



University of Stuttgart
Institute of Industrial Automation
and Software Engineering



Research and Teaching at IAS

2019

Prof. Dr.-Ing.
Dr. h. c.
Michael Weyrich



History



since 2013
Institute of Industrial Automation
and Software Engineering
Professor M. Weyrich

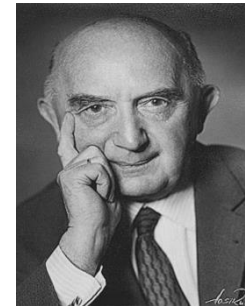


1970 – 1995
Institute of Control Systems
Engineering and Process
Automation
Professor R. Lauber

1995 – 2015
Institute of Industrial Automation
and Software Engineering
Professor P. Göhner



1935 – 1970
Institute of Electrical
Installations
Professor A. Leonhard



Institute of Industrial Automation and Software Engineering (IAS)

Faculty of Computer Science, Electrical Engineering and Information Technology of the University of Stuttgart

Research and teaching at the Institute focuses on the topic of **Software Systems for Automation Engineering**.

We see ourselves as a **bridgehead to Product and Plant Automation** in the research disciplines of **Information Technology, Software Technology and Electronics**.



Prof Weyrich was appointed to the University of Stuttgart in April 2013.



The IAS in the research environment of Stuttgart

The institute follows the mission statement "**Intelligent Systems for a Sustainable Society**" and is part of the **Excellence Strategy of the University of Stuttgart**.



Institute of Industrial Automation
and Software Engineering

We are part of the profile areas and emerging fields of the **excellence strategy**:

- Autonomous Systems
- **Architecture and Adaptive Building**
- Production Technologies



Universität Stuttgart

ARENA2036

Research Factory

CyberValley

Intelligent Systems



Technology transfer

Information about IAS

- Institute members
 - Head of institute: 1
 - Research staff: 15
 - Faculty support staff: 3
 - Apprentices: 2

- PhD graduates 2018: 1

- Undergraduate Projects and Master Theses 2018: 78

- Exams 2018: 1005

- Publications 2018: 30

- Student Assistants per annum: 40-50

Lectures at the Institute

- Industrial Automation I (German)
- Industrial Automation II (German)
- Technologies and Methodologies of Software Systems I (German)
- Technologies and Methodologies of Software Systems II (German)
- Software Engineering for Real-Time Systems
- Industrial Automation Systems
- Basics of Software Systems (German)
- Lecture Series: Software and Automation
- Reliability of intelligent distributed Automation Systems (German)

- Laboratory Software Engineering
- Laboratory Industrial Automation
- Laboratory Introduction in microcontroller programming

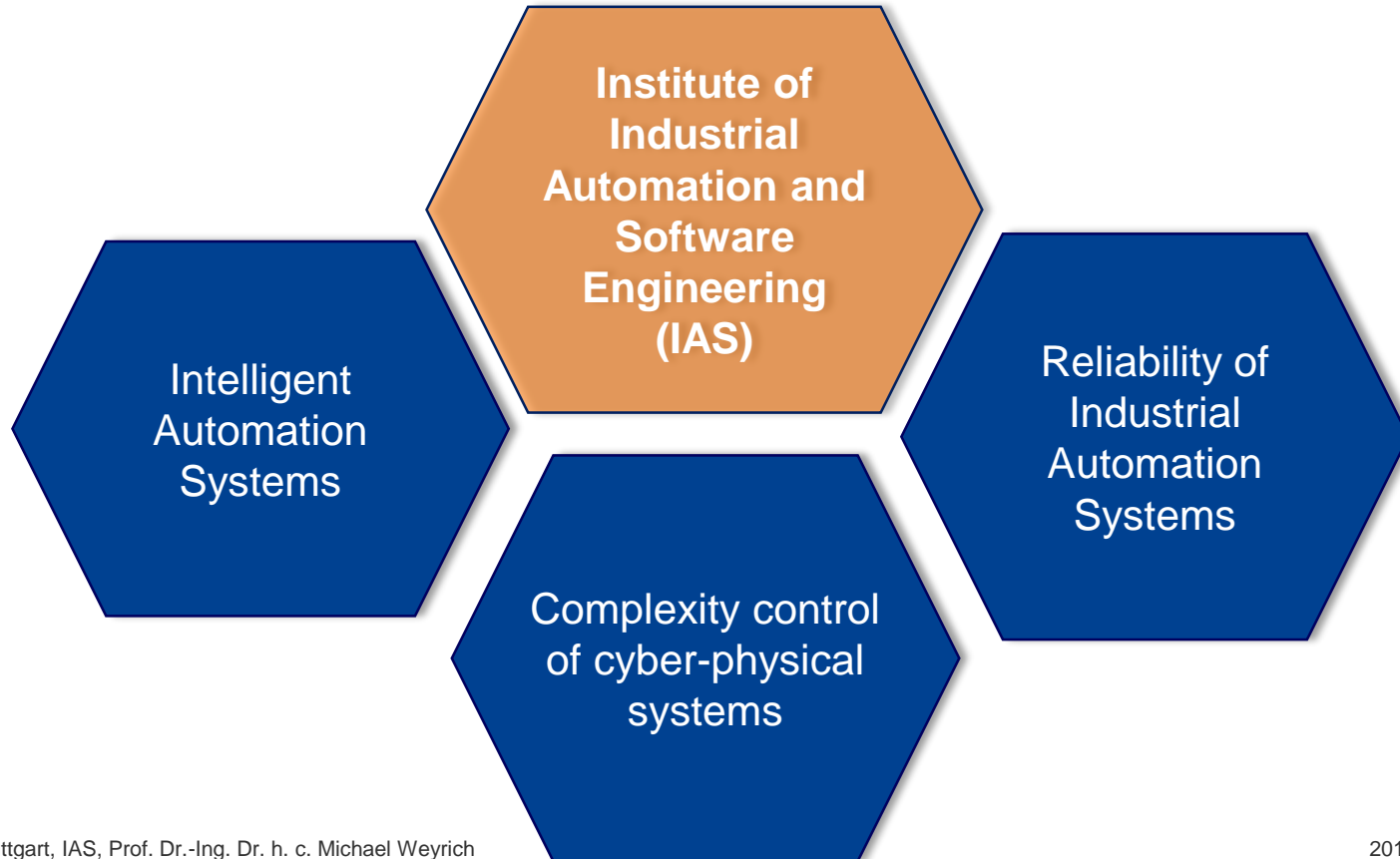
Courses for Degree Programmes

- B. Sc. Elektrotechnik und Informationstechnik
- B. Sc. Mechatronik
- B. Sc. Medizintechnik
- B. Sc. Erneuerbare Energien
- B. Sc. Technische Kybernetik
- B. Sc. Technikpädagogik
- B. Sc. Informatik

- M. Sc. Elektrotechnik und Informationstechnik
- M. Sc. Mechatronik
- M. Sc. Medizintechnik
- M. Sc. Information Technology
- M. Sc. Autonome Systeme
- M. Sc. Elektromobilität
- M. Sc. Nachhaltige Elektrische Energieversorgung
- M. Sc. Technikpädagogik
- M. Sc. Verkehrsingenieurwesen

Research at IAS

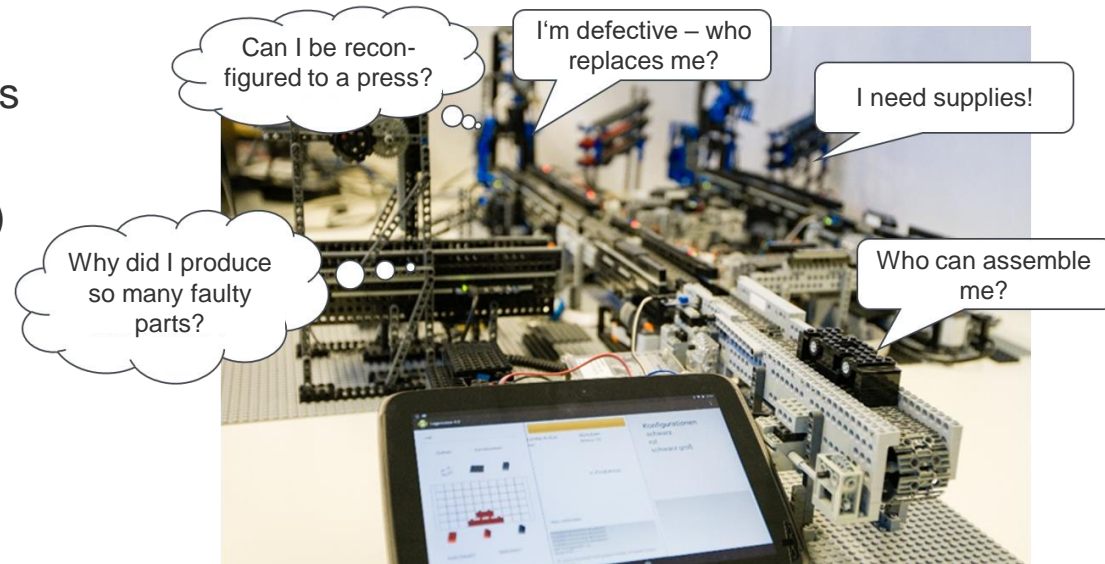
The research of Automation Technology is based on applications in the manufacturing industry, automotive and urban life.



Research area: Intelligent Automation Systems

Intelligent automation systems offer opportunities in the area of optimization, flexibility and networked information management.

- Autonomous integration of automation components (Self-X)
- Optimization of automation systems based on process data (Machine Learning, Big Data, Data Analytics)
- Distributed control methods for coordination
- Assistance systems to support the engineering process



Research area: Complexity control of cyber-physical systems

Digital twins, networking and cooperation enable novel engineering and work processes. At the same time, the complexity of cyber-physical systems is increasing due to software and IT.

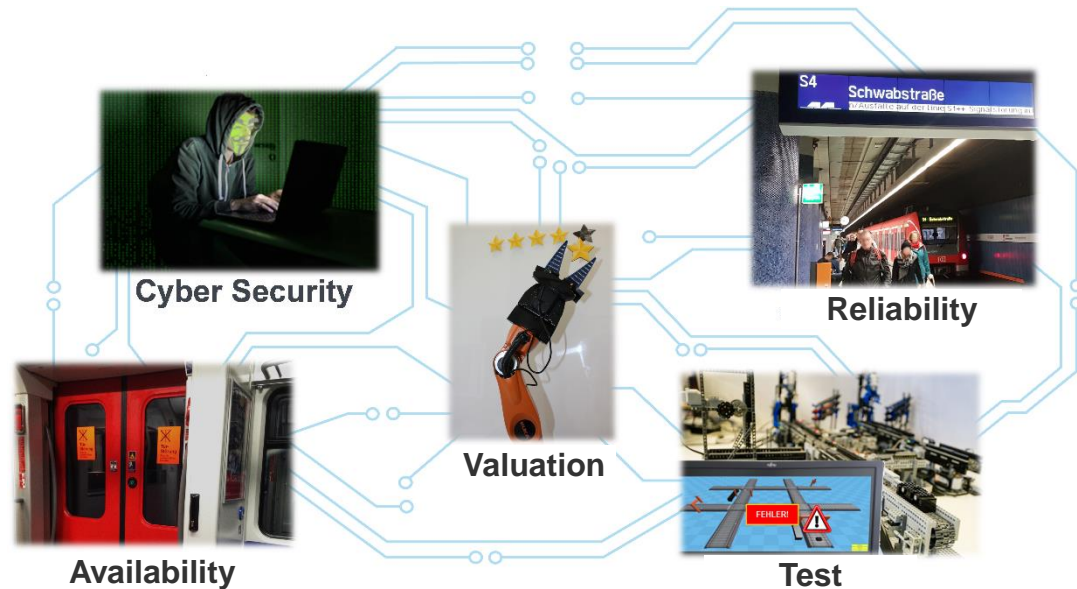
- Model-driven development of distributed plant controls
- Model-based test of dynamically changing software and hardware systems
- Digital twin and its applications
- Human-machine cooperation in a hybrid reality



Research area: Reliability of Industrial Automation Systems

The quality of automated systems in terms of improving reliability and availability is a key issue in automation.

- Assessment and evaluation of the reliability of automated systems in the Internet of Things
- Fault management and automatic reconfiguration to increase availability
- Test of automated systems and anomaly detection



Model processes at IAS

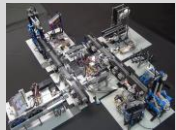
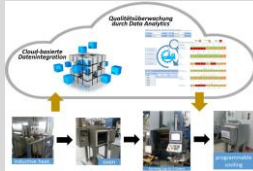
The model processes are used to represent special automation technology and to demonstrate the capabilities of software systems.

Intelligent Automation Systems



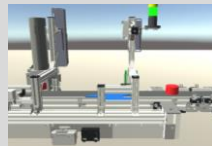
Production Process Chain

Data Analytics in Manufacturing



Industry 4.0 Assembly plant

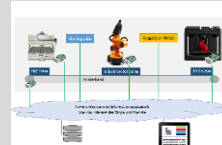
Simulation of plant modernization



IoT scenario: Mountain Hut

Complexity control of CPS

AutoSAR



eProduction-System

Modular Production System



Driving simulator

Reliability of Automation Systems



TestIAS with Virtual Reality

Automated Bottling Plant



Testfortschrittsübersicht		
	Variante 1	Variante 2
Subsystem X		
Component A	Green	Red
Component B	Green	Red
Component C	Green	Red
Component D	Green	Red
Component E	Green	Red

Assistance system Test case prioritization

Smartphone-based Fault Diagnosis



BMWi-Project EMuDig40

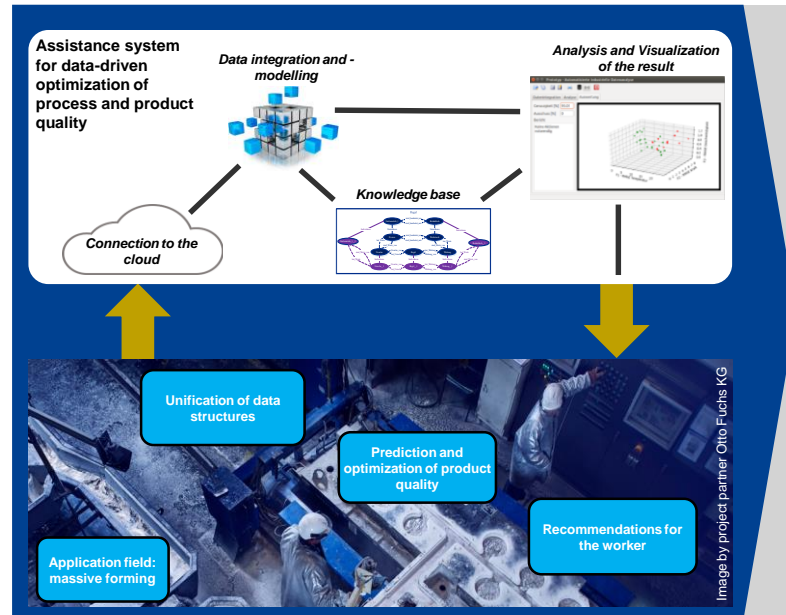
Data analytics in quality assurance

Requirements:

- Analysis of process data for compliance with defined quality characteristics
- Real-time recommendations to the worker

Core technologies:

- PLC-based data acquisition
- Feature extraction
- Data Analytics (online/offline)



Motivation

- Sensor data contains information about the plant and process status and can be used to improve the process quality

Approach

- Systematic extraction of unknown relationships and patterns
- Data acquisition and integration, dimension reduction, data analysis, recommendations
- Data-driven quality optimization

TANTUM

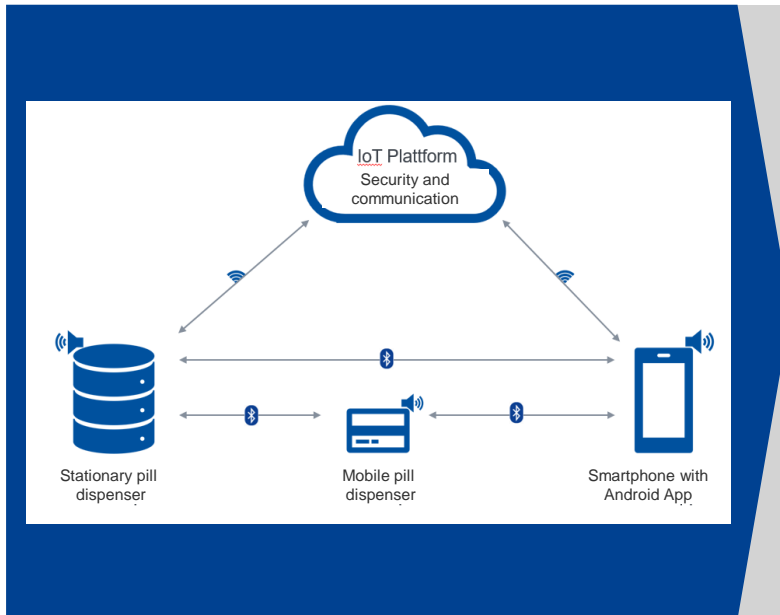
User-centric pill dispenser and pharmacy pill-placement system

Requirements:

- A networked system to ensure regular and accurate medication use with a stationary and mobile pill dispenser

Core technologies:

- Flow-based programming
- Multimodal adaptive user interface
- Internet of Things



Approach

- Implementation of an IoT approach for stationary and mobile use
 - Automatic recognition of the medication plan, alarming and pill dispensing as well as the recognition of taken pills.
 - Personalized support through alarm setting and adaptive alerting
- Realization of a multimodal, elderly-appropriate user interface by means of optical, acoustic and haptic channels

Digital Twin

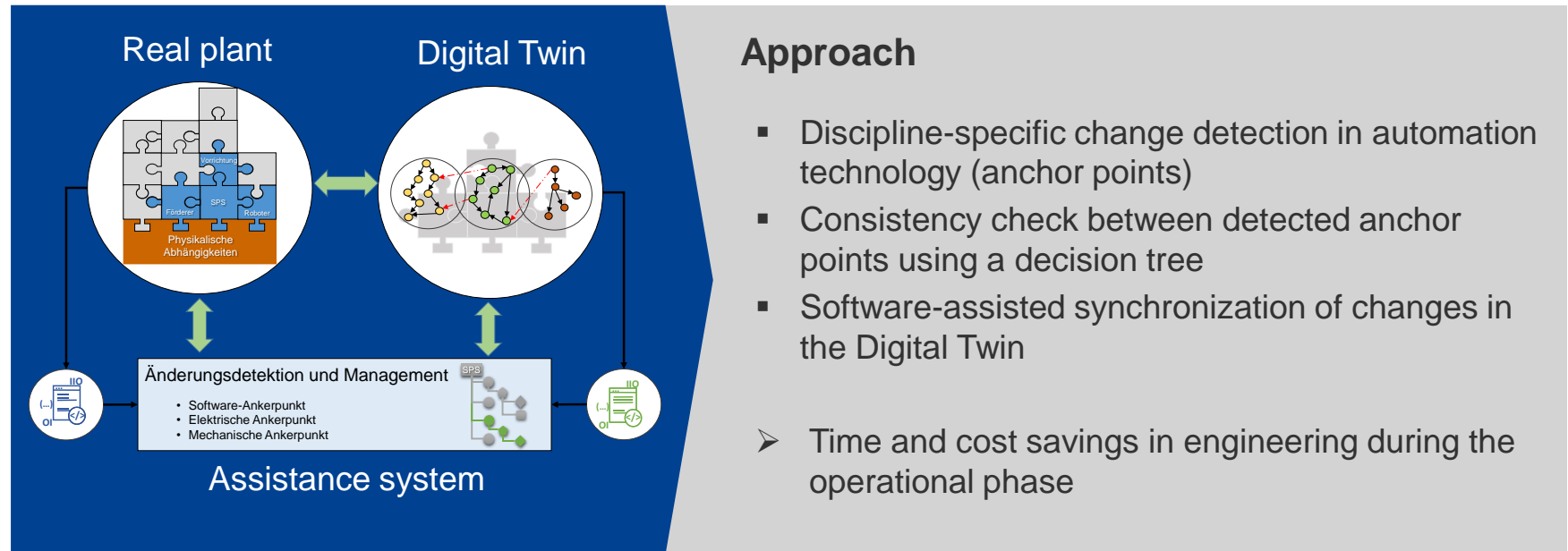
Synchronization of digital models with the real manufacturing cell

Requirements:

- Cross-domain synchronization of engineering models with a real manufacturing cell in operation

Core technologies:

- Engineering and simulation models
- Robot / PLC code analysis
- Decision Tree in Assistance System



Approach

- Discipline-specific change detection in automation technology (anchor points)
 - Consistency check between detected anchor points using a decision tree
 - Software-assisted synchronization of changes in the Digital Twin
- Time and cost savings in engineering during the operational phase

DFG-Project FlexA

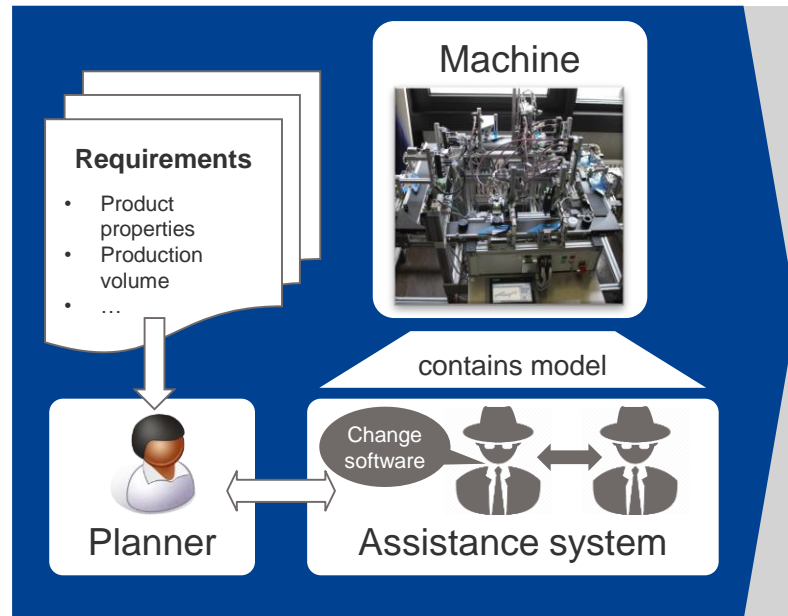
Flexibility of assembly and handling machines using multi-agent systems

Requirements:

- Methodical support of the planner in the flexibility process
- Generation and evaluation of adaptation options based on given requirements

Core technologies:

- Product-, process-, resource-model of the machine
- Agent-based assistance system



Approach

- Description of the machine using a model, agents represent components of the machine
 - Automated evaluation of production requests
 - Generation and evaluation of adaptation options using the model of the machine
- Decision support and assistance in the flexibility planning process

DFG-Project GekoProAg

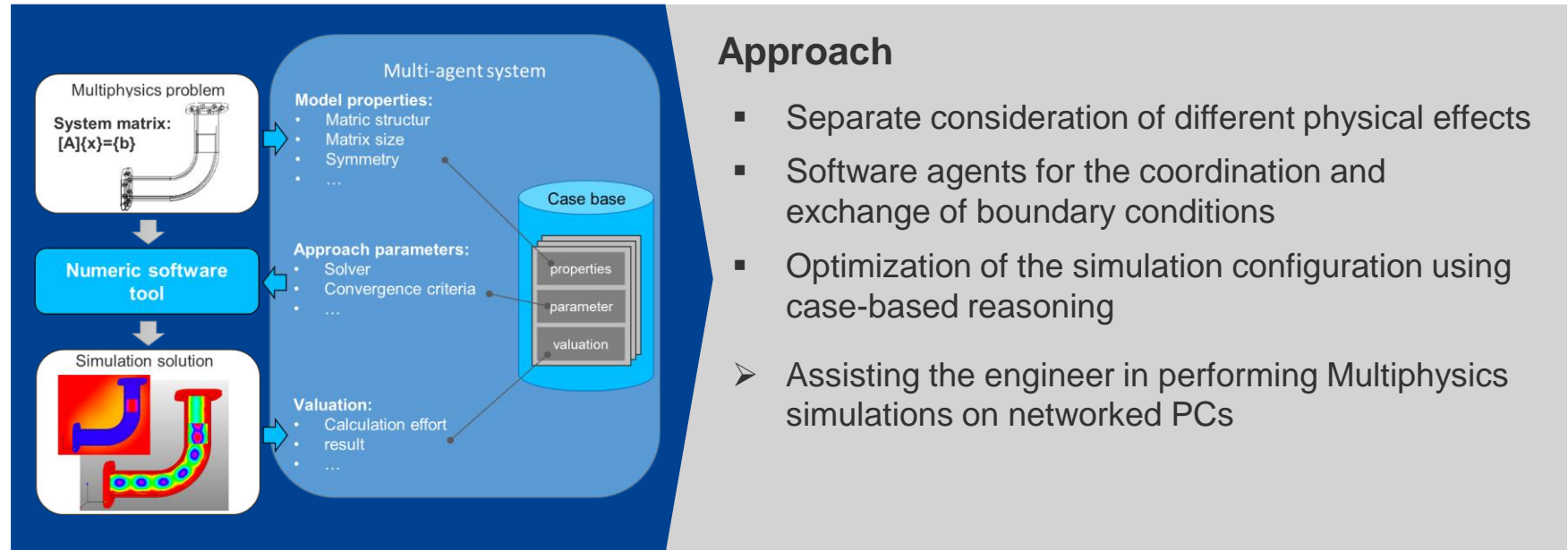
Decentralized Multiphysics simulation of coupled problems

Requirements:

- Intelligent problem decomposition and cooperation for decentralized simulation
- Improvement of the simulation configuration

Core technologies:

- Software agents
- Simulation
- Case-Based Reasoning



DFG-Project DEPIAS

Decentralized self-organized planning of intralogistics systems with the help of agents

Requirements:

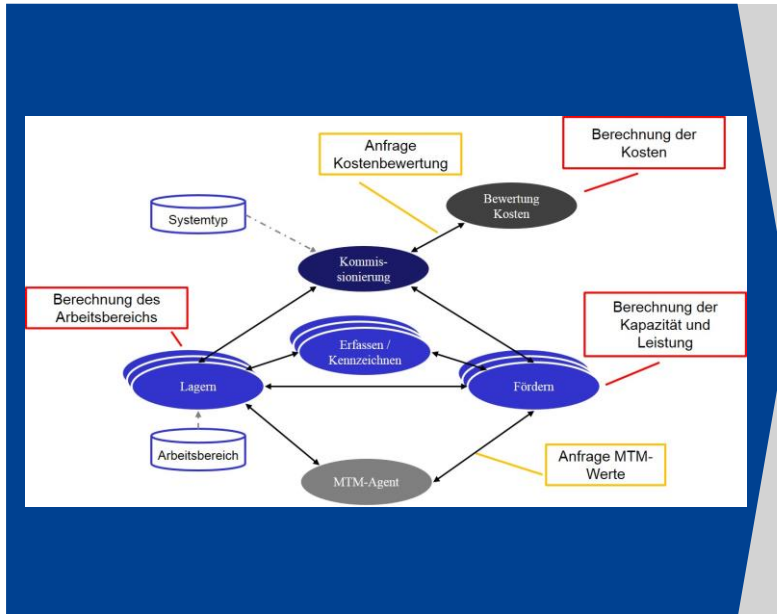
- Support of the planner in the rough planning phase of intralogistics systems

Core technologies:

- Multi-Agent System
- Self-organization

Approach

- Planning of material flow systems is modelled as a dialog-based process and applied to an agent system
- Agents represent resources and try to integrate them into the planned material flow system
- Determination of possible constellations for the material flow system to be planned



Cooperation with the following companies

- CompWare Medical GmbH
- Daimler AG
- Diffblue Ltd.
- Festo AG & Co. KG
- Hirschvogel Umformtechnik GmbH
- iss (Innovative Software Services GmbH)
- OTTO FUCHS KG
- Robert Bosch GmbH
- Siemens AG
- SMS group GmbH
- Vector Consulting GmbH
- Vector Informatik GmbH



BOSCH
Technik fürs Leben



DAIMLER **SIEMENS**



diffblue
AI for Code

FESTO



OTTO FUCHS

vector



Hirschvogel
Automotive Group

SMS  **group**

Maker Space

IAS supports various start-up companies and cooperates in research projects



Indoor
Navigation
Systems

Jan. 2017 – Dez. 2017

EXIST



Simulation and
commissioning of robots
in virtual reality

Apr. 2014 – März 2015

EXIST

März 2016 – Feb. 2018

Junge Innovatoren



Create technologies that
combine power
generation with efficient
control systems.

Juni 2014 – Mai 2015

EXIST

Juni 2015 – Mai 2016

Junge Innovatoren



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Thank you!



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