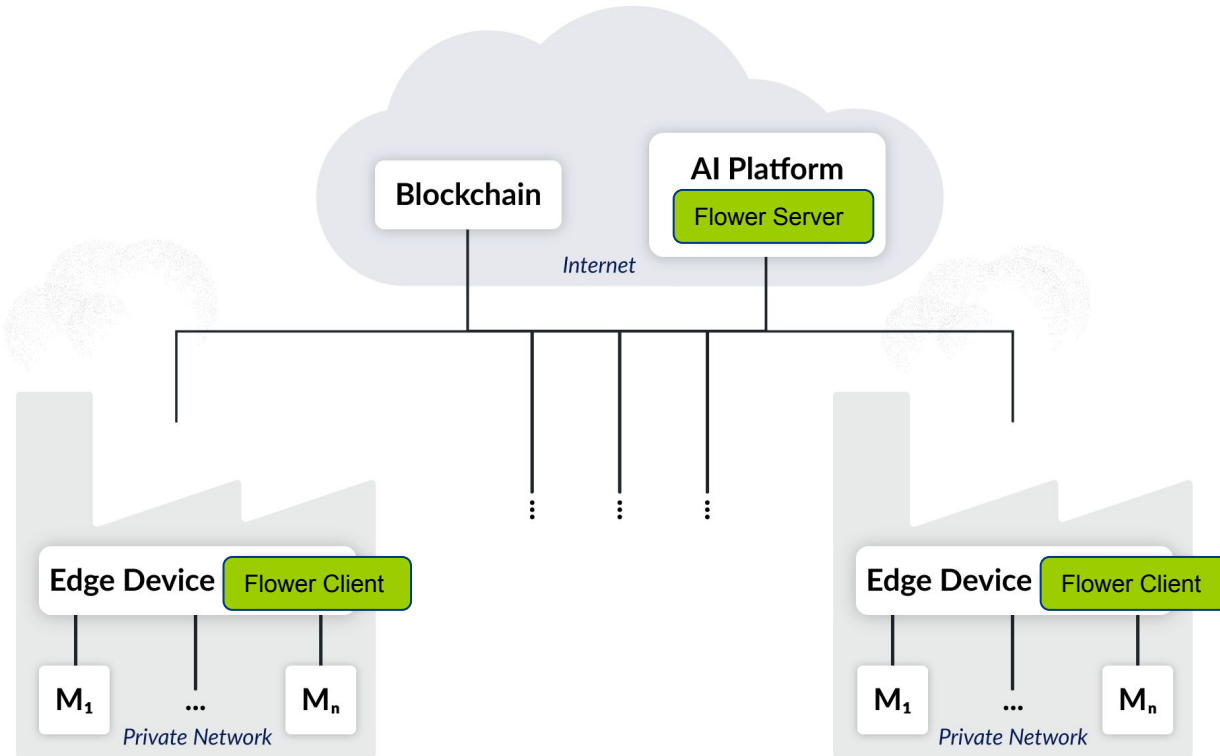


Flower in KOSMoS

- › [Potentially] should be executable on edge/embedded devices
- › Using Keras for machine learning framework
- › Flower as federated learning framework
- › Wrap it in a client selection tool and pack it up in Docker
- › A simulation environment for federated learning evaluation
- › Using MLFlow further to log the learning process



Flower in KOSMoS



Outlook

- › Hope to get access to production data
- › Include differential privacy and secure multi party computation
- › Multi client aggregation with consensus mechanism in the blockchain



Thank you

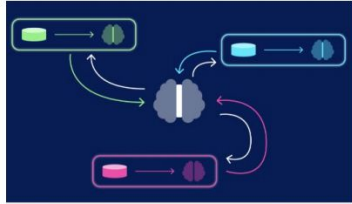
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Federated Learning: Frameworks for Decentralized Private Training – Part 2

This blogpost evaluates three different Federated Learning frameworks and the concepts they use to achieve a collaborative training.



Federated Learning: A Guide to Collaborative Training with Decentralized Sensitive Data – Part 1

This blog post explains how Federated Learning works and what privacy techniques are necessary to ensure that sensitive data is protected.

Problems and Requirements for Federated Learning at KOSMOS

Problems/Requirements:

- › No specific machine learning use case (tf, pytorch, numpy, sklearn, ...)
- › [Potentially] should be executable on edge/embedded devices
- › Consortium/team comes from different backgrounds
- › Everyone should be cheerfully about using it



Backup



Collaborative Predictive Maintenance

Challenges resulting from combining Datasources:

1. intended and unintended data manipulation
2. Transparent documentation of maintenances
3. Collaborative training of models for predictive Maintenance without revealing/exposing sensitive business information



Solution

- Collaboratively connecting data for training across machine operators
- Using blockchain and federated learning to preserve transparency and privacy



What is a Blockchain?

- Decentralized register of data that builds chronologically on each other and is secured by a consensus mechanism.
- Anyone can participate by creating a public/private key pair
- There is no central party managing the blockchain, anyone can run their own node or interact with the blockchain.
- Data in the blockchain is immutable
- Data in the blockchain is transparent

