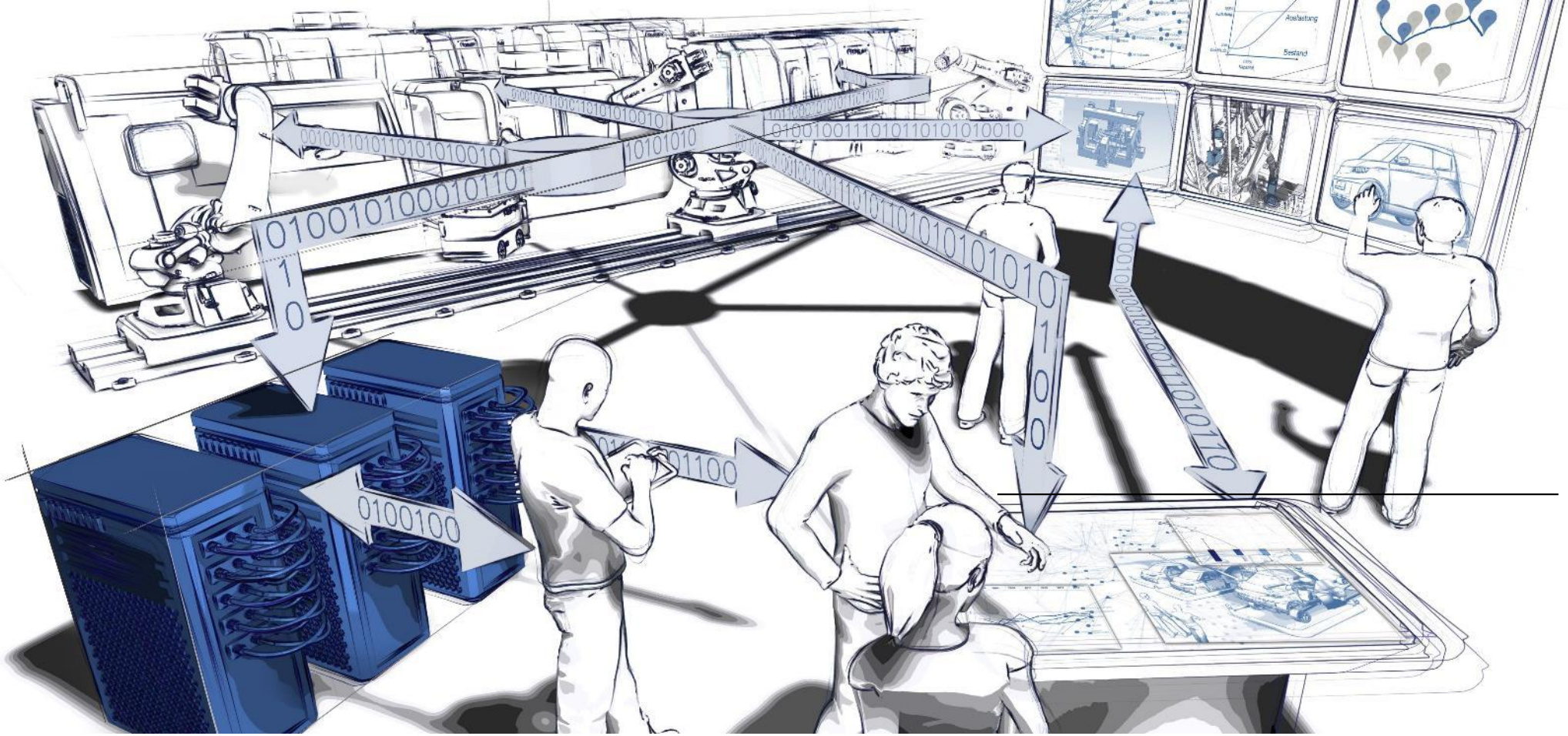


How GitOps solves Experiment Configuration Documentation

Moritz Kröger

INTERNET OF PRODUCTION | RWTH AACHEN UNIVERSITY

Agenda

1 **Who am I**

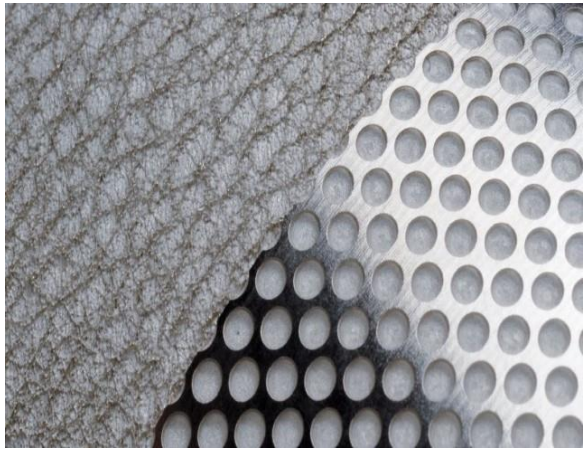
2 **Motivation Microservices**

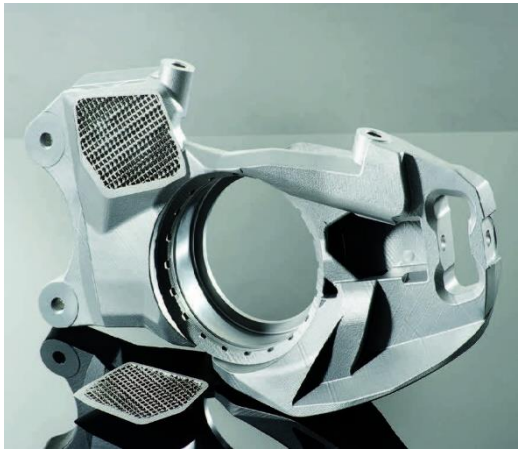
3 **Infrastructure as Code**

4 **GitOps for scientific experiments**

5 **Summary**

Who am I?





Chair:

LLT RWTH Aachen (since 2018)

Graduation:

M.Sc Engineering and Economics

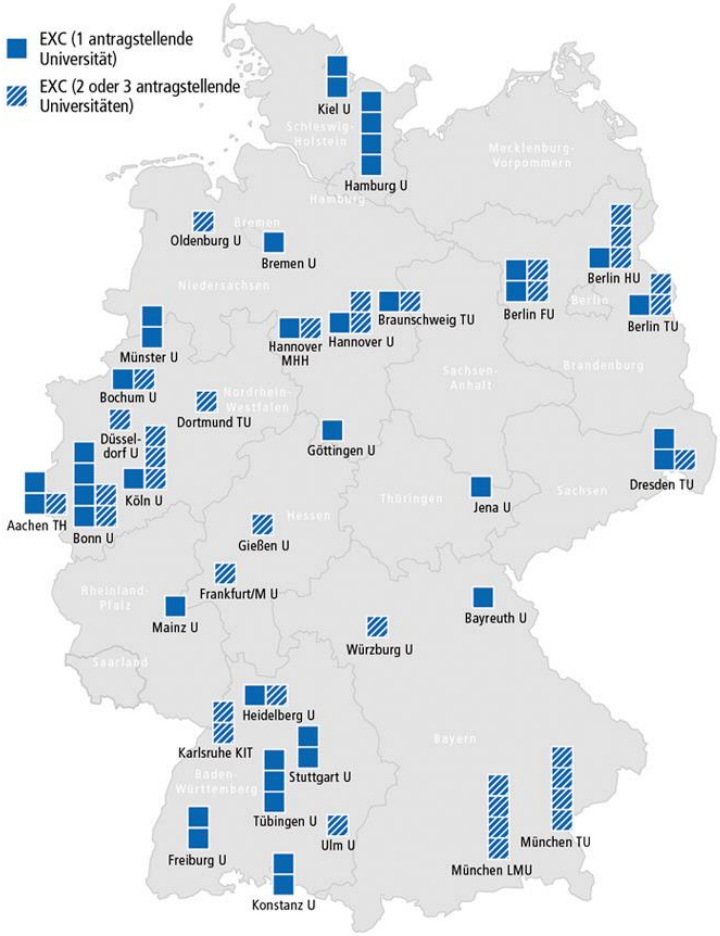
Laserprocess:

- Microstructuring
- Metal 3D Printing

Personal Research Topic:

- Datainfrastructure for manufacturing
- Cloud based manufacturing systems
- Integration of Datascience into Lasermanufacturing

Internet of Production 2019 - 2025



- **Cluster of Excellence „Internet of Production“**
- Funding ~ 50 Mio €
- 35 institutes involved in Aachen
- 200 involved scientists
- The only excellence cluster for manufacturing in Germany

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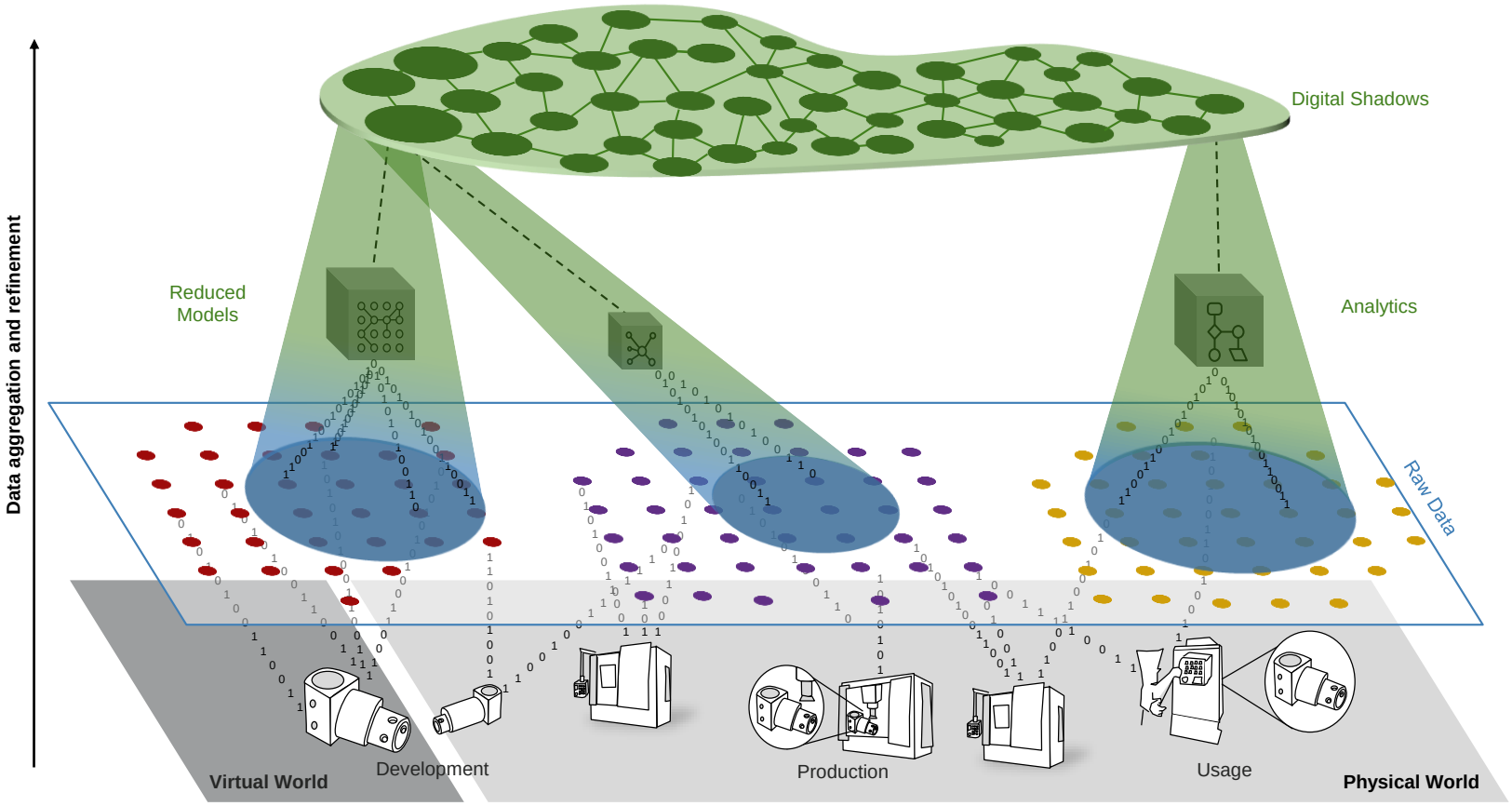
Vision of the Internet of Production – Digital Shadows



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Industry Partners

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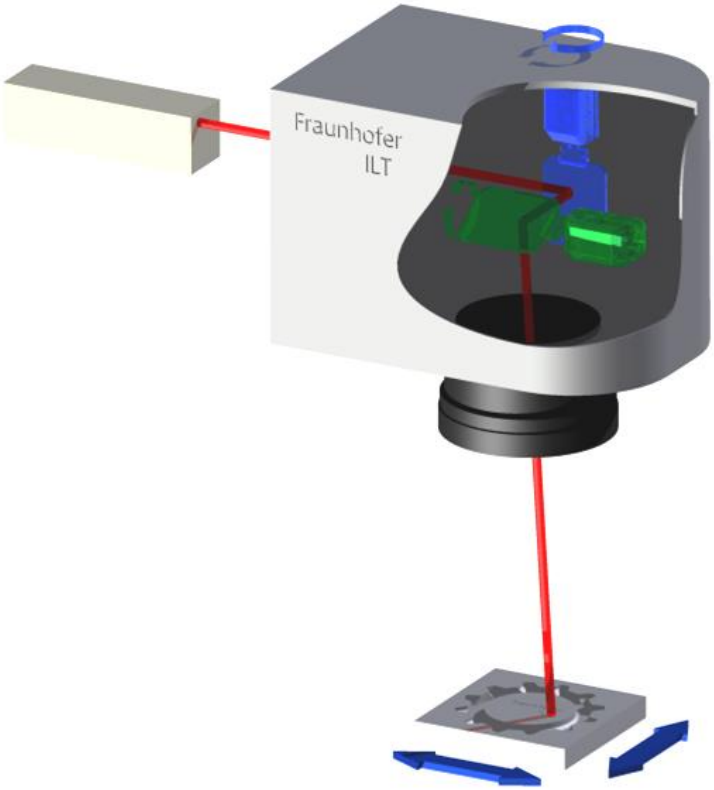
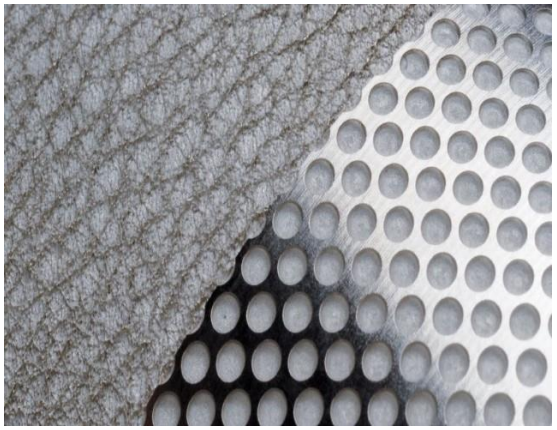
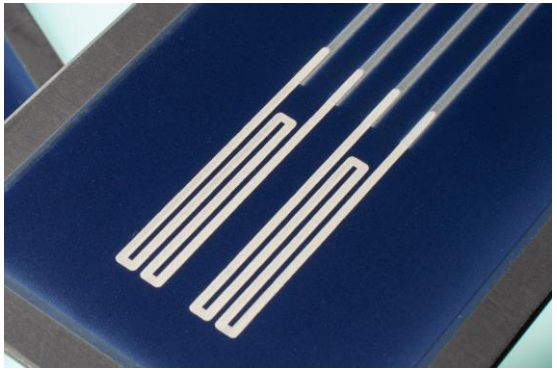
Motivation – Ultra short pulse manufacturing

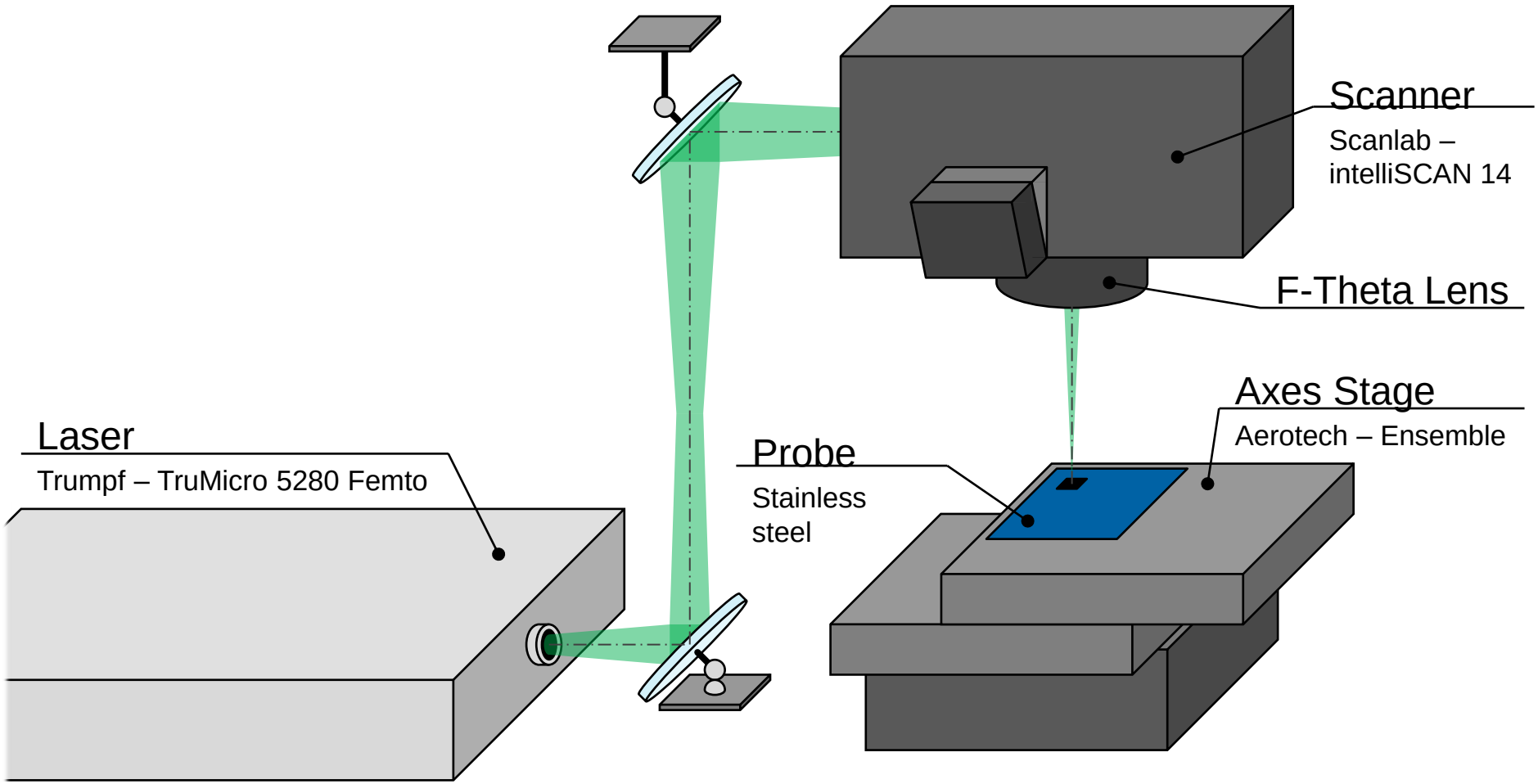






Source: Fraunhofer ILT

Ultrashort Pulse Ablation
Machine Setup



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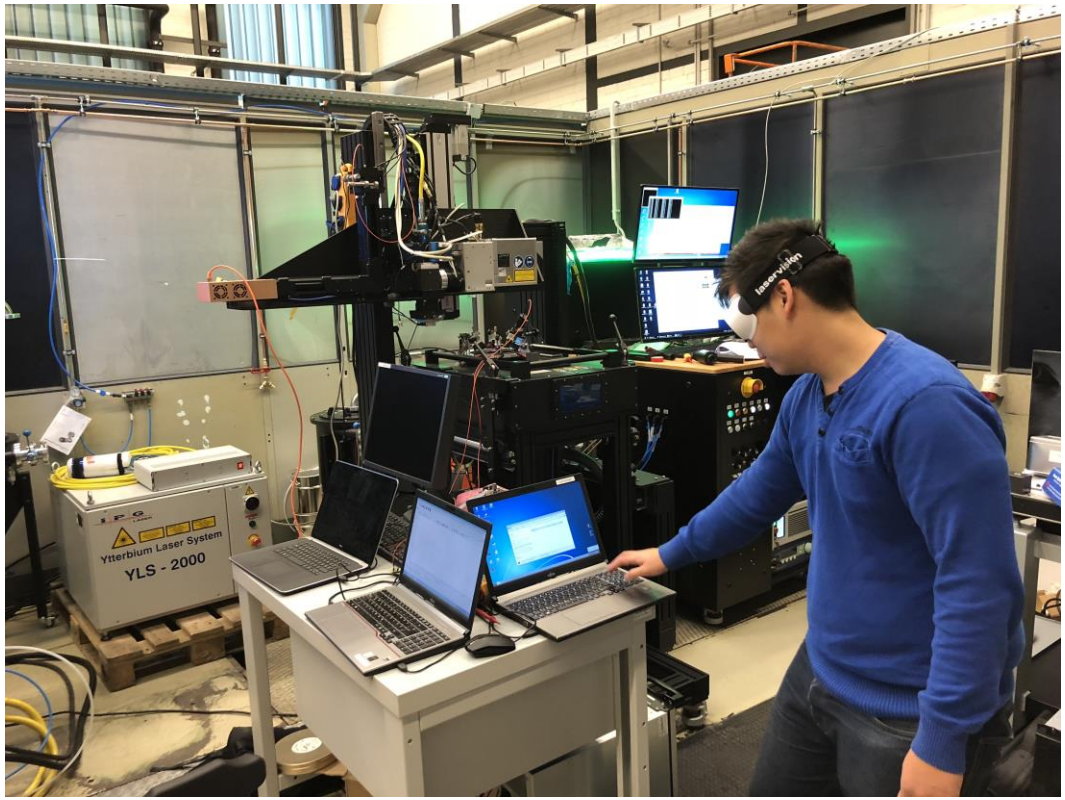
Motivation

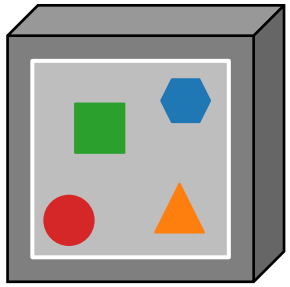


Due to increasing sensor acquisition rates we are already handling distributed computer systems!

Let’s try microservices!

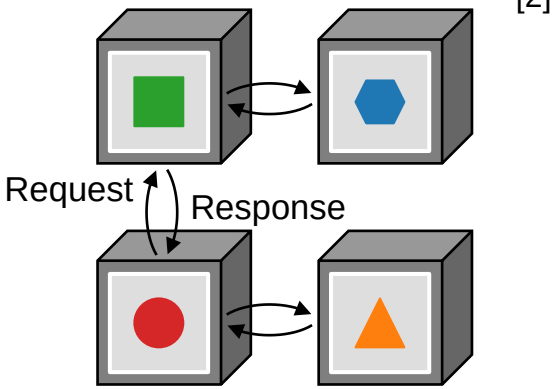
General Idea
Microservice-based Control & Measurement System

[2]



- Monolith
  A single executable software application whose modules rely on
  sharing the resources of the same computer. [1]
- Microservice
  A minimal independent process interacting via messages.[1]
- Messaging delay ~ milliseconds → No “real” time control

[2]



[1]: Microservices: yesterday, today, and tomorrow (Dragoni, 2016)
[2]: Microservices (Martin Fowler, 2014)

Objectives

- **Standardization** of hardware & process logic
- **Connectivity:** Hardware, Sensors **AND** data analysis in **ONE** system
- **Flexibility & Expandability**
- **Short development cycles**
- **Open Source**
- **Multi Language Support**
- **<u>Possibility Realtime Synchronization across Services</u>**

→Modular machine → Modular software

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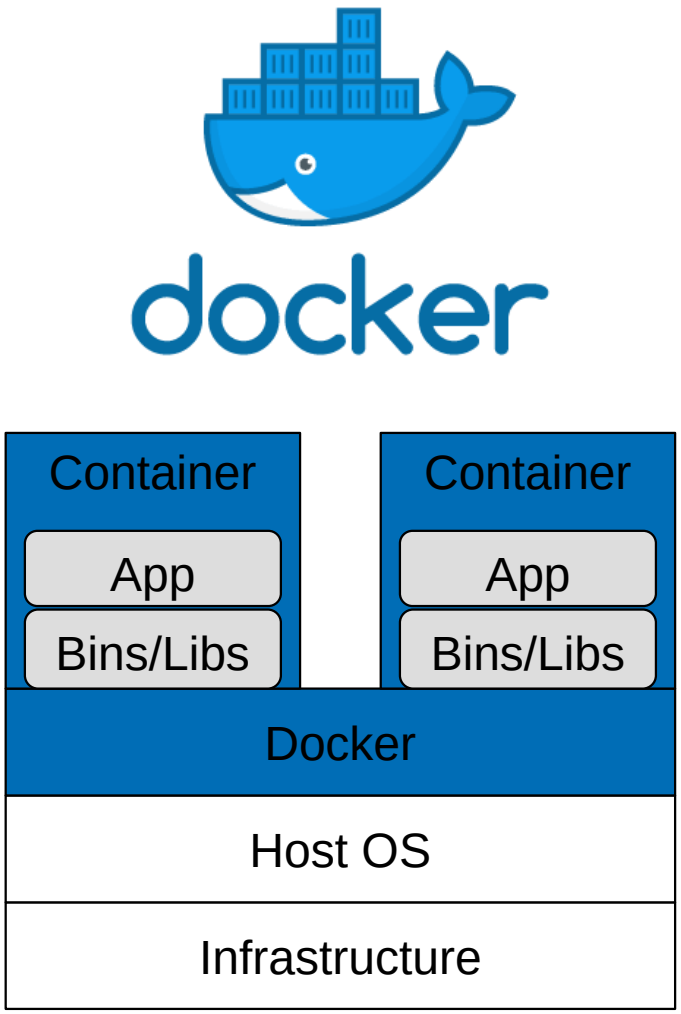
Managing Microservices - Docker



- Image based deployment of software
- Runs everywhere
- Automated deployment possible

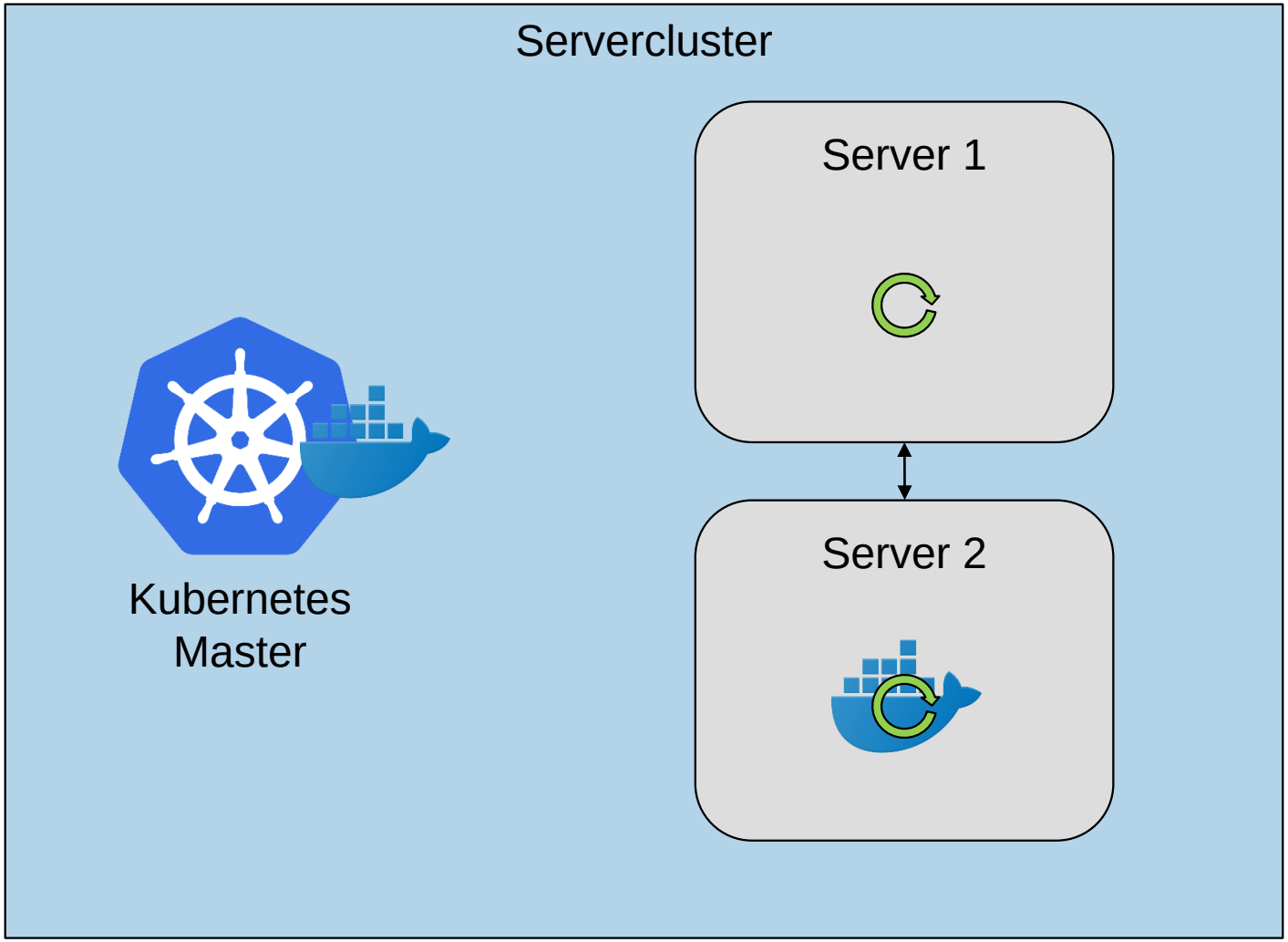
- **Allows hardware control**

Managing Microservices - Kubernetes in a nutshell

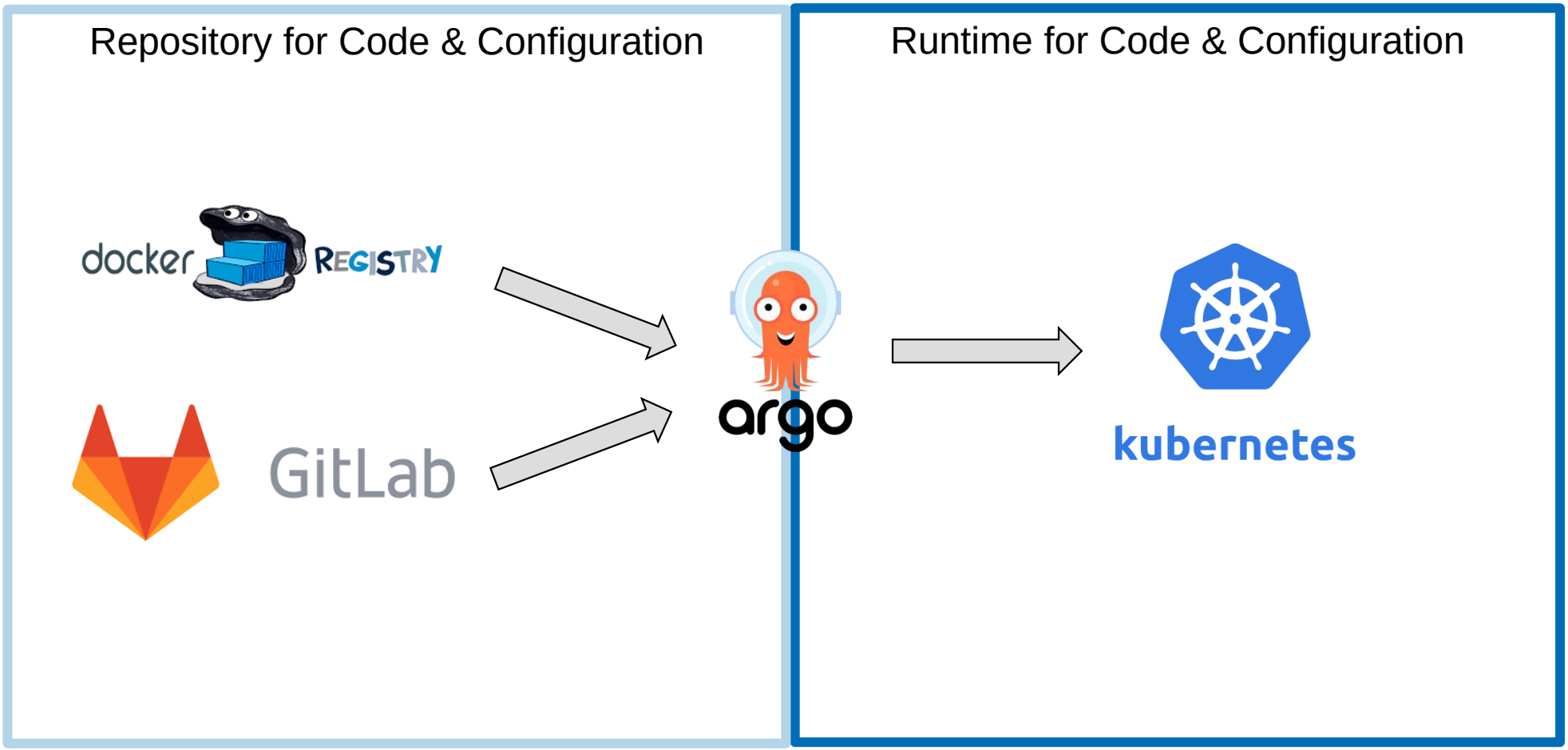
kubernetes

- Cluster/Server Manager
- Docker orchestration tool
- Offspring of Google‘s Borg
- ~45.000 Developers
- Completely open source

Kubernetes in a nutshell



ArgoCD for Hardware Deployment



Argo Demo

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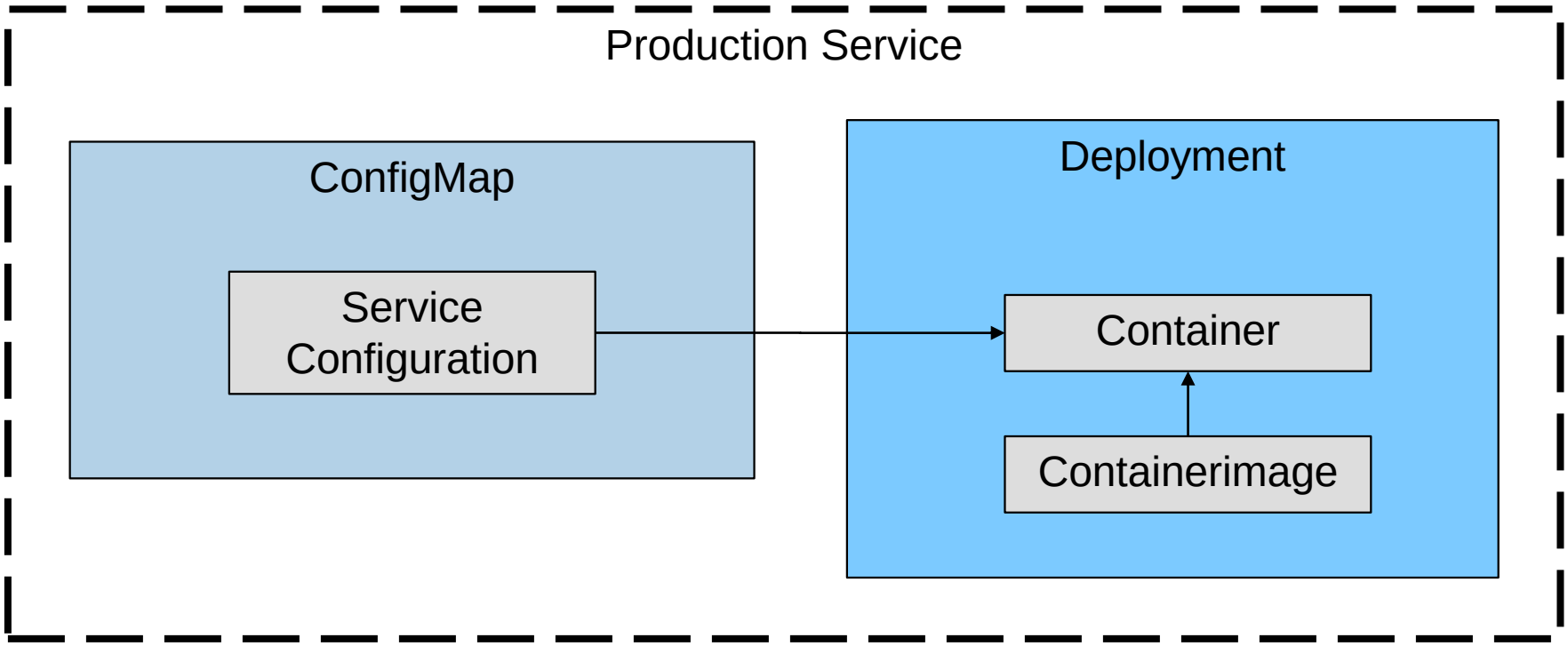
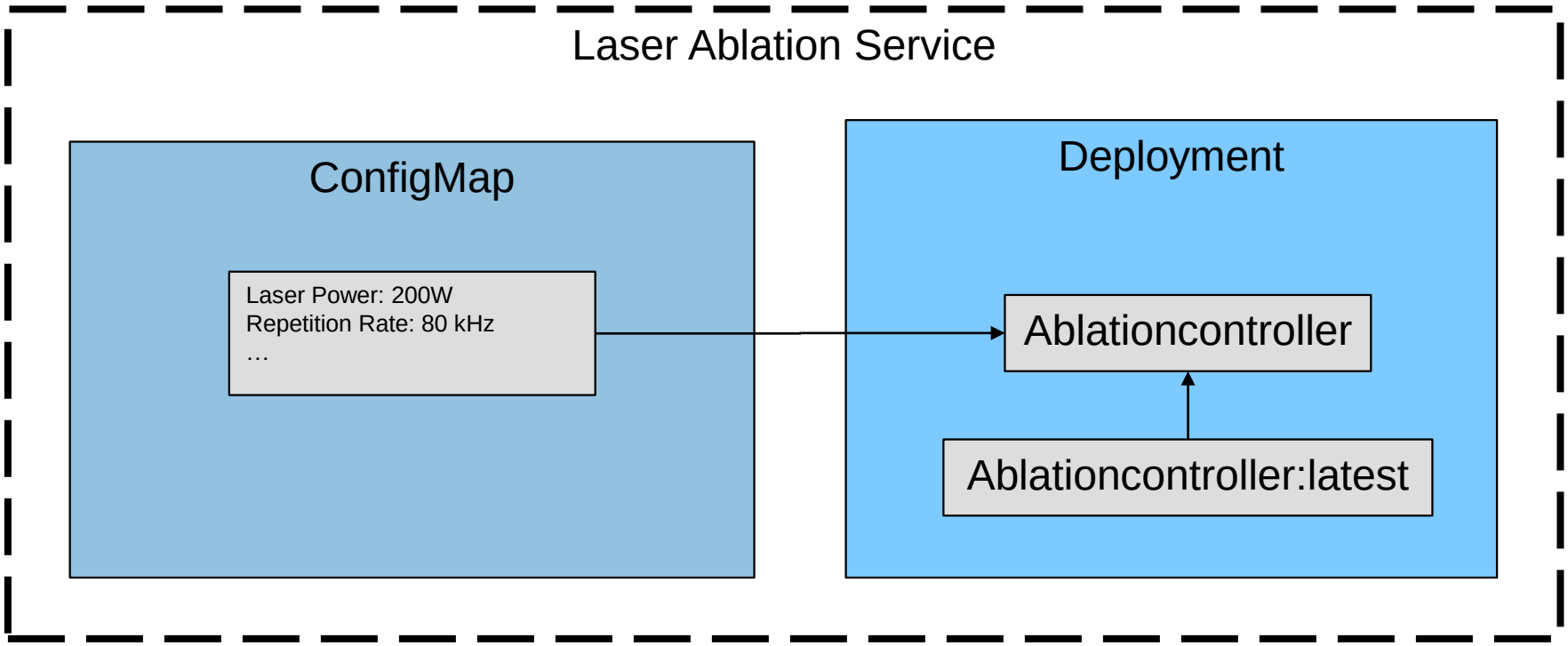
What is a Deployment?



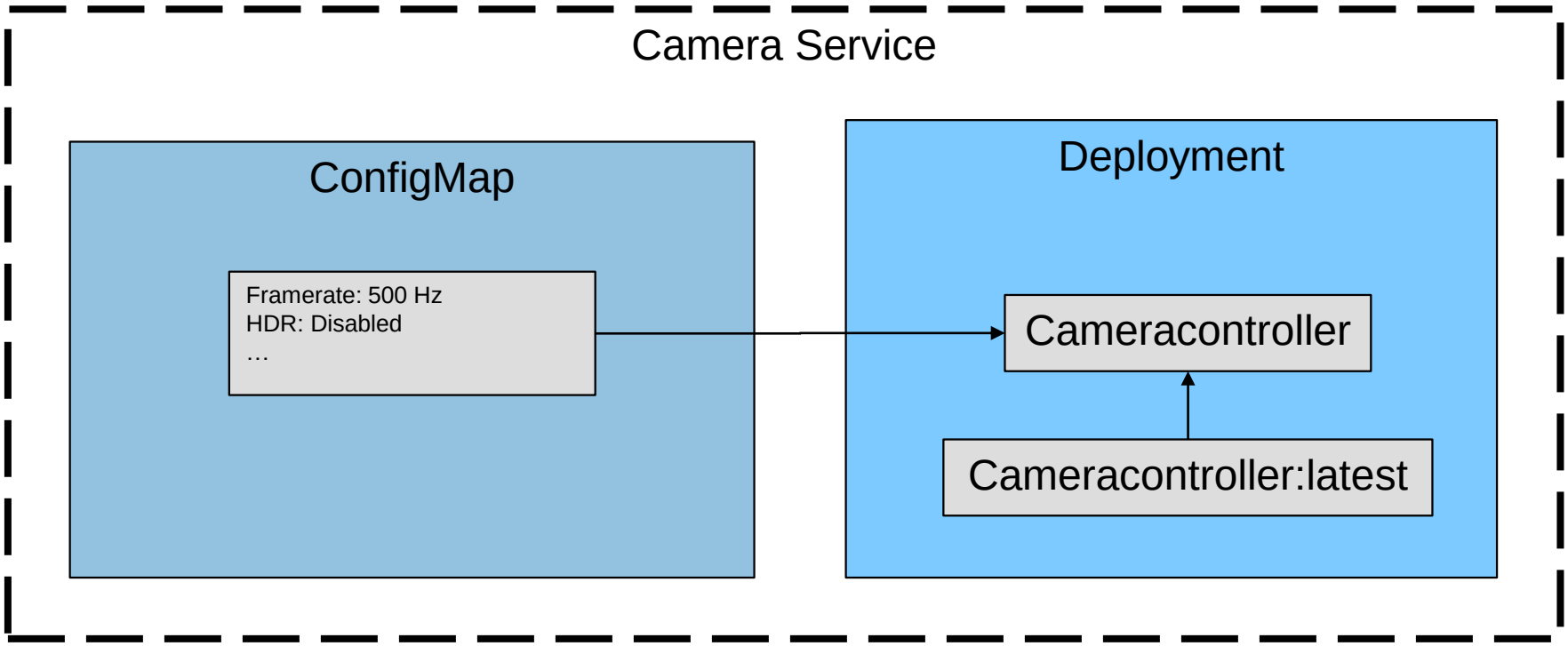
What is a Deployment?

Example 1:

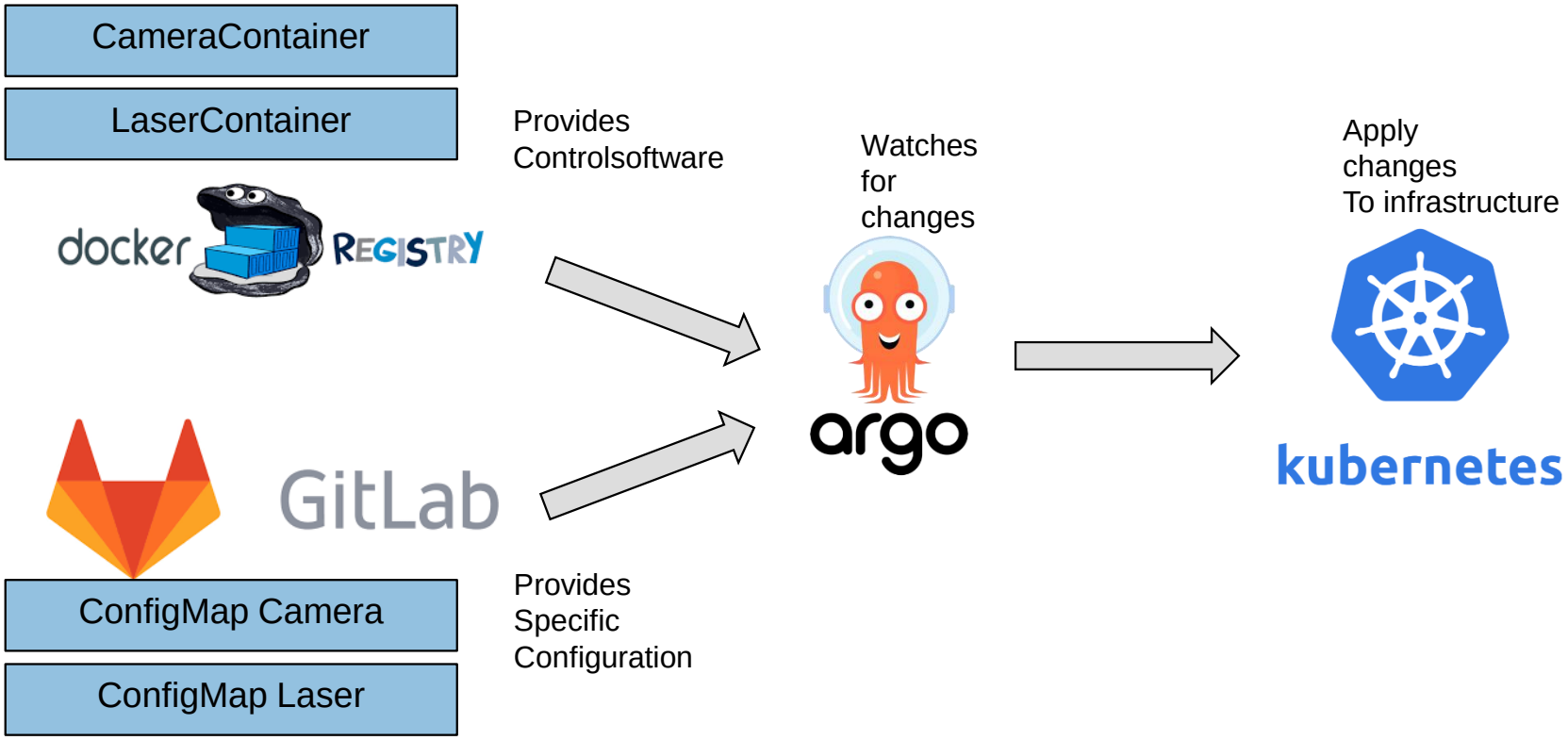


What is a Deployment?

Example 2:

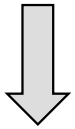


ArgoCD for Hardware Deployment



Solving scientific reproduciability

Versuchsnummer	Material	Laserleistung [W]	RepRate in kHz	Framerate Camera	HDR Enabled
1	In718	220	80	400	no
2	In718	240	120	400	no
3	In718	260	80	400	no



Versuchsnummer	Material	Machine Config Git Commit
1	In718	e3e6899
2	In718	8cf8463b
3	In718	34caa8ac

- No Human Documentation needed
- Documents all Parameters automatically
- Reroll possible
- Easy to retrieve automatically

Argo Demo

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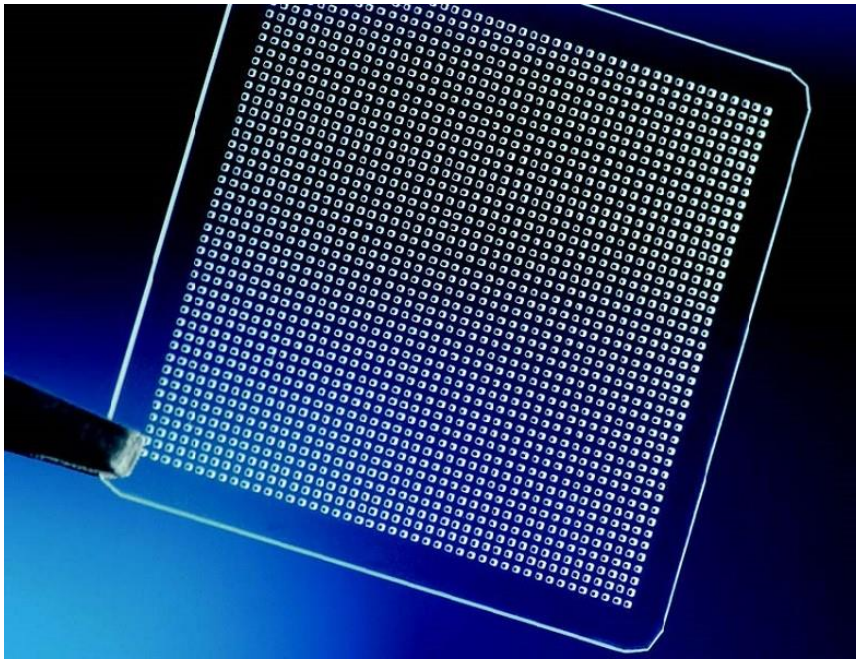

- Microservices for manufacturing systems
- Use of a Centralized Management System (Kubernetes) for Sensors, Actuators, Databases and Analytics
- Automatic generation of documentation through Git Commits
- Change in Git Automatically gets deployed via Argo
- Human errors are avoided through automation

Questions?

M. Sc. Moritz Kröger

RWTH LLT
Steinbachstraße 15
52074 Aachen - Germany

Tel.: +49 241 8040433
Email: Moritz.Kroeger@llt.rwth-aachen.de

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Backup: New Agenda