INDUSTRIE 4.0 - OPPORTUNITIES FOR PHARMACEUTICAL INDUSTRY

Prof. Dr.-Ing. Thomas Bauernhansl
May 11th, 2016

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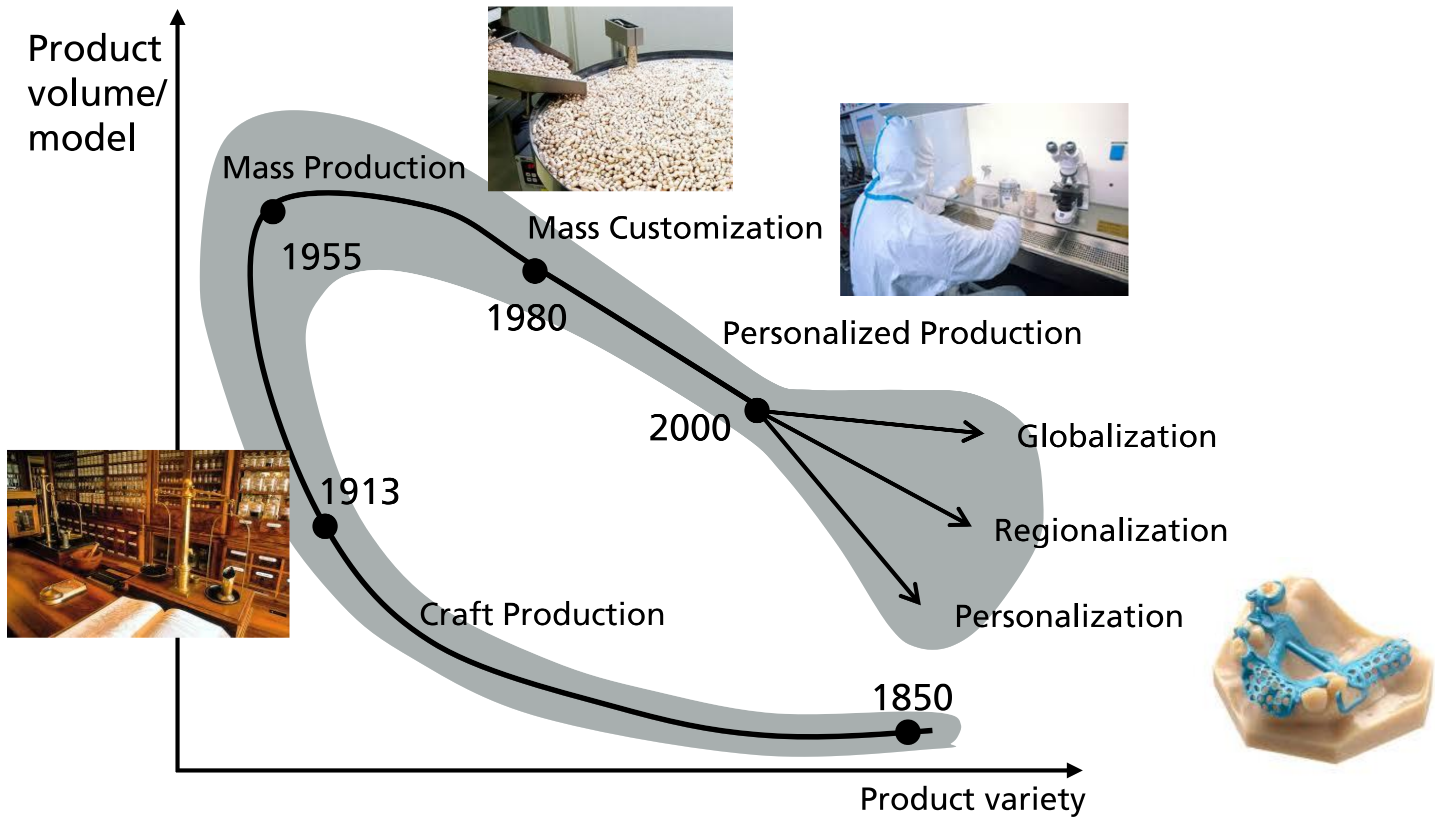
On the Edge of the Fourth Industrial Revolution

Increasing complexity leads to new added value systems



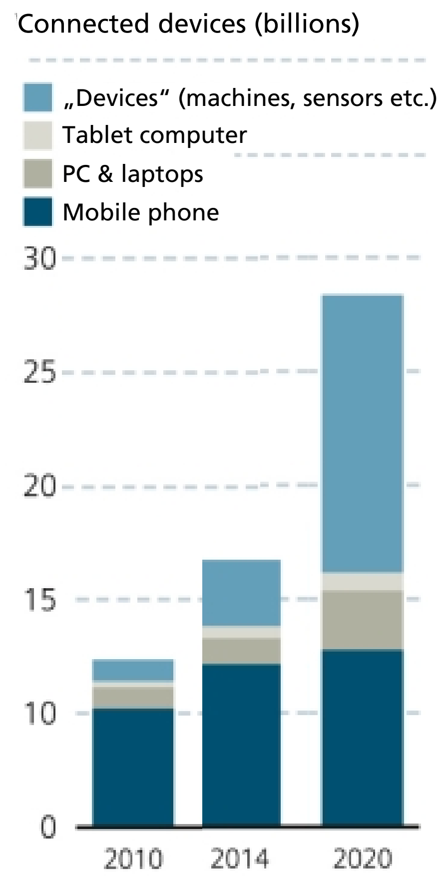
Optimal manufacturing system in terms of flexibility and configurability

The Digital World of Today and Tomorrow

Internet of Everything

Holistic global integration as base for new business ecosystems

- 3 billion people used the internet in 2014
- 17 billion things were connected in 2014 via internet. In 2020 the number it expected to rise up to 28 billion.
- internet services are uncounted.
  example apple store: > 1 million apps were downloaded more than 75 billion times
- new economic activities arise:
  - shared economy
  - prosumer
  - Industrie 4.0/industrial internet…



source: The Internet of Things, MIT Technology Review, Business Report, Siemens

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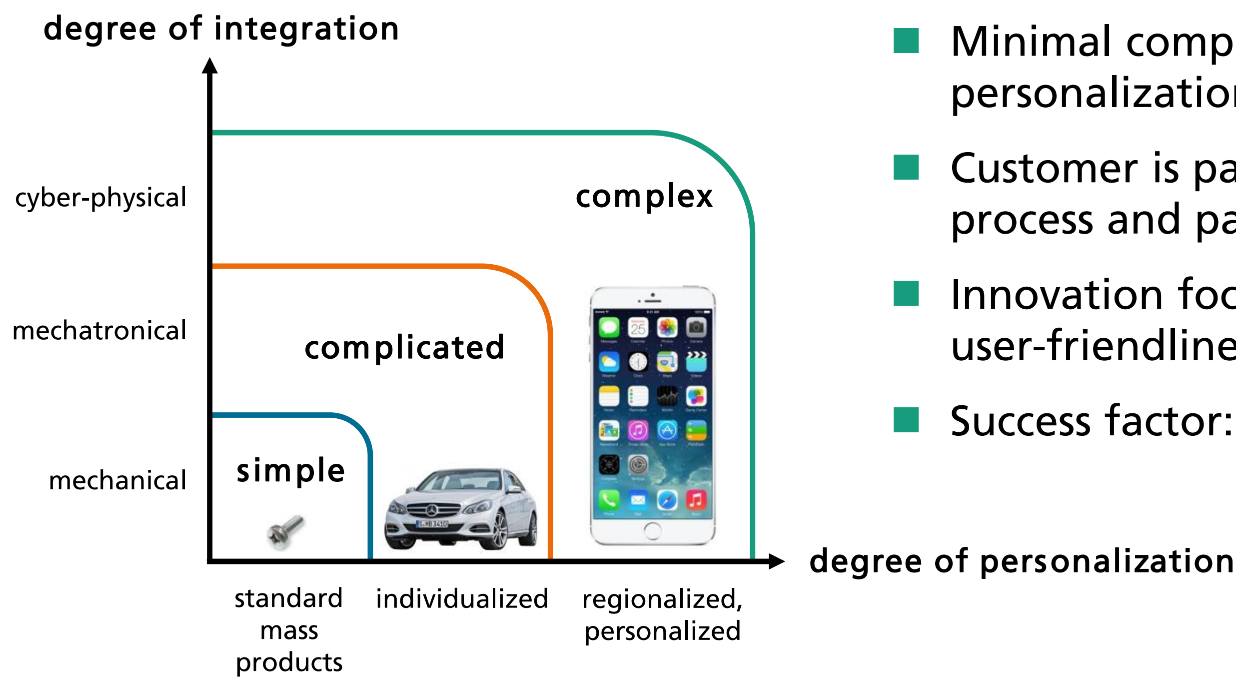
Change of Product Architecture

The ability to manage complexity effectively becomes a key competitive advantage



- Minimal complexity, maximum personalization and economies of scale
- Customer is part of the personalization process and pays for it
- Innovation focus: ecosystem, user-friendliness, design
- Success factor: openness

sources: Wildemann, H.: Wachstumsorientiertes Kundenbeziehungsmanagement statt König-Kunde-Prinzip; Seemann, T.: Einfach produktiver werden – complexity im Unternehmen senken; Bildquellen: apple.de

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Elements of the Fourth Industrial Revolution

Networking and computing power enables new design and optimization dimensions for added value systems

Infrastructure (physical, digital)

Cyber Physical System

Product Life Cycle (valuable = personalized + sustainable)

Interaction

Physical Systems (act, sense, communication)

Human Beings (decide, create, communicate)

Reflection

Digital Shadow (Real time Model of Everything)

Transaction

Software Service (Machine Skills, Apps for humans, Platform services)

Interoperation

Cloudbased Platforms (Private, Community, Public)

Prescription

Analytics (Big Data/ machine learning)

Communication

Internet of Everything (Human beings, services, things)

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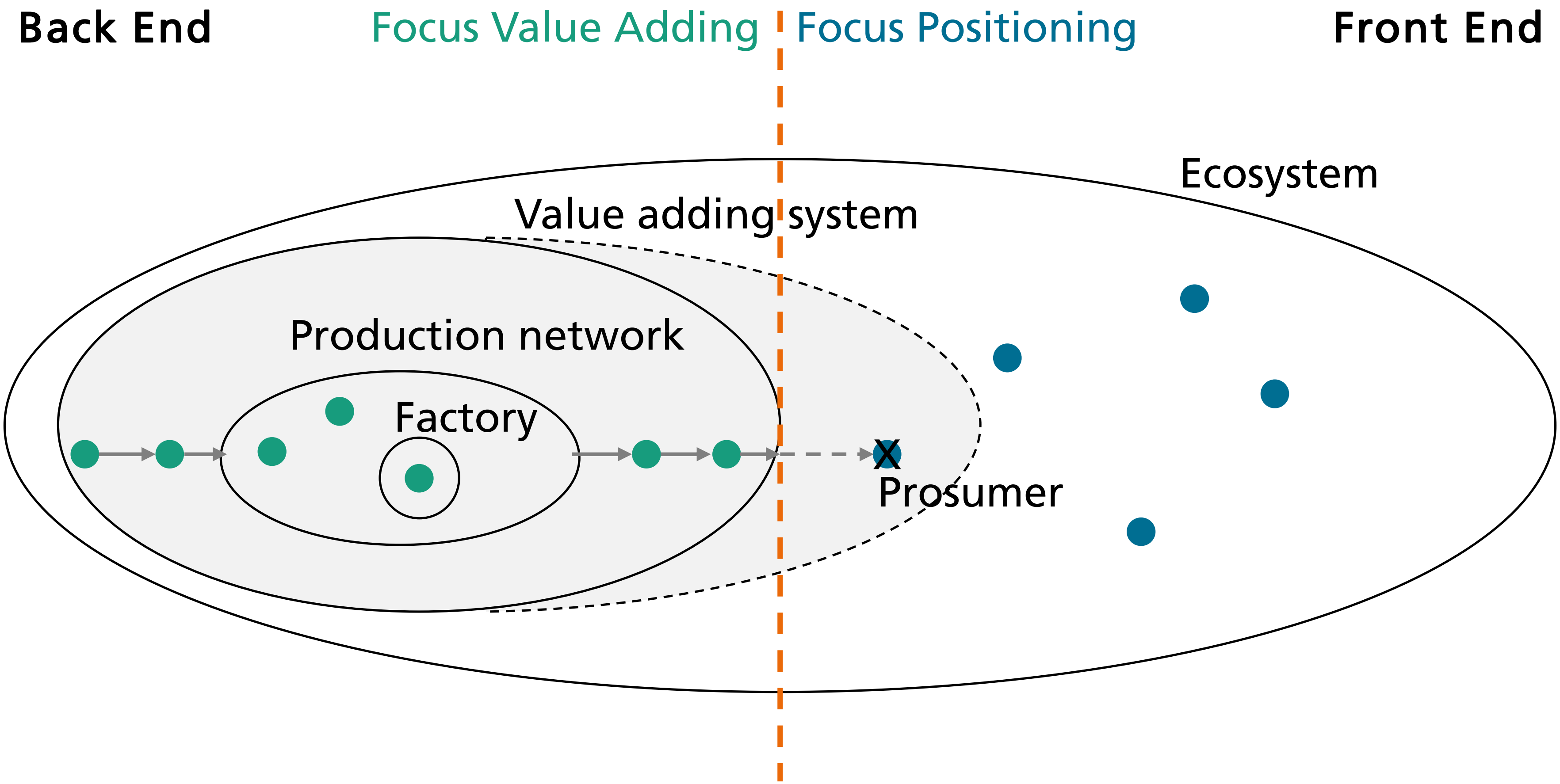
Structure of Ecosystems
Integrated design of Front and Back End



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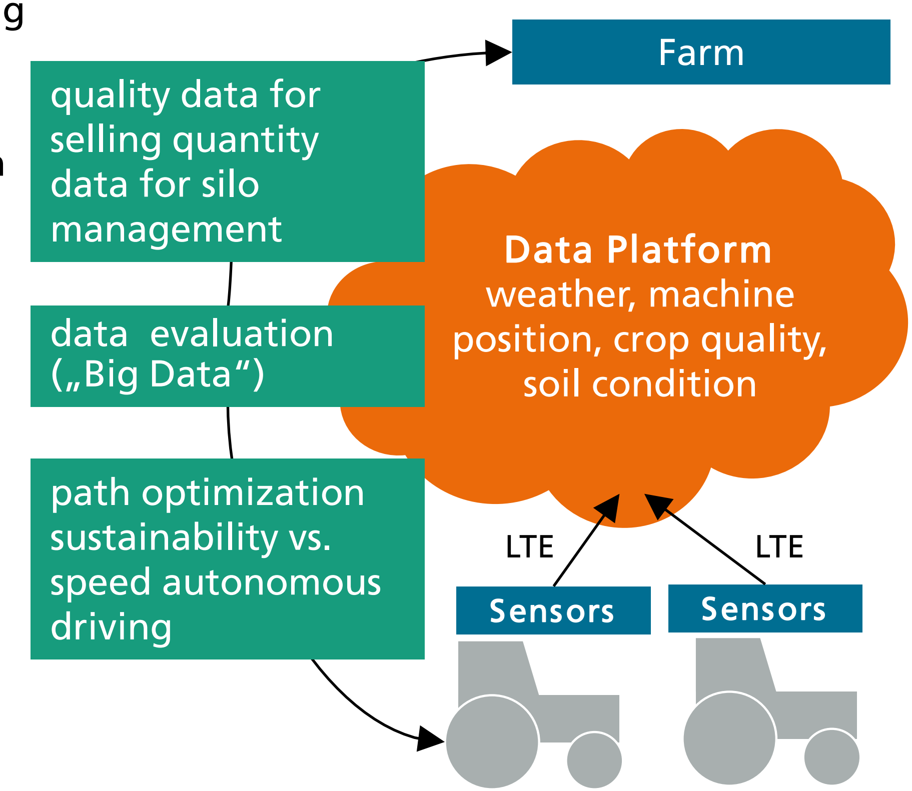
Business Ecosystems
„Farmnet 365“ – an agricultural machinery initiative

- pilot project 2013/2014 digitization of farming initially through integration of agricultural machines
- evaluation of customer data for optimization of the whole farm through service applications
- allocation of applications through partners from various branches on Farmnet online platform
- data storage on platform as central access point
- today: ecosystem with 15 partners from farm management (among others Allianz, GEA, Horsch)



source: Farmnet 365

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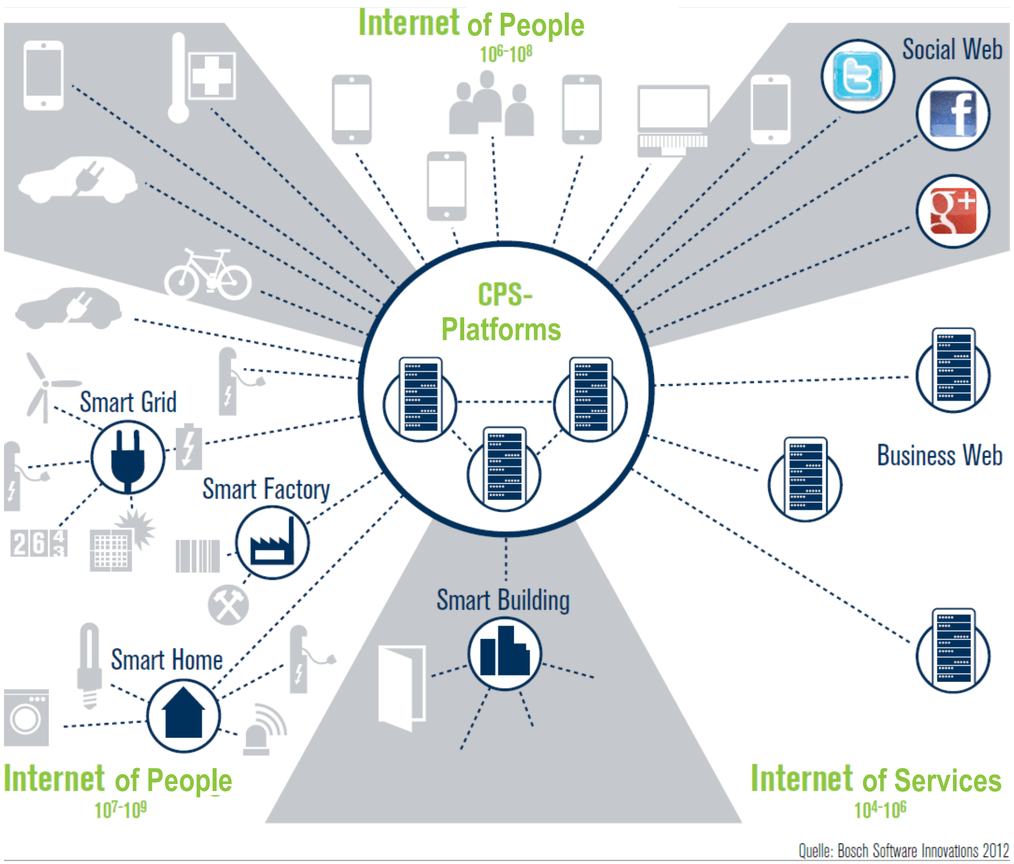
Digitization of Business Models

Everything goes smart and changes industrial branches



CPS Cyber-Physical System, **RFID** Radio Frequency Identification

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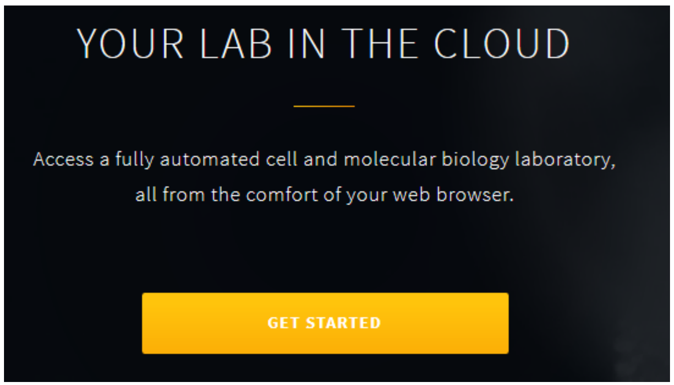
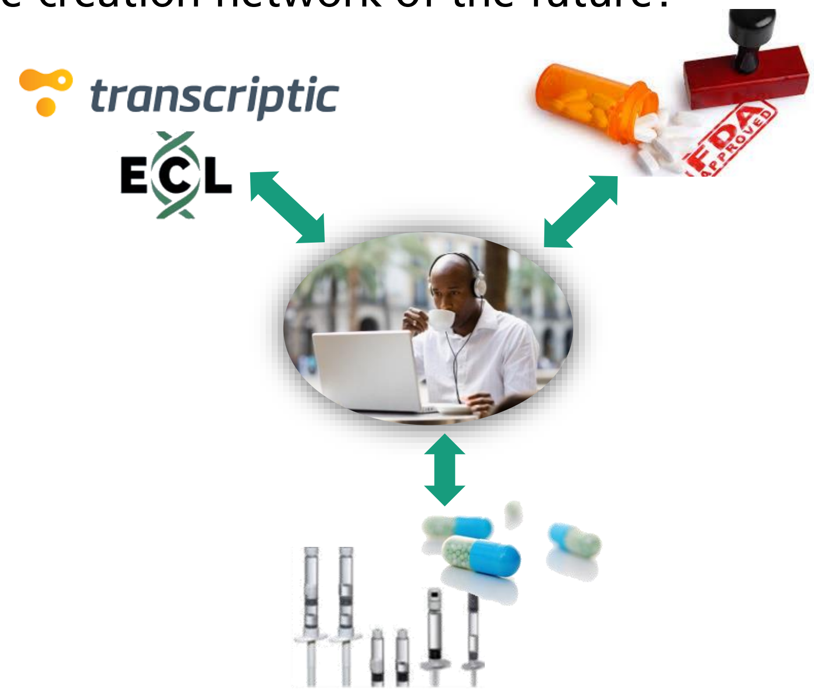
Business Models in the Course of Time

Disruptive Ideas – Flexibility as Key for success

How is the laboratory integrated in the value-creation network of the future?





We set out with the goal of giving the life sciences the same structural advantages that web has enjoyed, making it possible for two postdocs with a laptop in a coffee shop to run a drug company.
Max Hodak, CEO of Transcriptic Cloud Lab, 2014

→ **XaaS enables new competitors with innovative solutions to establish themselves on the market!**

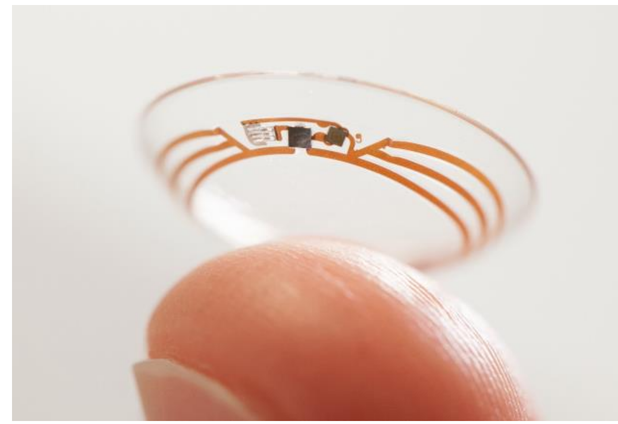
source: Transcriptic.com, Emeraldcloudlab.com, Huffingtenpost, Pixelio.de, Vetter Pharma, paradisi.de

Business Models in the Course of Time

BigPharma tests new cooperation models

- Roche/ Qualcomm
  teaming up to develop a next-generation remote patient monitoring system
- Novartis/ Qualcomm
  joint investment of $100 million to fund early-stage companies
- Novartis/ Google X
  smart lens technology
- Biogen Idec/ Google X
  multiple sclerosis progression studies
- UCB/ MC10
  Biostamp platform for patient-focused disease management solutions

→ **Shift of value-adding networks**



source: Pharma Voice, "The Internet of Things: Beyond the Hype and Into Reality", 2015, MC10inc.com

The Base: Processing Power and Connectivity

Moore and Metcalfe are right and define the scope and value of an enterprise

Connectivity

Metcalfe:

"The benefit of a communication system increases with the square of the number of participants."

Performance

Moore:

"Computer performance doubles every 18 months."

Ecosystems for Smart Business Models

Transparency

- cyber-physical systems
- Internet of Things and Services
- real time & at run time
- everything as a service

Knowledge

sources of pictures: wikipedia.de, ibm.com, abcnews.com

Smart Factory: Concept and potentials

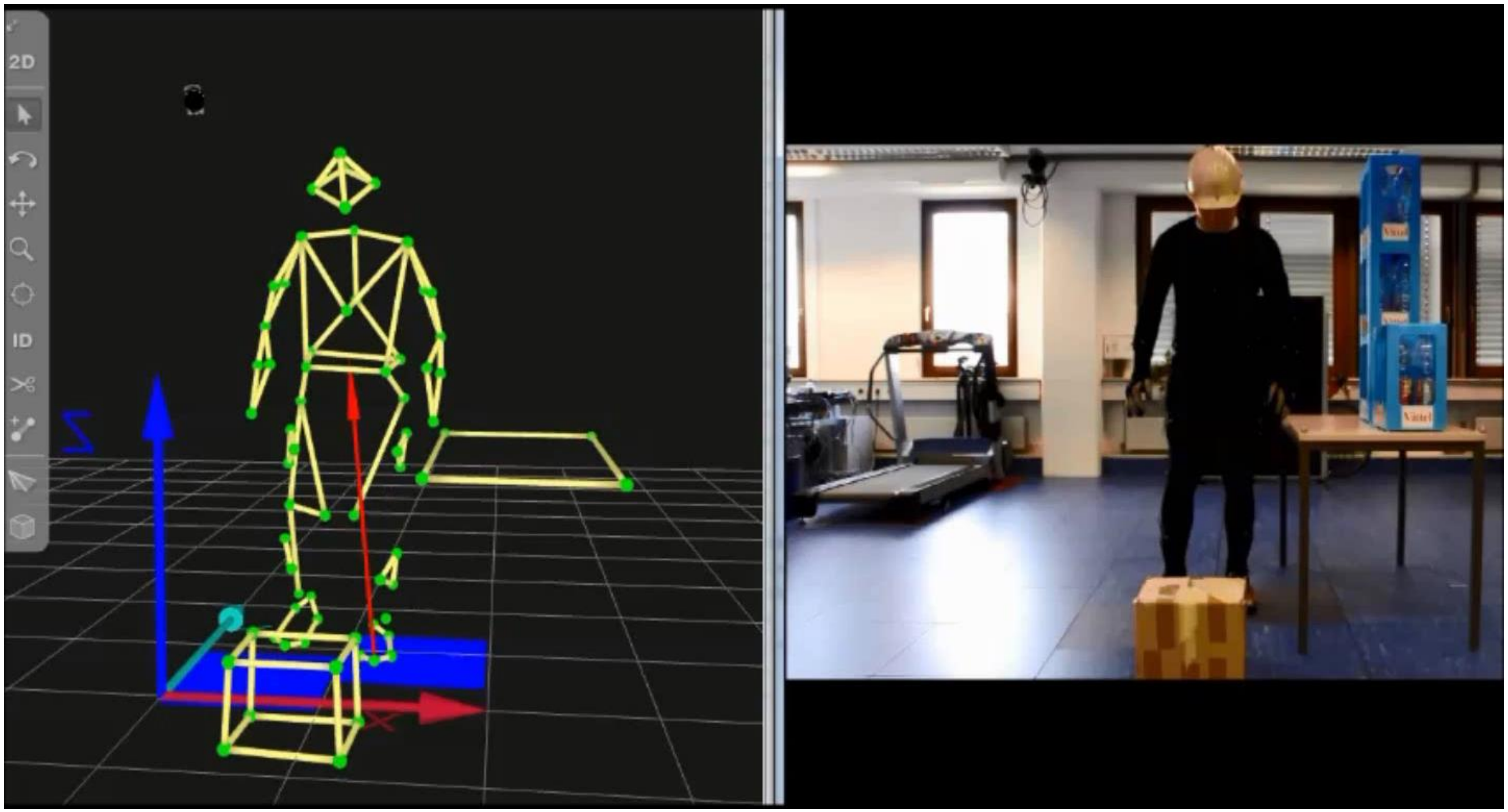
Core thesis for value creation systems of the future

- Optimal distribution of value creation in ecosystems (prosumer, horizontal integration) leads to low complexity costs und high profit margins.
- Optimal distribution of functionalities (services) in the cyber-physical system-architecture (cloud vs. fog, vertical integration) leads to economies of scale and high functional adaptivity along the life cycle.
- Mass-based forecasts of futures based on the digital shadow (real time, big data) set the fundament for high process capability of complex systems.
- The production of personalized hardware through actionable, generative manufacturing decides over economic efficiency.
- Waste-free integration of workers through adaptive and self-learning human-computer interaction interfaces (remote and physical interfaces) ensures comprehensive acceptance in the working system.

Source of pictures: faz.net, google.de

All Entities of a Factory have a Digital Shadow

Example: Motion Capturing for feed-back of real processes into planning models



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Challenges when Dealing with Big Data – Change of Perspective

Dealing with Complicated Contexts	Dealing with Complex Contexts
Complicated contexts are being systematically analyzed (root cause analysis)	Complex contexts are no longer being analyzed with regard to their causes (correlation replaces causality)
The complicated network is divided in small entities and correlations are being examined	Regularities are being derived from all available data (pattern recognition, e.g. customers' behavior patterns)
Random sample analysis, deductive approach	Complete data screen is being analyzed, inductive approach
The question is "why"	The question is "what"

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Analysis of Fully and Semi-automated Systems
The Smart Productivity Analysis

Target
Tool for feature based analysis and optimization of constantly adapting production systems of discrete parts

Concept
- Minimally invasive sensors for optimization purpose
- Feature based recognition and configuration in quasi real-time and at all critical processes simultaneously
- Flexible adjustment of the sensor network regarding new system configurations or additional features
- Correlation of features & extraction of influencing factors

Benefits
- Autonomous and quasi real-time detection of the dynamic bottleneck in order to derive situational actions
- Quantitative evaluation of technical and organizational potentials targeting process optimization

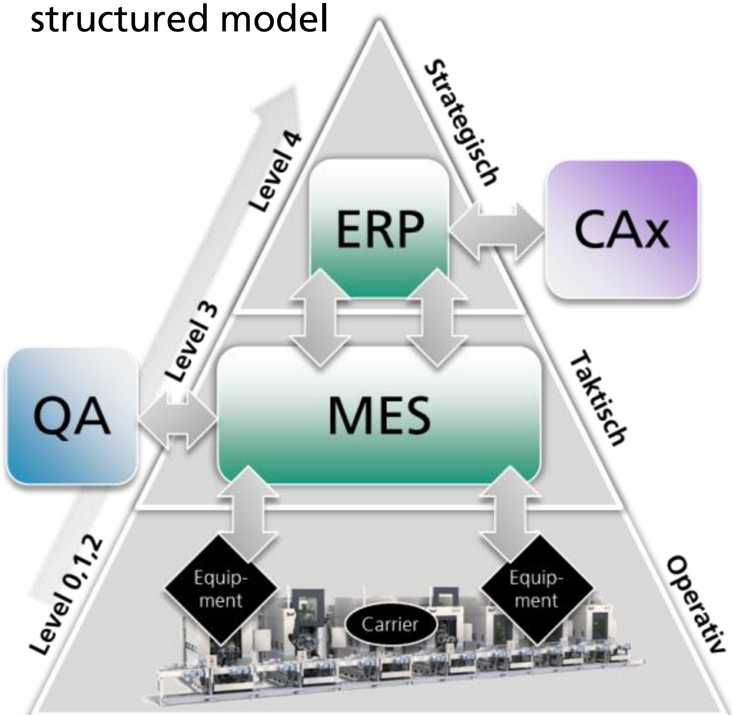
source: Felix Müller, Fraunhofer IPA

Decomposition of Established IT Architectures

The pyramid becomes a net in the cloud

Today

- Historically clear hierarchically structured model



Tomorrow

- **Service-orientation**
  - Service-orientation (XaaS) in all areas
  - Service-oriented IT architecture (SoA)
- **De-hierarchization**
  - Decomposition of hierarchical structure
  - New applications based on services
- **App-ization**
  - App development by process owner
  - Simulation in real time
- **Open standardization**
  - Efficiency advantages of IT clouds
  - Focus on information/semantics

ERP Enterprise Resource Planning, **MES** Manufacturing Execution System, **QA** Quality Assurance, **CAx** Computer-Aided x

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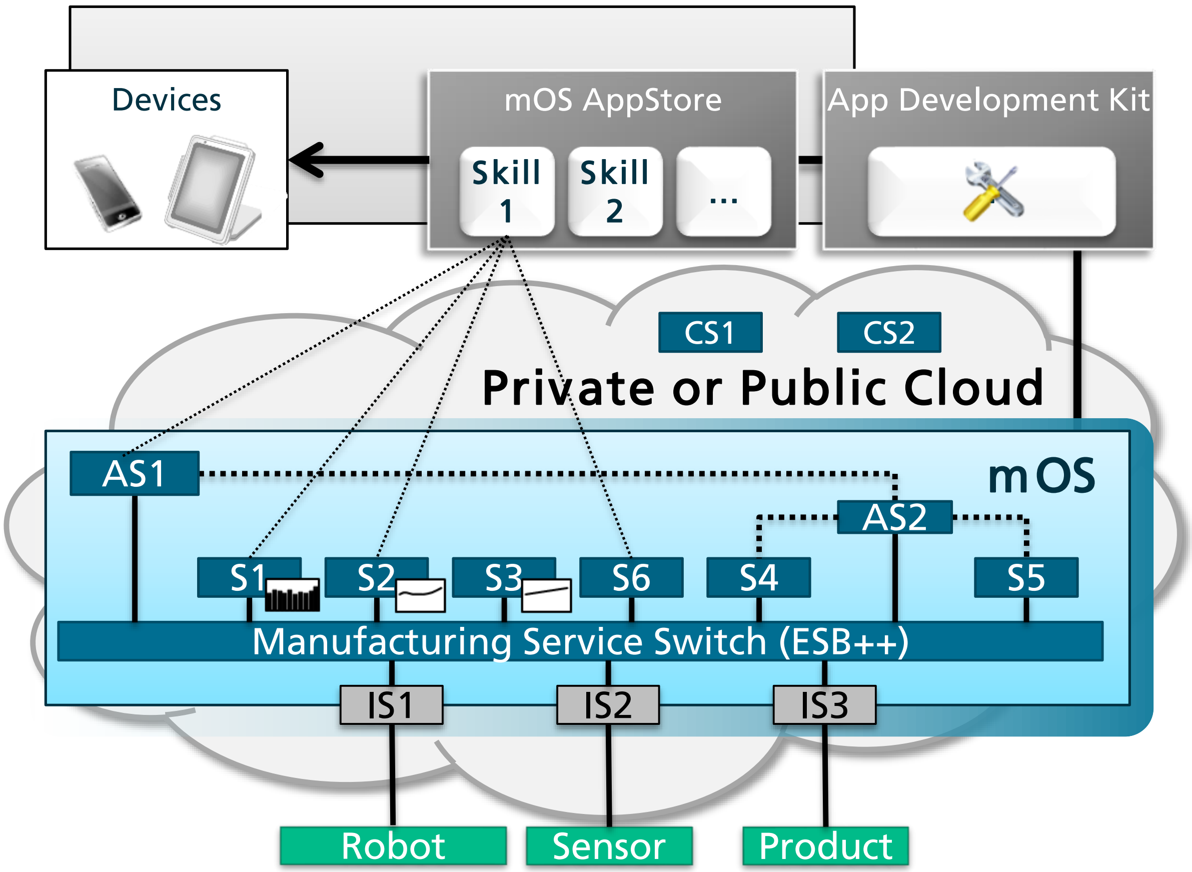
Security and Trust in ICT for Production

Virtual Fort Knox



Robots will be mobile, flexible and safe

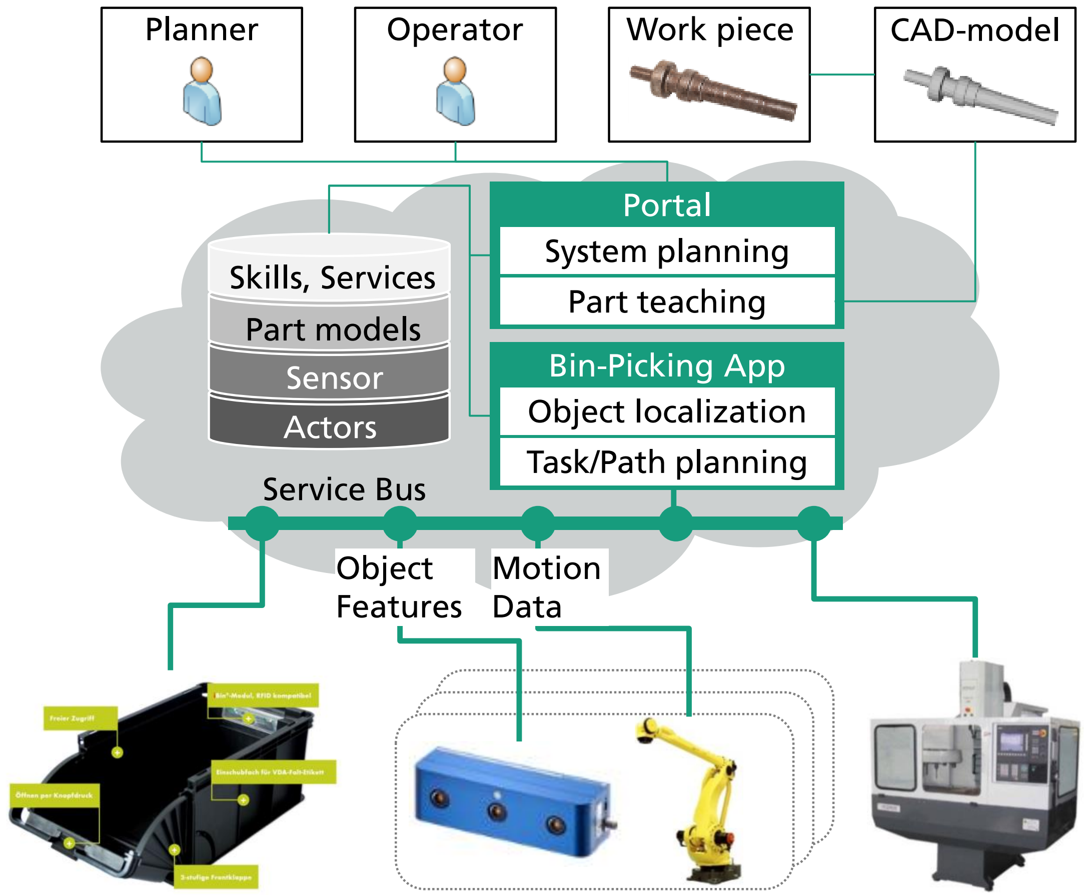
Example: SEW Eurodrive – freely navigating DTS (carries the robot for bin picking)

source: IPA

What if Bin-picking came out of the Cloud?

Advantage

- externalization of skills, services, maintenance
- lean robot workcell ("Lean Client")
- centralized collection of data
  - optimization by statistical learning
- best practice solutions accessible
- to be displayed at HMI2015



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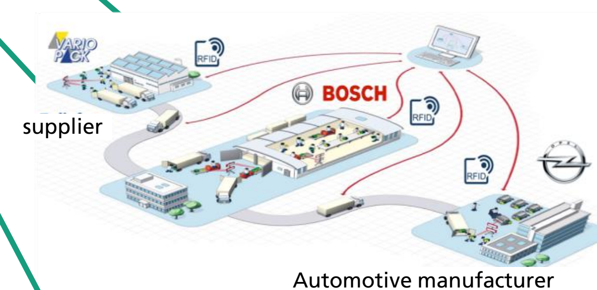
Business potential of Integrated Industry (Industrie 4.0)

Specialists expect an increase in overall performance between 30 to 50% in value creation

Estimation of potential benefits

Costs	Effects	Potential
Carrying costs	■ Reduction of safety stocks ■ Avoiding Bullwhip and Burbidge effects	**-30 to -40 %**
Manufacturing costs	■ Improving of OEE ■ Process control loops ■ Improvement of vertical and horizontal staff flexibility ■ Usage of Smart Wearables	**-10 to -30 %**
Logistic costs	■ Higher level of automation (milk run, picking etc.) ■ Smart Wearables	**-10 to -30 %**
Complexity costs	■ Wider span of supervision ■ Reduced trouble shooting ■ Prosumer model ■ Everything as a Service (XaaS)	**-60 to -70 %**
Quality costs	■ Near-realtime quality control loops	**-10 to -20 %**
Maintenance costs	■ Optimization of stock levels ■ State-oriented maintenance (process data, measurement data) ■ Dynamic priorization	**-20 to -30 %**

Pilot project at Bosch: Restructuring of complete distribution process based on an in-plant logistics center in an Industrie 4.0 project.



-10 % milkruns

+10 % produc-tivity

-30 % stock reduction

source: IPA/Bauernhansl, Bosch

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Cyber-physical Systems in labs and pharmaceutical produktion

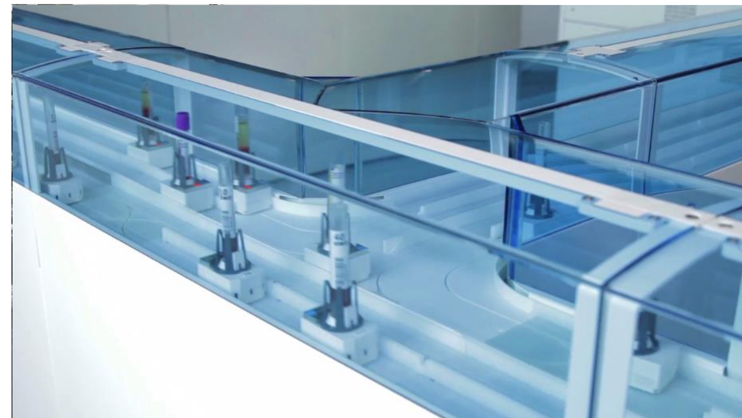
Cyber-physical Manufacturing Support
Networked industrial robots in intralogistics

i-car Track & CubeXX

- Flexible transport unit for manual to fully automated loading and unloading
- Event-based action control system
- Connected with MES/ ERP (SAP) systems

Aspects of pharma production

- Reduction of valuable laboratory space in the environment of expensive laboratory space
- Just-in-time supply of material
- Flexible, automated intralogistic



source: Still GmbH – CubeXX, GLP Systems

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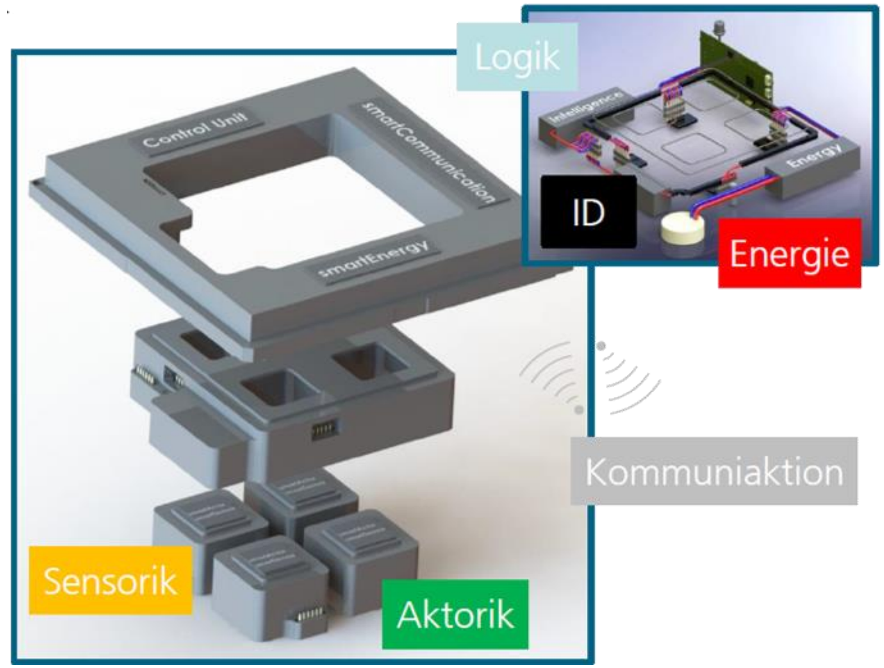
Cyber-physical Manufacturing Support

smartWT in laboratory logistics

smart work pieces in the laboratory

- Work piece as active system with own logic, sensor and actuator technology
- Active usage of holding/ transport times (cool down, measure)
- Complete traceability (sampling, analysis laboratory, supply)
- Decentralized, connected control system



Cyber-physical Manufacturing Support
Adaptive assembly workstation

Flexible, intuitive and individual support for assembly of complex products

- Pick-by-light-system for worker-assistance and detection of correct withdrawal of parts
- Put-to-light-system for indexing and control of the correct position and orientation of the part

Application and advantages in laboratory context:

→ Correct recorded process sequence

→ Minimum effort for training on the job

→ Identification of operator or
level of qualification und authorization

Cyber-physical Manufacturing Support
Augmented reality in processes and maintenance

The Comprehension of the human as integral component of the process chain

- Entirely connection of human and machine
- Applications fields
  - Context based information
  - Decentralized, real time process information
  - Support by technical modification, maintenance & reparation
  - Support by regulated process steps

Cyber-physical Manufacturing Support

Augmented Reality in laboratories

Understanding of an human being as an integral part of the supply chain

- Seamless connection of human, process and documentation
- Applications fields
  - Visual support of incoming goods and monitoring
  - Monitoring of training
  - Reduction of manual documentation steps
  - Employee training and continuing education

source: Digital Science User Lab

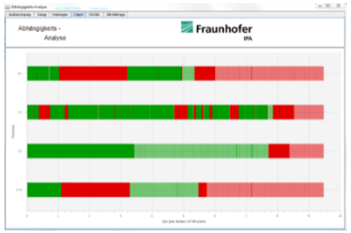
Cyber-physical Manufacturing Support

Connected planning and control system

Consistent, transparent data base for everyone

- Real time operating demand management
- Reduction of coordination processes
- Automation of order processes
- Virtual images of the “shop floor laboratory”
- Automated data preparation for GMP, iVD, ISO 13485
- Real time productivity analysis



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LabOS – an IT-supported Ecosystem for Laboratories

Shaping the laboratory environment of the future

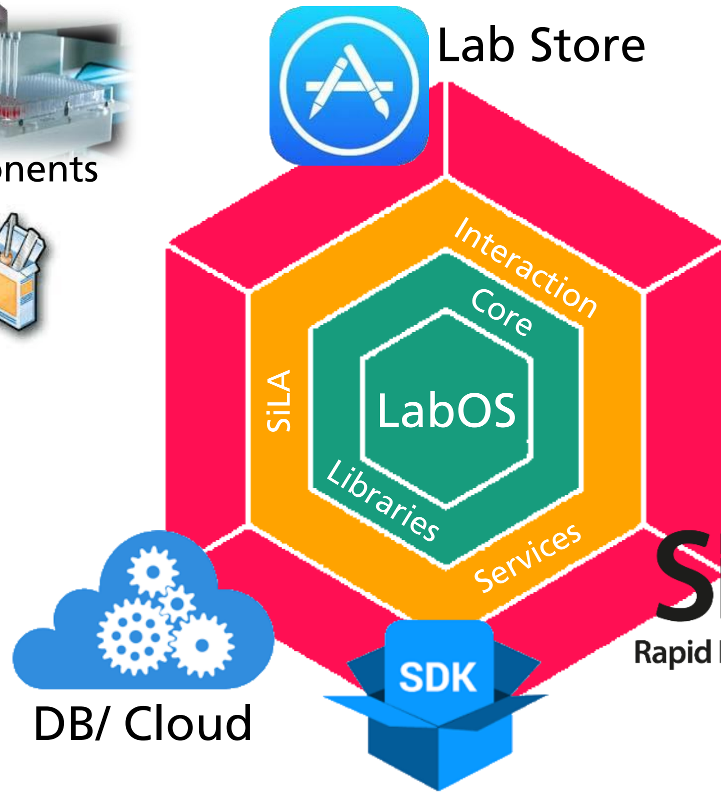
Make Complexity useful

Application

Components

Software

Standards/
Rules



Lab Store

DB/ Cloud

SiLA
Rapid Integration®

Industrie 4.0 in the Laboratory

- Self organization
- Autonomy
- Prescriptive analytics

- Cooperative
- Mobility
- Decentralization

- Real time capability
- Transparency
- Standardization
- Documentation

Inspired by

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We work at …

nICLAS

Innovation Campus for lab automation in Stuttgart

nICLAS Reference Lab

Cooperative R&D:
Solutions for a better future

nICLAS Academy:
Training & Education

Industry on Campus

Laboratory of the Future

Industry on Campus

- Development of innovative CPS solutions
- Decentralized & real time self organization in the laboratory
- Demonstration of the latest solutions in research and industry
- Trainings in the field of Industrie 4.0 / Labor 4.0

… perhaps with you, too?


„When the wind of change is blowing,
some people build walls, while others
build windmills."
(Chinese proverb)

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OPPORTUNITIES FOR PHARMA INDUSTRY

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