ROS-Industrial

European updates

Fraunhofer-Gesellschaft

Research and create innovations

At a glance

- World's leading applied research organization
- Founded in Munich (headquarters) in 1949
- Over 30,000 employees divided among 76 institutes and research units
- Annual research budget of €2.9 billion; Fraunhofer generates €2.5 billion of this from contract research
- Research excellence is an overarching goal
- Industry-oriented services for industrial customers

Fraunhofer IPA

Innovation driver with a scientific reputation since 1959

Key figures in 2021 in € million [1]	
Total budget	82
Operating budget	77[2]
Investment budget	5
Industrial revenues	23

Additional Key Indicators
Over 1,000 projects with industrial customers each year
Approx. 1,200 employees at 9 locations (headquarter: Stuttgart)
24 patents granted (5 in Germany, 19 internationally)
870 publications

1) All values incl. Fraunhofer Austria Research GmbH, Vienna, Business Unit Production and Logistics Management
2) Adjusted operating budget: increased by unburdening internal cost clearing in the amount of € 2 m with IPA value creation

Departement robots and assistive Systems

Innovating robotics since 1973

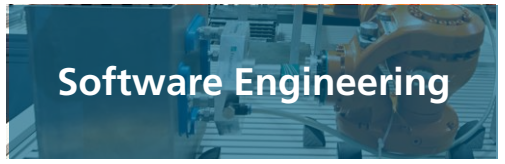
~ 70
employees

~ 40
robot

8
teams

11,5 M€
budget

Technologien



Software Engineering und System Integration

The team

Christoph Hellmann Santos
Team Manager

Dr. Björn Kahl
Modelling Expert

Nadia Hammoudeh Garcia
Modelling Expert

Vishnuprasad Prachandabhanu
Integration & Test Expert

Ruichao Wu
Deployment Expert

Harshavadan Deshpande
Modelling Expert

Ragesh Ramachandran
Integration & Test Expert

Anna-Maria Meer
Integration & Test Expert

Fraunhofer IPA

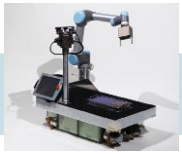
Innovation by Fraunhofer IPA fuelled by ROS

State funded research

Technologies

2009

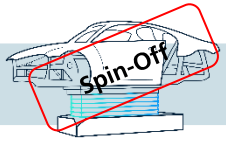
Care-o-Bot 3



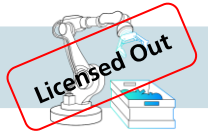
Rob@Work 3

Care-O-Bot 4

Easy robot programming



cooperative navigation



bin picking

easy force-feedback

easy robot welding

2023

Spin-Offs

Software Engineering und System Integration

Some common problems in robotics

1	**Reusability** of software components is not very common in robotics.	**Robot Software Frameworks**
2	**Composition** of a functional and reliable robot software systems is challenging.	**Integration Tools & System Integration**
3	**Validation** of robot systems is difficult	**System Testing Environments**

Software Engineering und System Integration

Revolutionising robot software integration

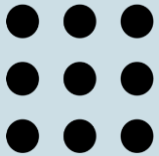
We revolutionise robot software integration by:

- Providing model-driven integration tools that reduce programming and integration efforts drastically
- Supporting our customers system composition projects with our expertise and tools
- Providing test and experimentation environments for our customers to evaluate and boost their robot technology developments
- Enabling easy integrating of professional robot software with the robot operating system to leverage the most recent control, planning and sensing algorithms.

Integration Tools

System composition

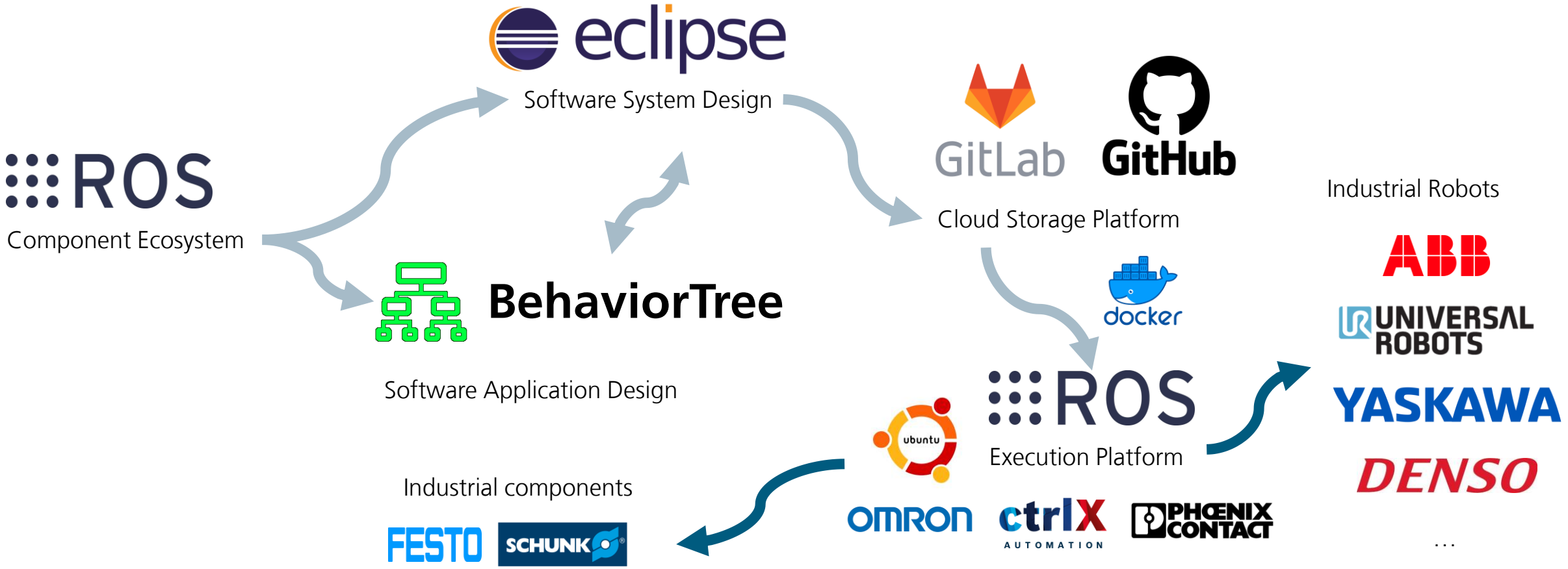
System Testing



Robot Operating System

Software Engineering und System Integration

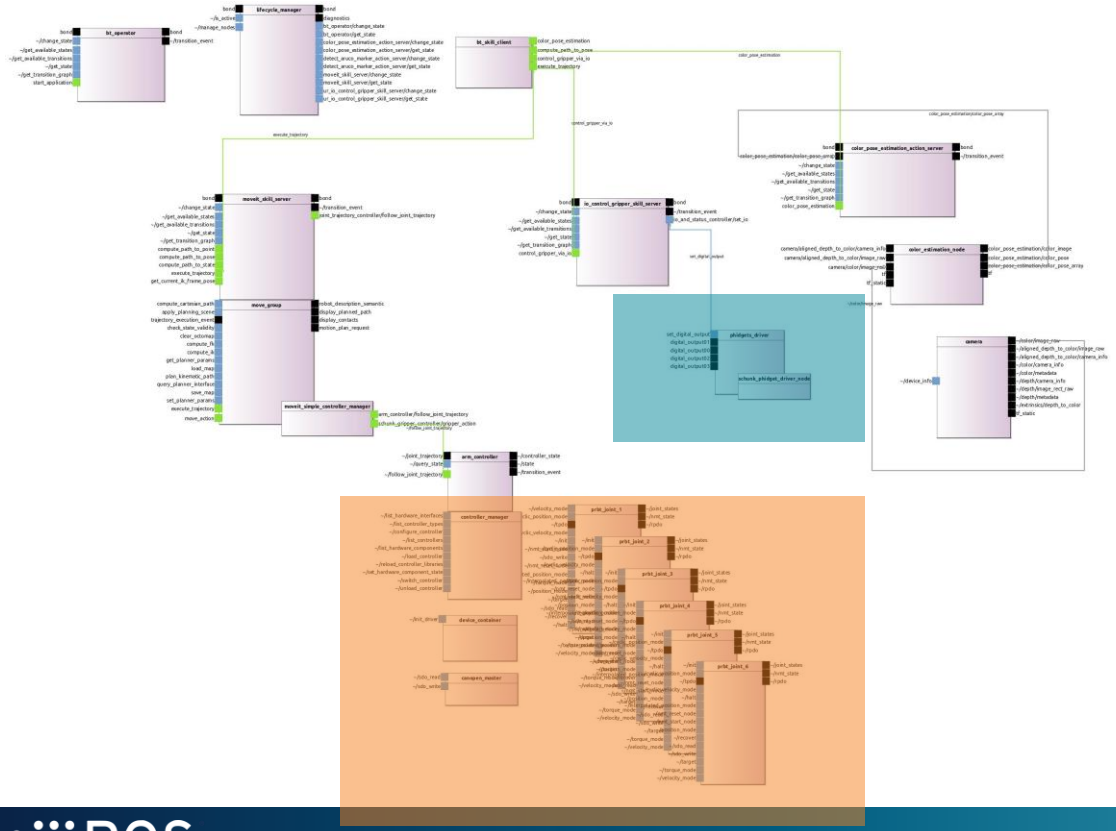
An opensource model-driven robot software toolchain



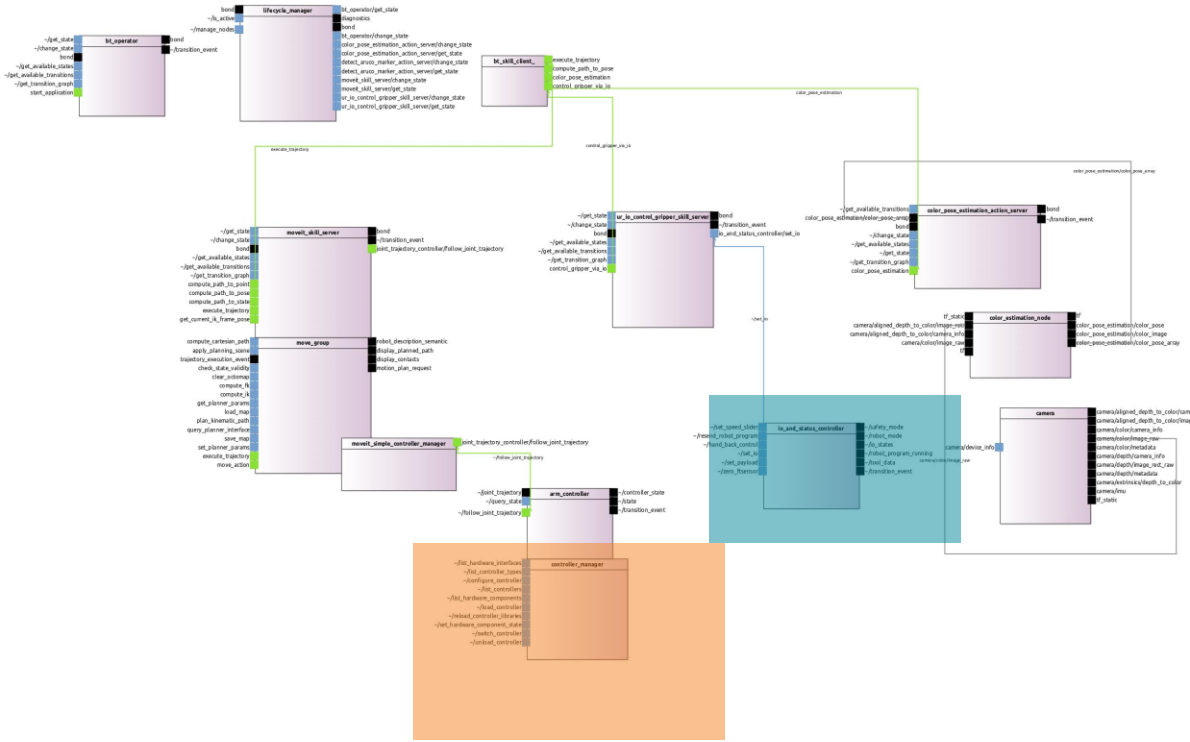
Software Engineering und System Integration

Software system model

Software system – Pilz Application



Software system – UR Application

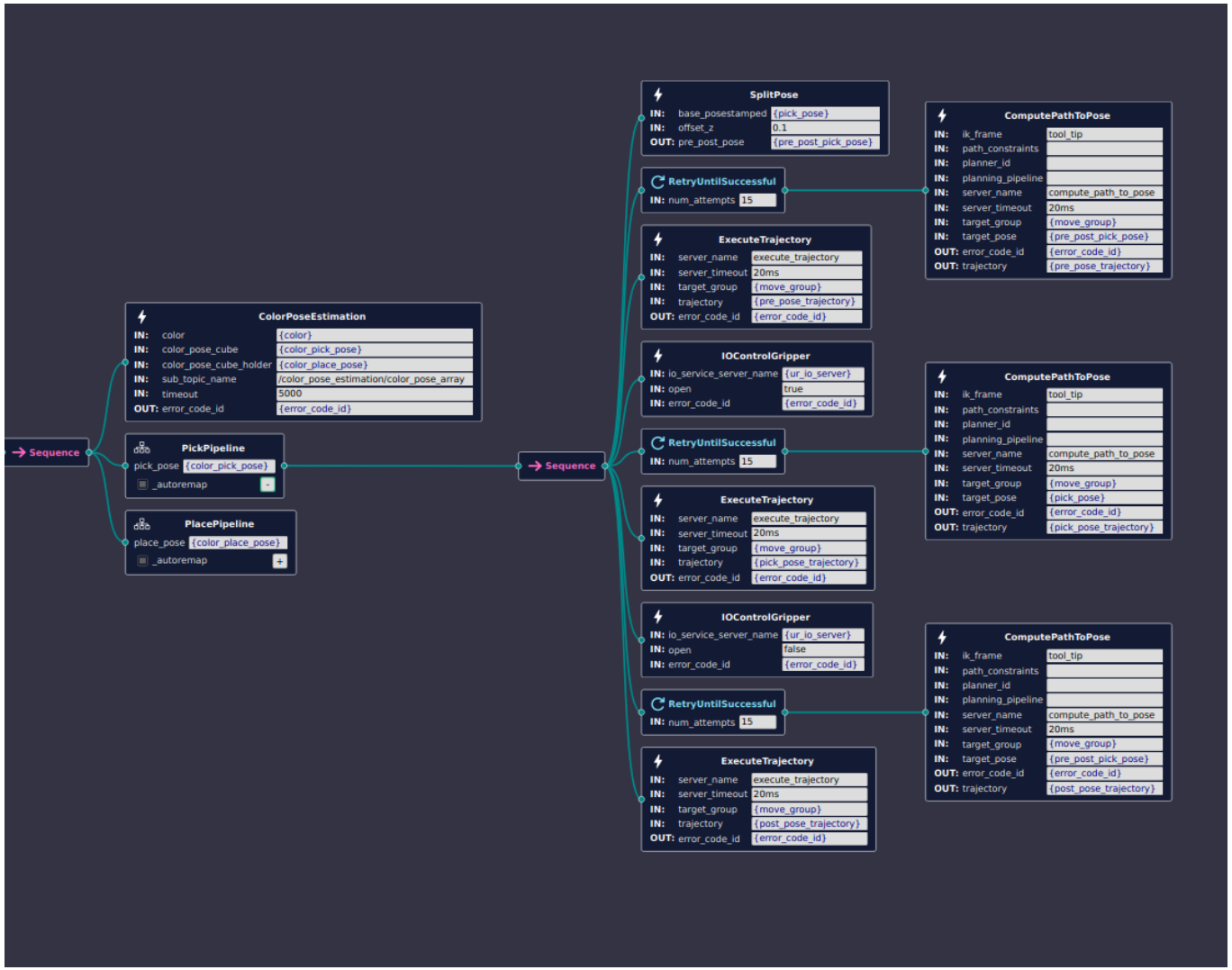


Software Engineering und System Integration

Software application model

BehaviorTree

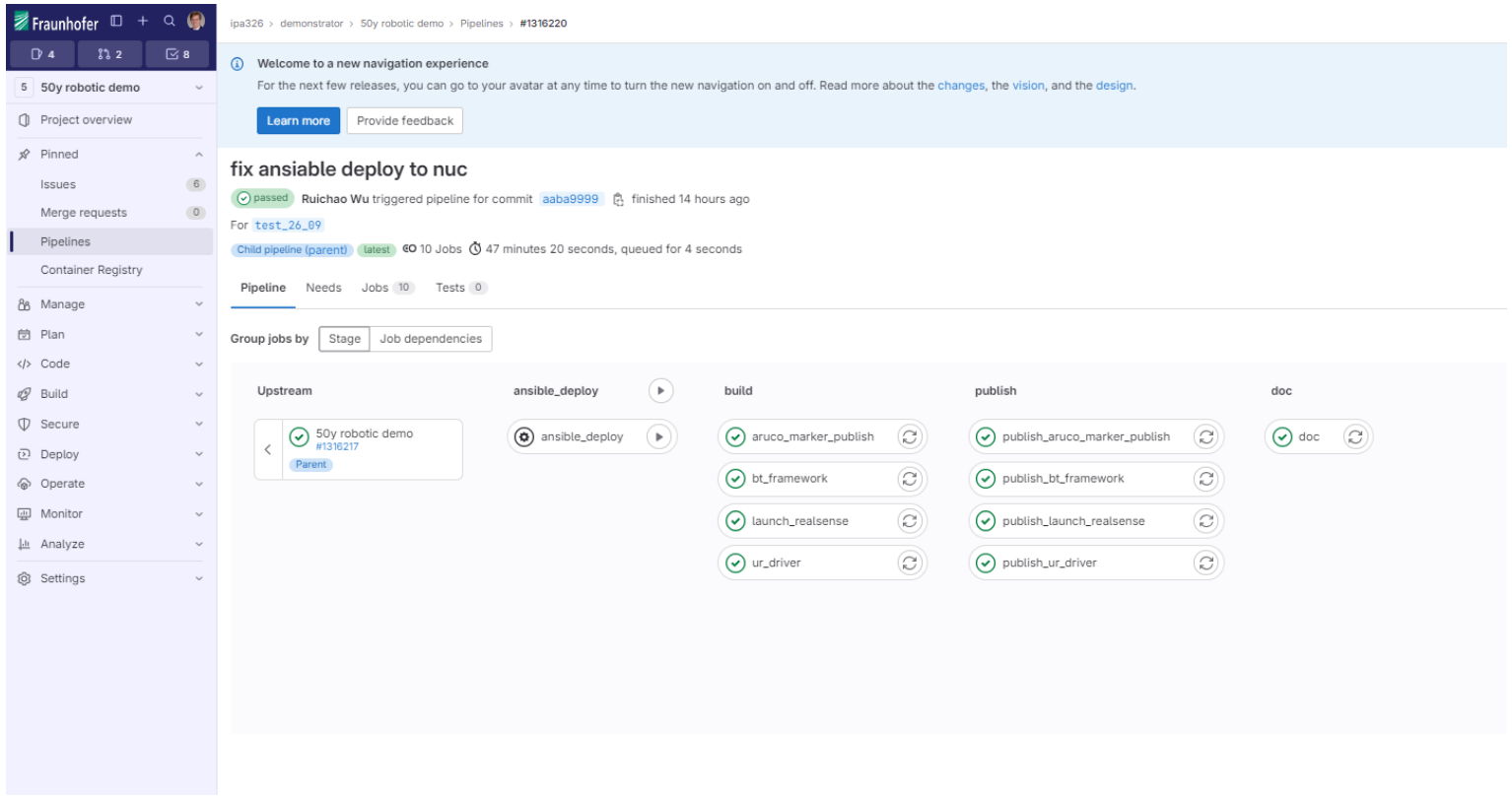
- Own library of skills for behaviour trees based on behaviortree.cpp
- Easy addition of new or existing skills
- Even skills that are not supporting ROS can be integrated
- Fast and error resilient development of robot applications
- Only minimal changes necessary when running on different robots



Software Engineering und System Integration

Deployment

- Direct integration into version control systems such as GitHub or GitLab
- Always know which model is deployed to which robot
- Integration with previous integration tests possible

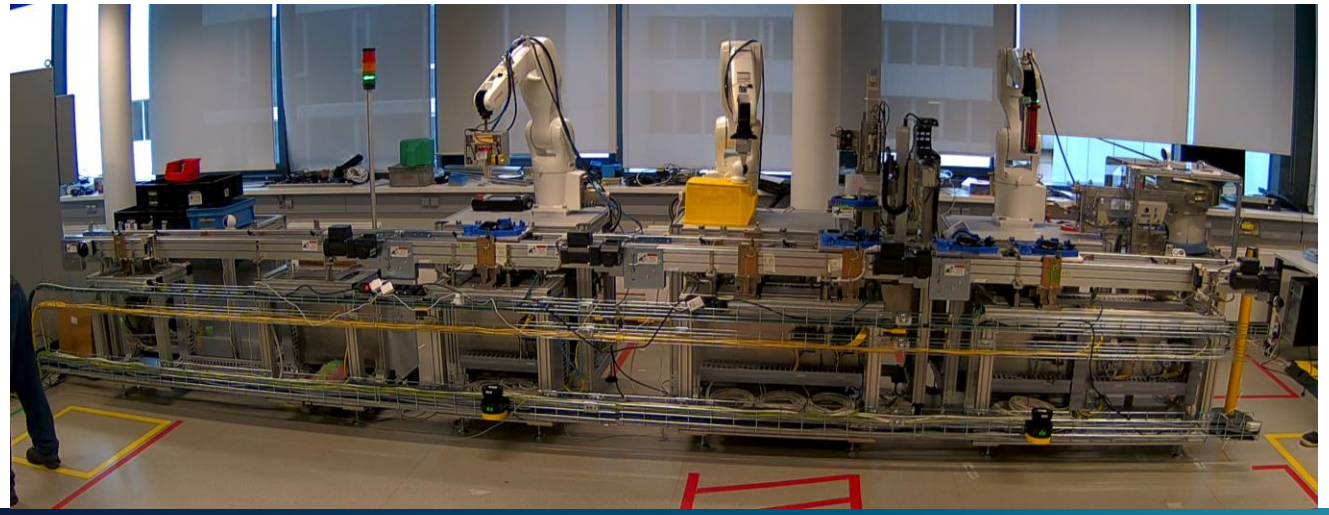


Software Engineering und System Integration

Concepts deployed in different lines and robot cells

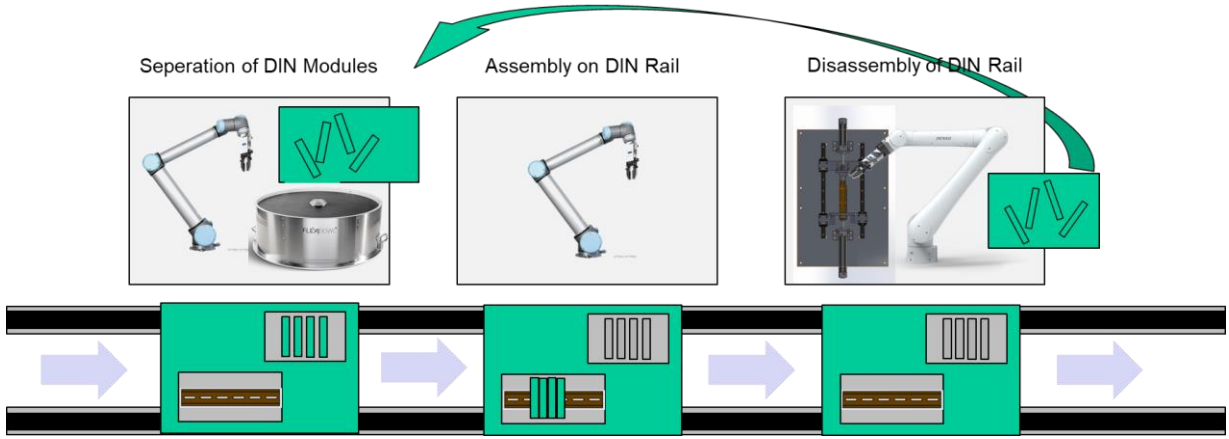
Testing line (2022)

- Manufacturing line with one manual station and 3 robot stations
- Configure production with recipes flexibly
- Define behaviour of stations with proprietary behaviour tree library written in Ladder



Testing line (Q1/2024)

- Manufacturing line with 3 robot stations



Reference robot cell

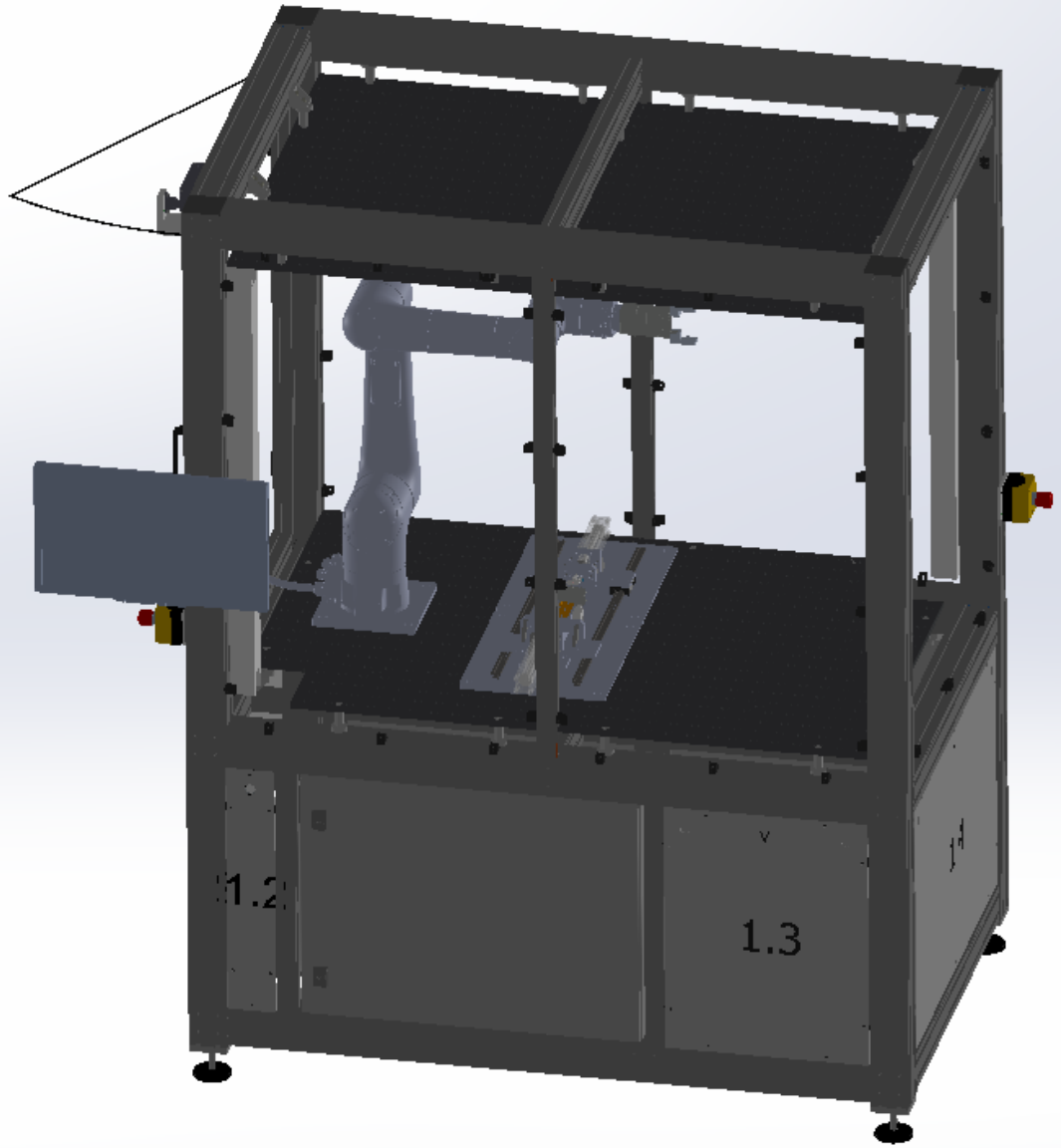
Ongoing effort – First iteration

Current status:

- Initial design done
- First two cells being setup

Component status:

- Robots:
  - Universal robots: U5e, UR10e (tested)
  - Denso: Cobotta Pro 900 (tested)
  - Yaskawa Motoman: HC10 (ordered)
  - Kuka: KR10 (ordered)
- PLCs:
  - Omron: NJ (OPC-UA driver – tested - propietary)
  - Bosch Rexroth: CtrlX (PLC integrated driver – under development)
  - Phoenix Contact (PLC integrated driver - tested)
- Peripheral equipment:
  - Intel: realsense (tested)
  - Schunk: EGP grippers (tested)
  - Festo: VTEM (under development)



Reference robot cell

Ongoing effort – First iteration

System features:

- Mounting grid 50x50 mm (compatible adapter plates available or easily designed)
- Normal as well as top down mounting possible
- Built-in cabinet (DIN rail)
- Screen mount
- Space for robot controller, pneumatic cabinet and industrial PC
- Industry ready: safety guard locking and emergency buttons

Services:

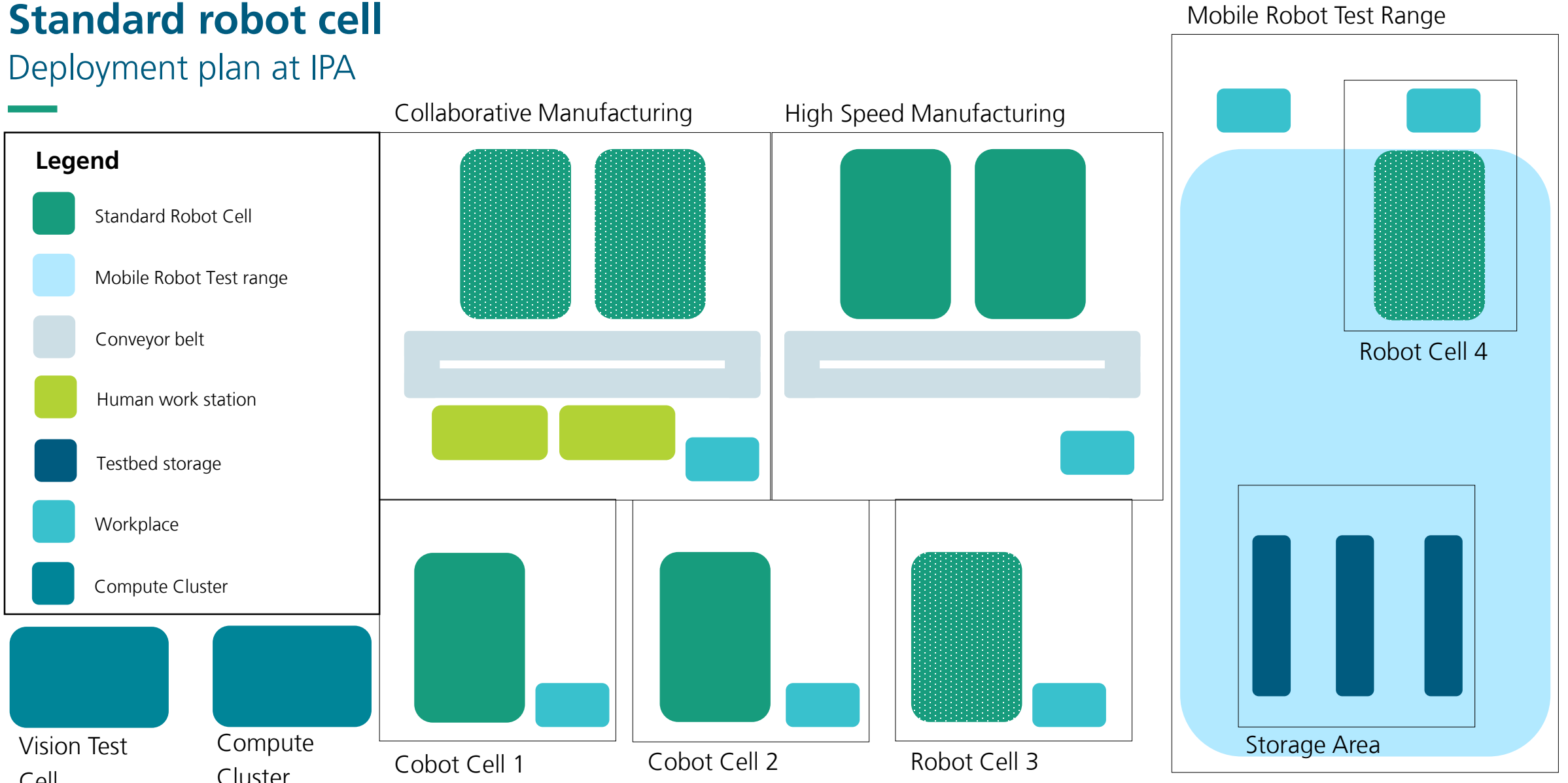
- Cell including safety wiring, PLC and IPC: ~35k€
- Robots and applications can as well be designed

To be open source'd:

- Hardware specifications
- Software repositories

Standard robot cell

Deployment plan at IPA



Other efforts

Ongoing in Europe

CANopen
(IPA)

Industrial CI
(IPA)

UR robot driver
(Universal Robots &
FZI)

EtherCAT
(ICUBE)

Contact

Christoph Hellmann Santos
Team Manager Software Engineering and System Integration
Fraunhofer IPA
Nobelstr. 12
70569 Stuttgart

Tel: +49 711 970-1097
Mail: cmh@ipa.fraunhofer.de

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technik und Automatisierung IPA