Industrie 4.0 - industrial applications and guideline for implementation

Prof. Dr.-Ing. Jürgen Fleischer

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KIT – University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

Agenda

1 Fourth industrial revolution

2 Successful implementation of Industrie 4.0

3 Industrie 4.0: practical use cases

4 Industrie 4.0: use case at AMTC

5 Summary

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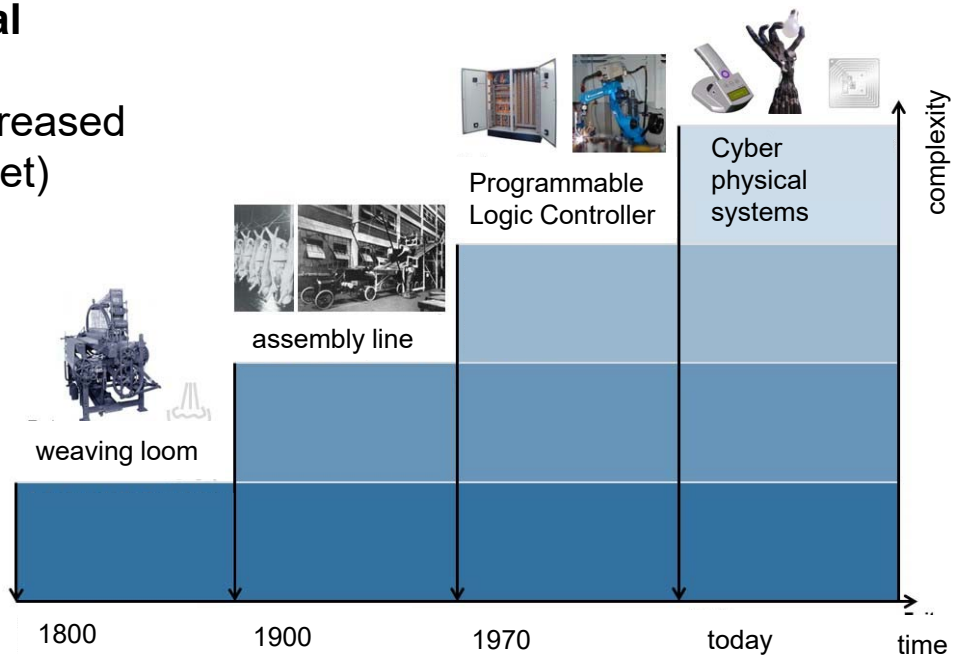
Fourth industrial revolution

The fourth industrial revolution is called „Industrie 4.0“

- Approaches for Industrie 4.0- technologies:
  - **Integration of additional sensors and actuators on field level** (more information and more influence on processes for new applications)
  - **Increased networking of physical components as well as focused collection of generated data** (increased data availability by using the internet)
  - **Generation of information from data** (services)
  - **Use of common standards for data exchange**



An added value results form the intelligent use of the information made available.

Quelle: DFKI

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Fourth industrial revolution

- Chances of the digital revolution in production
  - Real-time data availability in production
  - Networking of all instances of supply chains
  - Realization of self controlled production environments
  - Establishing of new business models
- Design principles for the fourth industrial revolution
  - Interoperability
  - Virtualization
  - Decentralization
  - Real-Time Capability
  - Service Orientation
  - Modularity

Source: Acatec - Umsetzungsempfehlung , Image: esntl.com, Siemens

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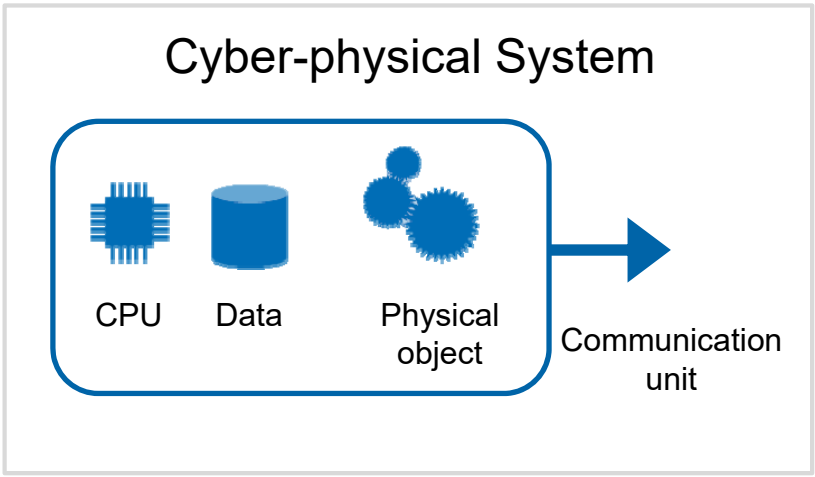
Fourth industrial revolution

Key enablers: Internet of Things and Cyber-physical Systems

- Internet of Things
  - Physical objects (“things”) connected to the internet
  - Exchange of data from everywhere
  - Approximately 14 billion connected devices worldwide by the end of year 2022

- Cyber-physical Systems
  - Physical object with
  - an embedded communication unit,
  - Information processing and data storage
  - and Networking.



Source: Machina Research, 2014

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Fourth industrial revolution

Industrie 4.0 pyramid

Service

- Development of business activities by providing Services
- E.g.: Condition Monitoring

Connectivity

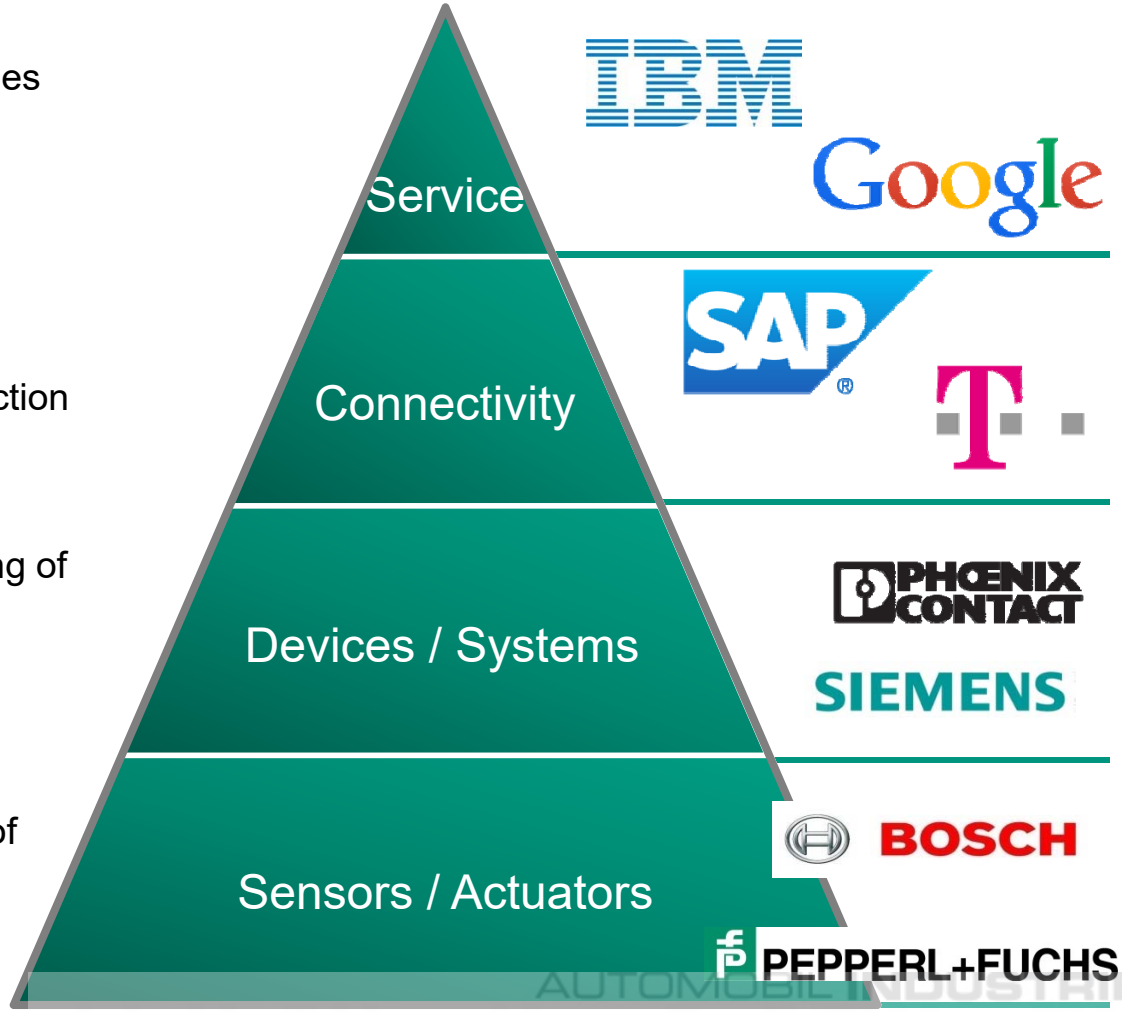
- Network and middleware and communication platforms .
- E.g. Connection between production systems

Devices / Systems

- Device with integrated processing of sensor data.
- E.g. Adaptive systems, smart grippers

Sensors / Actuators

- impact on processes or control of processes.
- E.g. Temperature sensor



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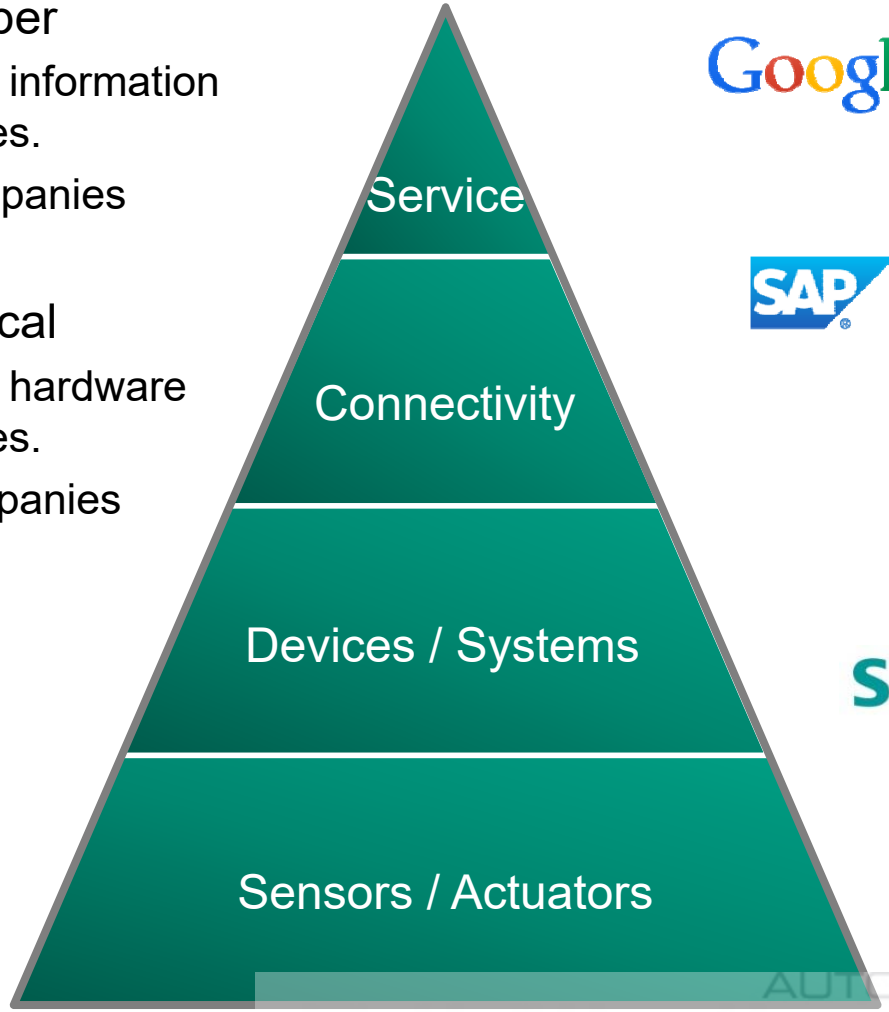
Fourth industrial revolution

Industrie 4.0 development directions

- Physicalize the Cyber
  - Approach of the information driven companies.
  - Information companies
- Cyberize the Physical
  - Approach of the hardware driven companies.
  - Production companies



Development directions:

Google

T

Information companies

SAP

IBM

SIEMENS

Production companies

BOSCH

Source: Lee

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Approaches to introduce the 4th industrial revolution

Plattform Industrie 4.0

Top Down: Standardization first

- Political framework
- Collaboration in industrial consortia
- Better standardization

Industrial Internet Consortium

Bottom up: Use Case first

- Fast implementation
- Development of quasi-standards

A optimal implementation of Industrie 4.0 can be realized by fast implementation of use cases and simultaneous standardization.

Quelle : Plattform Industrie 4.0

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Successful implementation of Industrie 4.0

Challenge and Potential

- Challenge Industrie 4.0:
  - Industrie 4.0 is no „Value“ by itself!
  - Enabler for new:
    - Products,
    - Processes and
    - Services

- Potential of Industrie 4.0:
  - Better fulfillment of customer needs
    - → Increase in sales!
  - Improvement of processes
    - → Reduction of production costs!

You cannot buy Industrie 4.0, you must work for it!

Images: diepresse.com

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Successful implementation of Industrie 4.0

Industrie 4.0 filtering process

- How can Industrie 4.0 improve your profit?

Market Potential

Market needs?

- New Products
- Efficient production

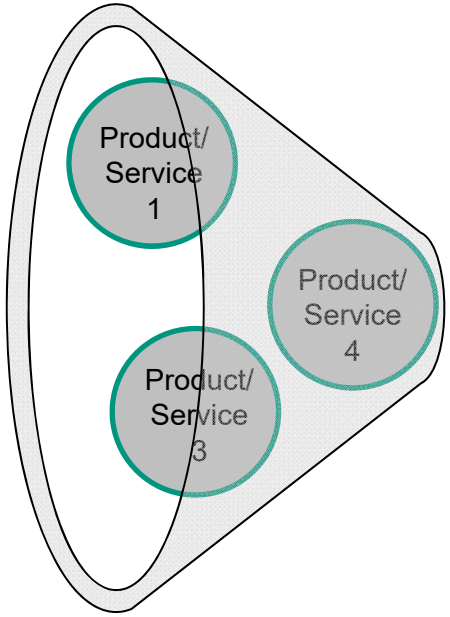
Resources / Strengths

Our competencies?

- Relating to Industrie 4.0
- Industrie 4.0 pyramid

New ideas Product and Process

Filtering process



Product/ Service 2

You can generate new product and service ideas in a systematic process based to your companies competencies.

Images: onlinemarktplatz.de, consulting-spirit-solutions.com

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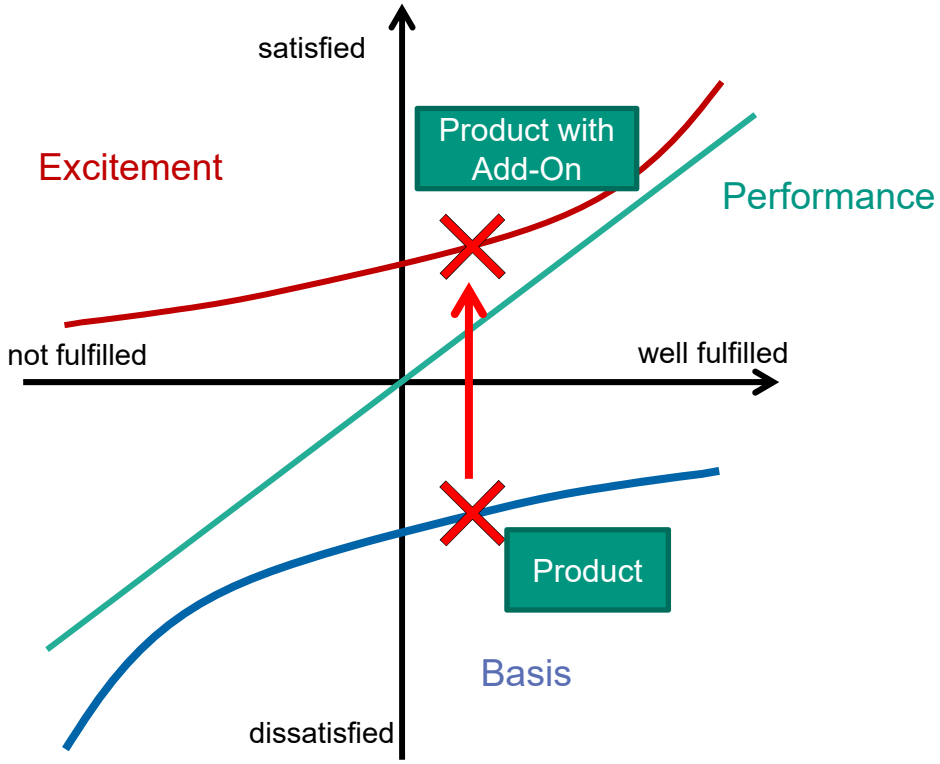
Market Potential

- Assessment of the market needs.
- Example: Product with add-on functionality



Market Potential

Market needs?

- New Products
- Efficient production

Images: preparebrandingstrategy.com

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Successful implementation of Industrie 4.0

Resources / Strengths

- Assessment of the competences related to Industrie 4.0.

Resources / Strengths

Our competencies?

- Relating to Industrie 4.0
- Industrie 4.0 pyramid

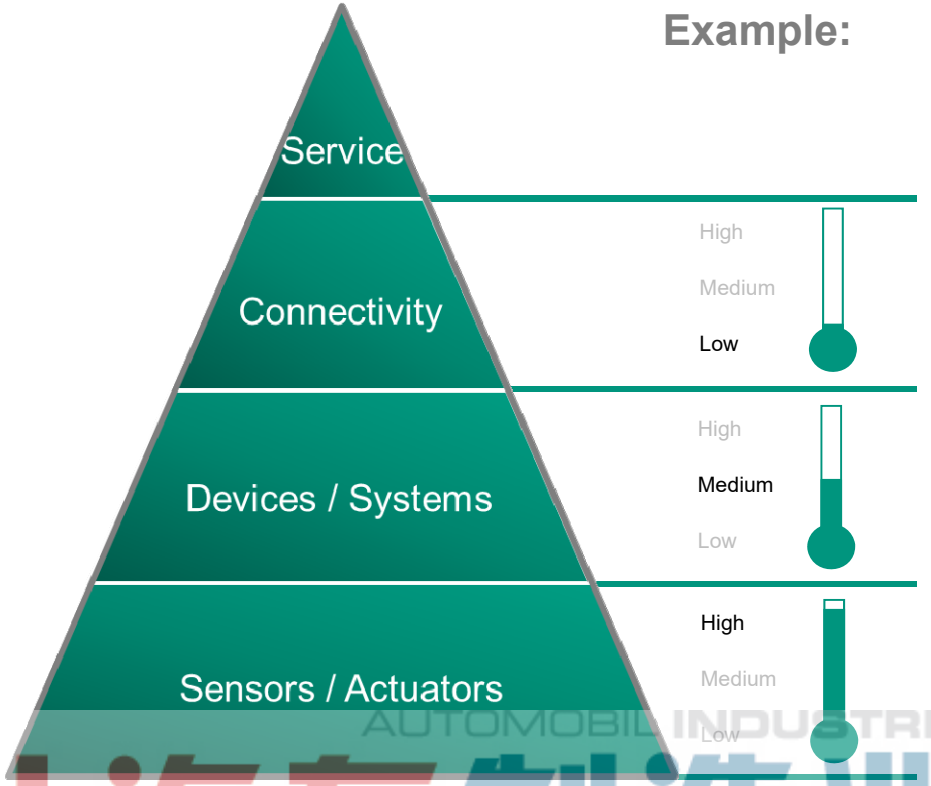
Product

- Integration of sensors
- Processing of data
- Communication (Machine to Machine)
- IT supported Services

Production

- Data collection
- Communication in production (M2M)
- Vertically communication
- Human Machine Interfaces

Example:



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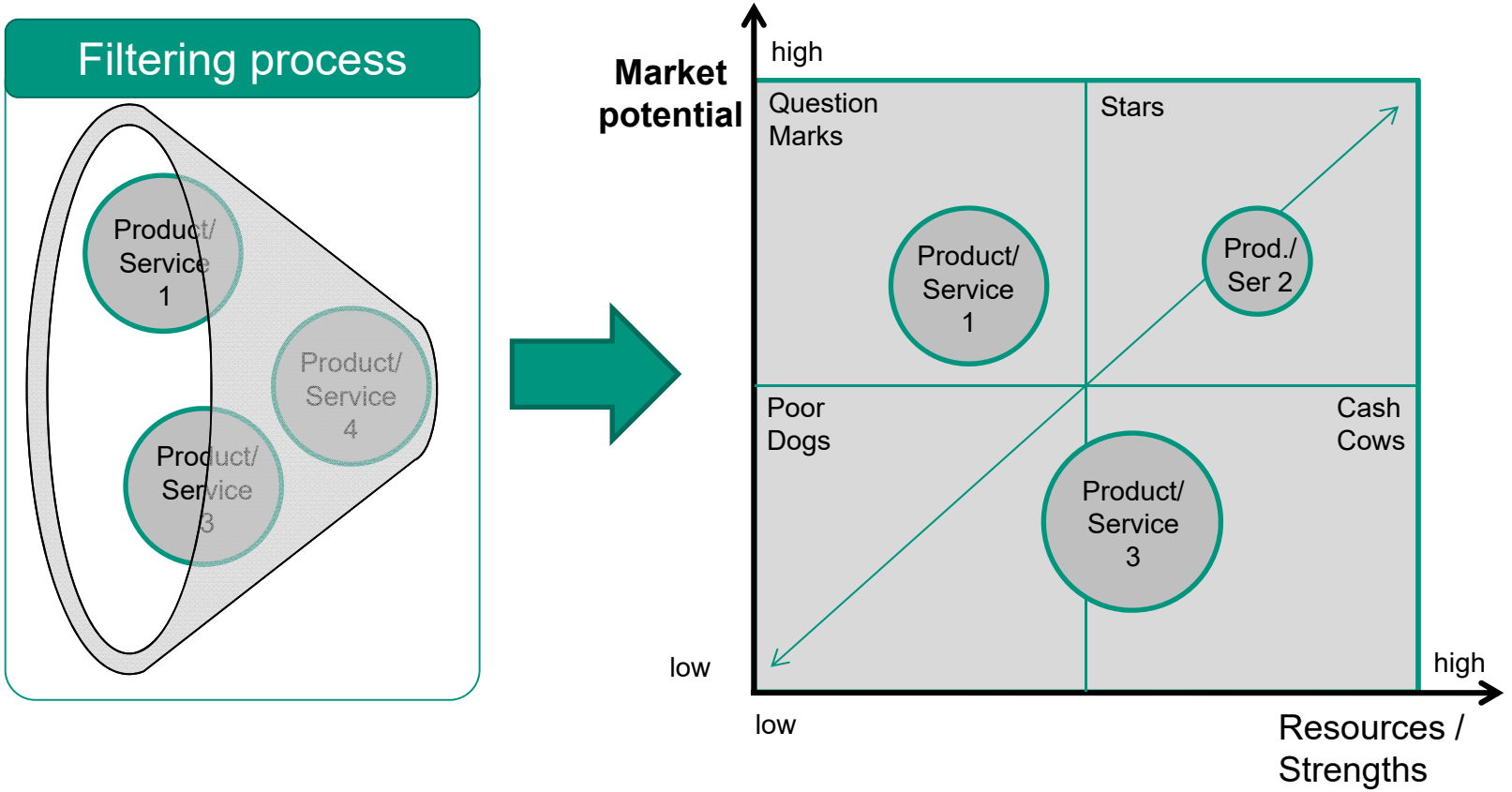
Successful implementation of Industrie 4.0

Filtering process for new product ideas



This process ensures the optimal order of innovations regarding Industrie 4.0.

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Smart Factory: Bosch Rexroth Assembly Line in Homburg

- Implementation in a smart factory:
  - Assembly line for over 200 versions of hydraulic valves
  - Manufactured products are equipped with RFID-chips for identification
  - Based on the current product, individual work instructions are displayed to the assembly operator
- Added value:
  - The complexity of a high product variety becomes manageable for the operator
  - High productivity despite small batch sizes and large numbers of product variants

Source: Rexroth

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Machine Tools in a Smart Factory: DMG Celos

DMG MORI

- Product:
  - Uniform man-machine interface for machine tools
  - Integrated management, documentation and visualization of job-, process- and machine-data
- Added value of the product:
  - Time saving through direct access of relevant data
  - High user friendliness
  - Premium price for the machine manufacturer
  - Time saving for the machine user

Source: DMG Mori Seiki AG

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Base Components in a Smart Factory: Signal Converters with TCP/IP

- Product:
  - Signal converters which are able to continuously receive signals and information of production systems and transmit them to networks (PCs, machine control) via Modbus/TCP
- Added value of the product:
  - Base-component for possible Industrie 4.0 applications
  - Quick and simplified diagnosis within the network
  - Accelerated troubleshooting during production processes
  - Internet-capable by the use of TCP/IP

Source: Weidmüller Interface GmbH & Co. KG

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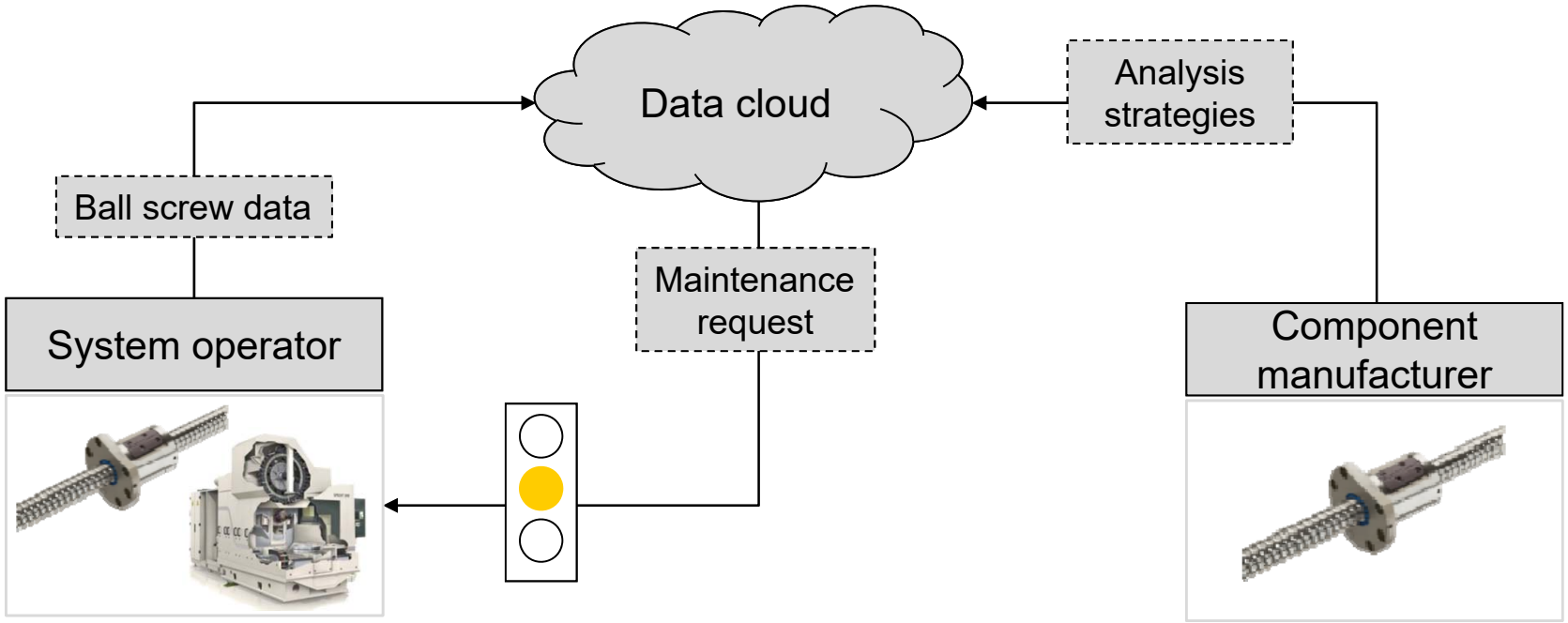
Predictive Maintenance in a Smart factory

- The ball screw of a machine tool sends data of it's use and integrated sensors to the cloud
  - Analysis strategies for the data are provided by the manufacturer
  - Maintenance requests are triggered out of the cloud



Images: MAG, Steinmeyer

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In-line Sensor Management in Smart Factories: Pepperl+Fuchs SmartBridge

- Product:
  - Adapter for communication between sensors and mobile devices (tablets, smartphones)
  - Safety aspect: The new Bluetooth capability has no influence on the function of the sensor or it‘s communication with the machine control
- Added value of the product:
  - Enabler for an in-line sensor management
  - Simplified commissioning, diagnosis and troubleshooting for the operator

Source: Pepperl + Fuchs

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New Business Models and Maintenance: Rolls Royce Total Care

- Product:
  - An airplane engine is provided to the customer; the manufacturer carries out monitoring, maintenance and repairs throughout the lifetime of the engine
  - The Engine remains property of Rolls Royce
  - Airlines pay for the function of the engine
- Added value of the product:
  - Reduction of financial risks for the airline
  - Cost of operations become projectable
  - Operational availability can be increased
  - Product improvements can be implemented more directly

Source: Rolls-Royce plc

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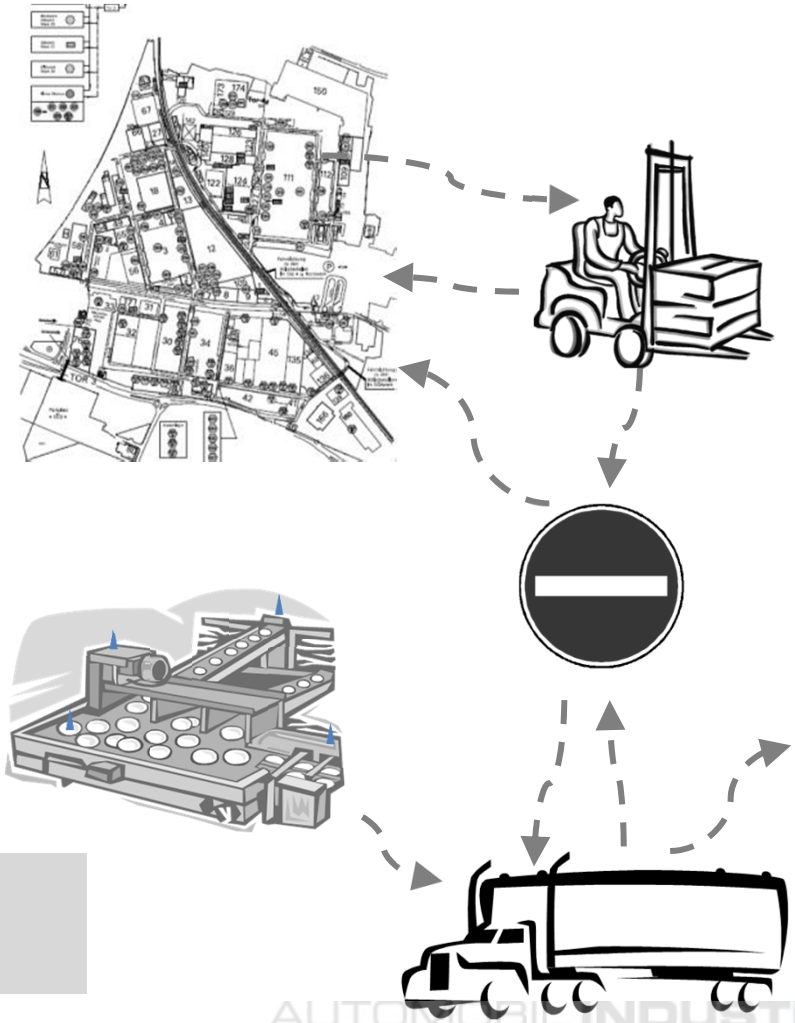
Industrie 4.0: practical use cases

Smart Supply Chains

- Self-organizing, adaptive logistics
- Traceability with CPS:
  - Information of the position of every load carrier
- Logistics
  - Exposure of weak spots in supply chains
  - Fast derivation of emergency strategies
- Intra logistics
  - Paperless logistics
  - Efficient handling



Logistics supported with Internet of Things services to save money and increase efficiency.

Source: Daimler

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Intelligent Inventory in a Smart Supply Chain: Würth iBin

- Product:
  - Small parts container with built-in camera to monitor its filling level
  - Autonomous triggering of re-orders through the system → Real-time control of the supply chain
- Added value of the product:
  - New business segment for the manufacturer of small parts: Optimization of the customer‘s supply chain
  - High supply reliability combined with low inventory levels
  - Strong customer relationships through the use of a closed system

Source: Würth

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Industrie 4.0: use case at AMTC

Showcase for Smart Automation: Valve manufacturing with Industry 4.0

- Product:
  - Hydraulic Valve manufacturing with Industry 4.0
- Added value of the product:
  - Autonomous manufacturing with real time control
  - No inventory in the production
  - Quick and simplified diagnosis within the network
  - Accelerated troubleshooting during production processes
  - Internet-capable by the use of TCP/IP
- Vision
  - Extension to other product variant

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Industrie 4.0: use case at AMTC

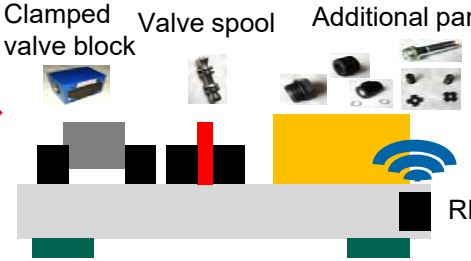
Showcase for Smart Automation: Valve manufacturing with Industry 4.0

Valve spool

valve block

Additional parts

Work piece carrier

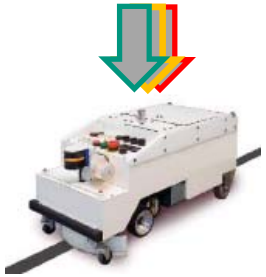


Logistic

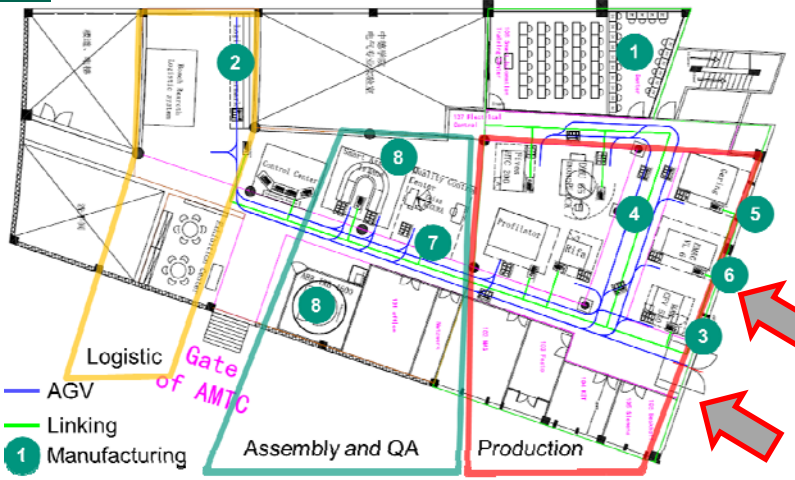
Cloud

Control

Zero point clamping



Conveyor



Milling and honing

Turning

Assembly & QA

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Summary

Industrie 4.0

- Changes through Industrie 4.0
  - Future products and production systems get communication abilities
  - Sensors and actors extend access to the physical world
  - Services improve product functionalities

- Industrie 4.0-technologies
  - Many necessary technologies are already available
  - An added value is generated through the intelligent combination of different technologies; only implemented use cases can demonstrate true values

- You cannot buy Industrie 4.0!
  - The successful implementation of Industrie 4.0 is a process
  - Start with the company's know how and needs
  - Implement the most obvious applications first
  - Learn with application!

Source: Plattform Industrie 4.0

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Thank you!

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