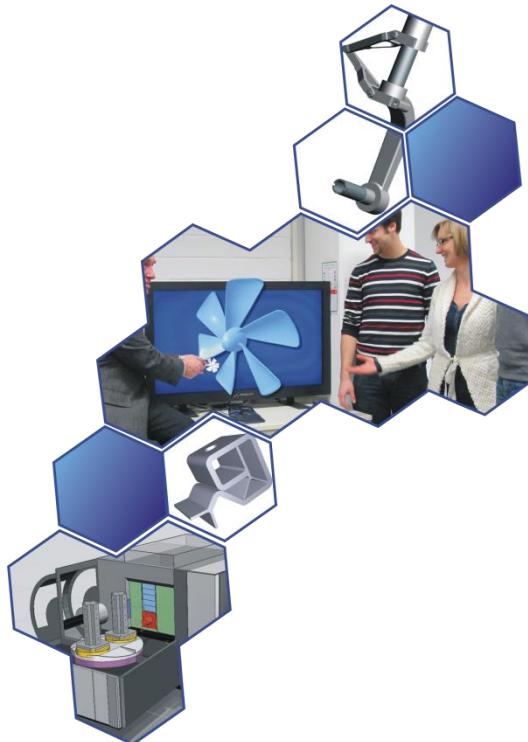
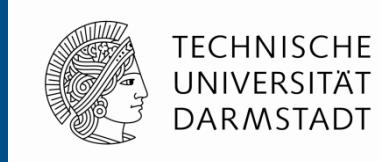


A Realization Guideline for Industrie 4.0



Prof. Dr.-Ing. Reiner Anderl

**Department of
Computer Integrated Design (DiK)**
Faculty of Mechanical Engineering
Technische Universität Darmstadt
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64287 Darmstadt
www.dik.maschinenbau.tu-darmstadt.de





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2. Approaches for Implementation of Industrie 4.0

- Implementation Recommendation Plattform Industrie 4.0
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 - Efficient Factory 4.0
 - Competence Center Mittelstand 4.0

3. The VDMA Guideline

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- Toolbox Production
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- Business models

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4. Summary



Development of information and communication technology (1)



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Hypermedia hyperlinked documents

YAHOO! (1995)

NETSCAPE
 (1985, 1997, 1998)
AOL

MOSAIC
X Window System • Microsoft Windows • Macintosh

ebay (1995) **amazon** (1994)

World Wide Web

Multimedia hyperlinked media

Google (1998)

 **Alibaba.com**
Global trade starts here.™
(1999)

Java, UML, XML

Socialmedia (1) networking people

 (2004)

 (2005)


Web Services

Web

Web 1.0

Web 2.0

1995

2000

2005



Source: Dr. Dais, Bosch

Development of information and communication technology (2)



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Socialmedia (2)
networking
companies



App technology

Cyber-Physical Media
interconnected and
communicating systems



Industrie 4.0
component

Future Media



Web 3.0

Web A.B

Web X.Y

2010

2015

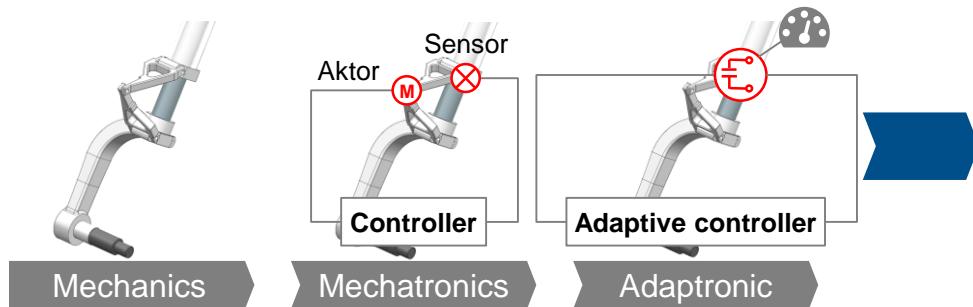
2020



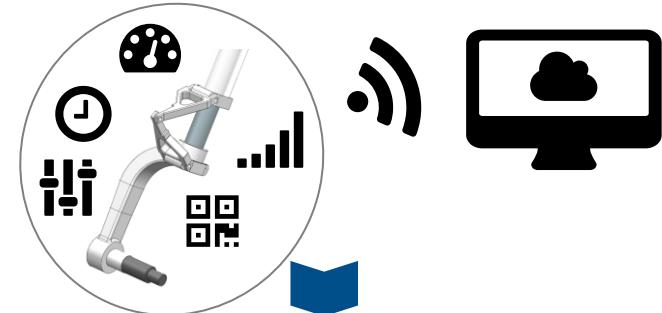
Approaches for smart systems



Improvement of the added value
Based on functional integration

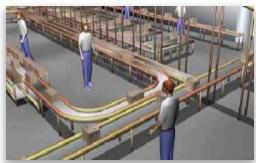


Further improvement of the added value
based on cyber-physical systems



Networked and communicating systems

Smart Plant



Source: TU Darmstadt, Effiziente Fabrik 4.0

Smart Factory



Smart City



Source: TU Darmstadt

Smart Grid



Source: TU Darmstadt, ESE

Smart Products



Smart Logistics

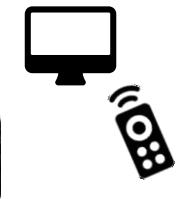


Smart Home



Cyber-physical systems support
networking and communication

- Condition Monitoring
- Systems and Structural Health Monitoring
- Remote Diagnosis and Control
- Tracking and Tracing





1. Introduction

2. Approaches for Implementation of Industrie 4.0

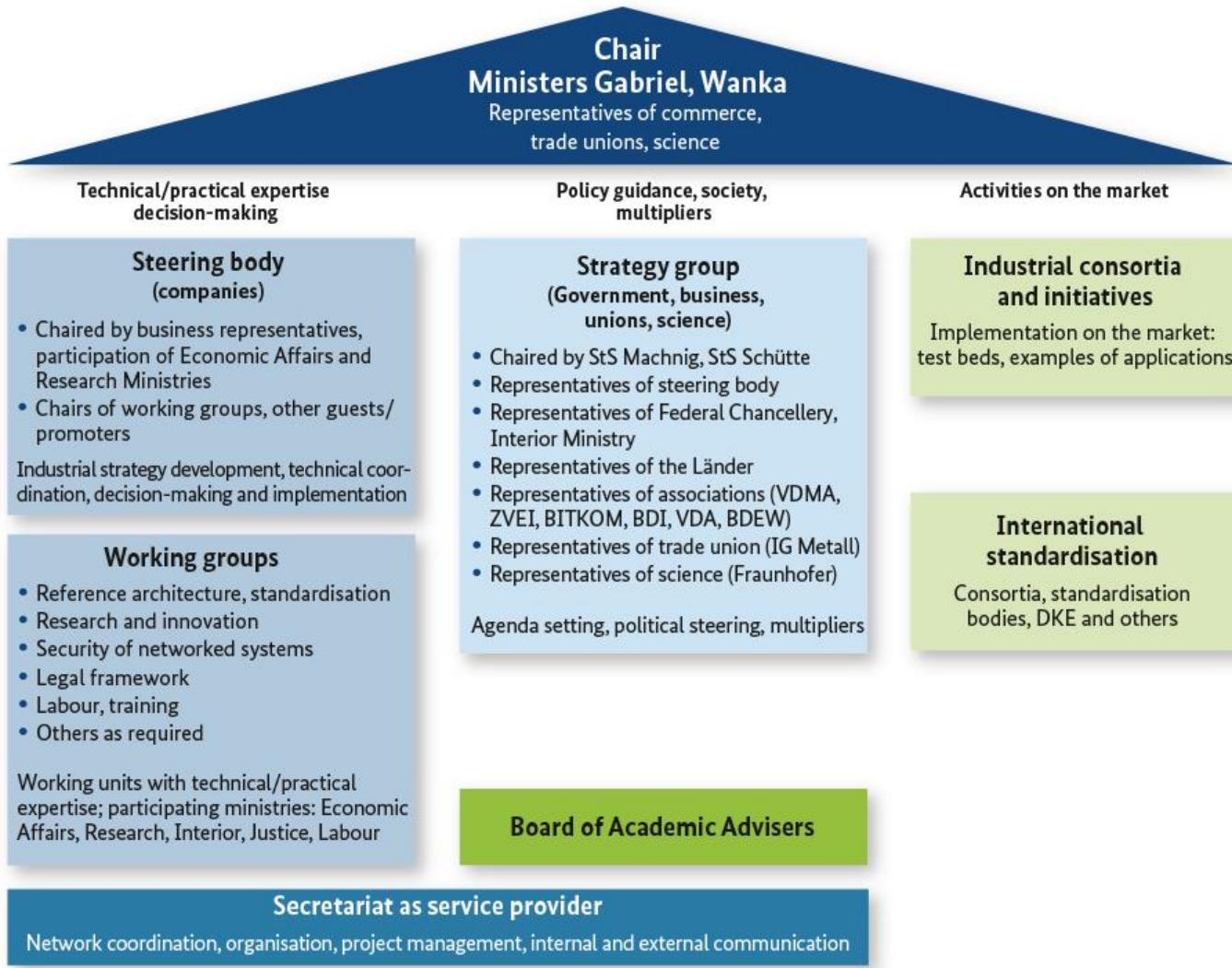
- Implementation Recommendation Plattform Industrie 4.0
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Fertigung und Fabrikbetrieb, Fraunhofer IPA

Implementation recommendations for Industrie 4.0

Effective: April 14, 2015



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Umsetzungsstrategie Industrie 4.0

Ergebnisbericht der Plattform Industrie 4.0

Industrie 4.0
component

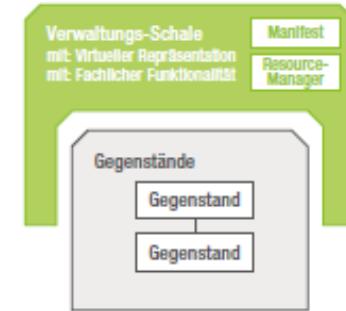
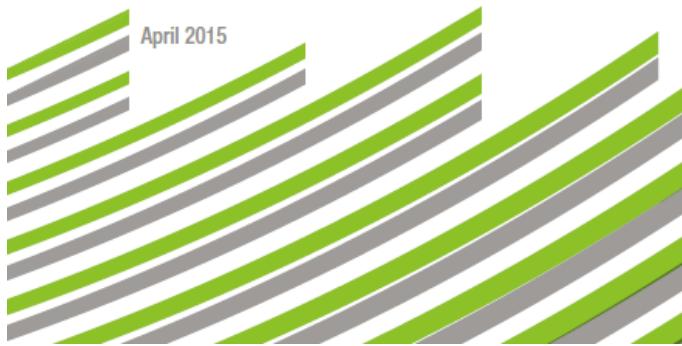


Abbildung 23: Industrie 4.0-Komponente



RAMI 4.0

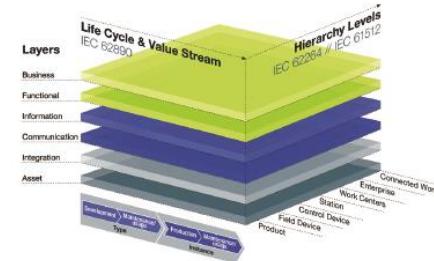


Abbildung 15: Referenzarchitekturenmodell / Reference Architecture Model Industrie 4.0 (RAMI 4.0)

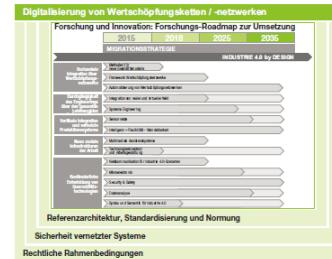


Abbildung 1: Vier Phasen Industrie 4.0

Research roadmap



Implementation recommendations for Industrie 4.0

Effective: April 14, 2015



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Umsetzungsstrategie Industrie 4.0

Ergebnisbericht der Plattform Industrie 4.0

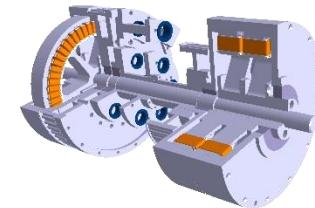
Added Value
Use Cases
Examples of execution



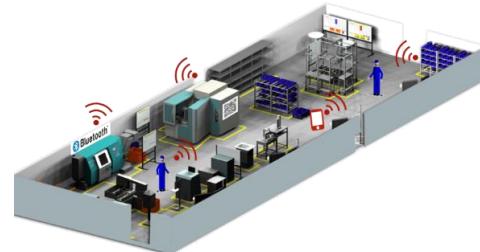
Business models



Products



Production



Model factory for Industrie 4.0

Unique selling point TU Darmstadt: Effiziente Fabrik 4.0



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DARMSTADT

- Build on existing, real production system



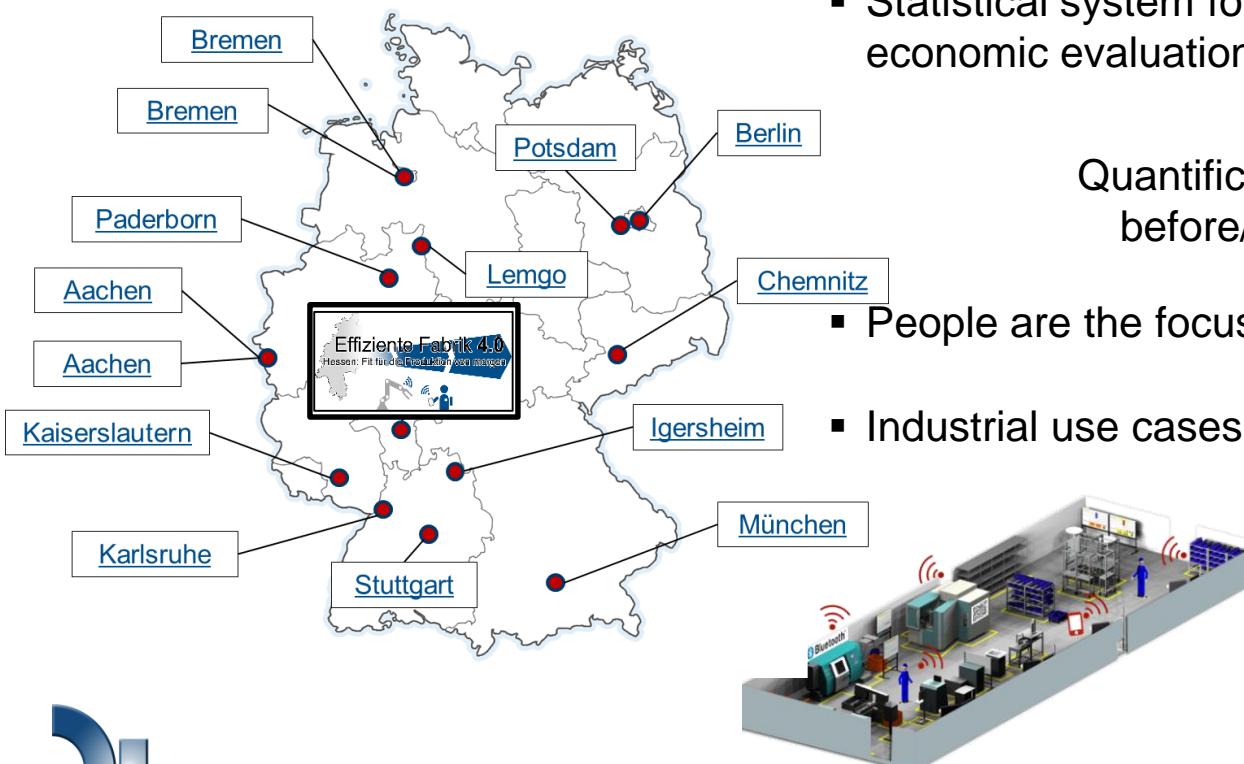
Brown instead of Green Field

- Statistical system for the organizational and economic evaluation



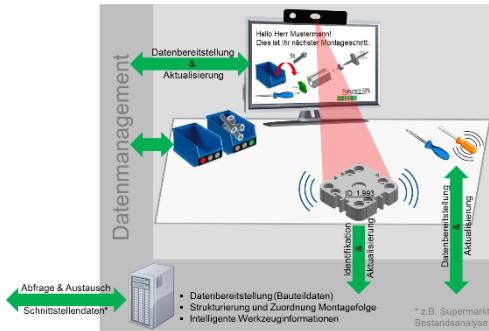
Quantification of benefits via
before/after comparison

- People are the focus
- Industrial use cases (application scenarios)



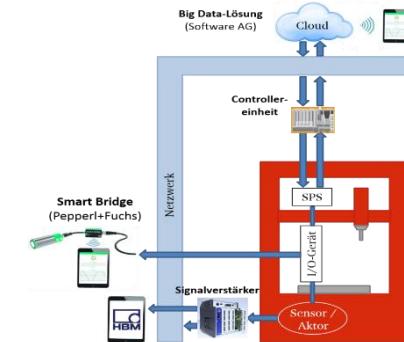
Project partners			
IG Metall Institution/ employee association	Heidelberger Druckmaschinen User Company	:em engineering methods AG Supplier/Software	TE Connectivity Supplier
Rittal GmbH User Company	Software AG Supplier/Software	Pepperl+Fuchs Supplier	Hottlinger Baldwin Messtechnik Supplier
ESR Pollmeier Supplier	PEPPERL+FUCHS Supplier	Östling Supplier	HBM Supplier
BR Automation Supplier/Software	memex GmbH Supplier		

Uses Cases – Efficient Factory 4.0



Use Case 4

- ### ➤ **Flexible intelligent worker assistance systems**



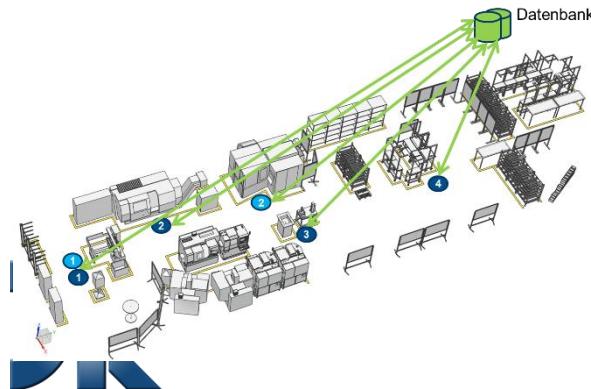
Use Case 1

- ## ➤ Paperless and integrated quality assurance

- Components as information carriers
- Unified data management

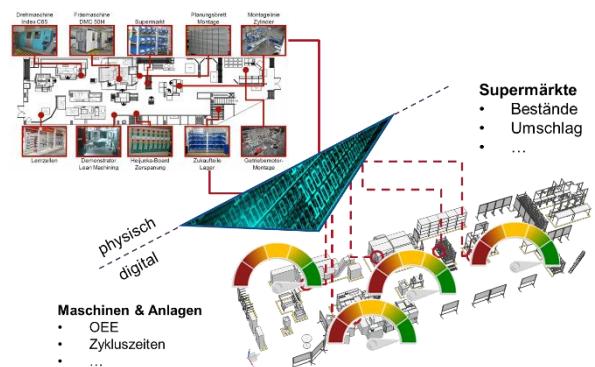
Use Case 3

- ## ➤ Condition and energy monitoring

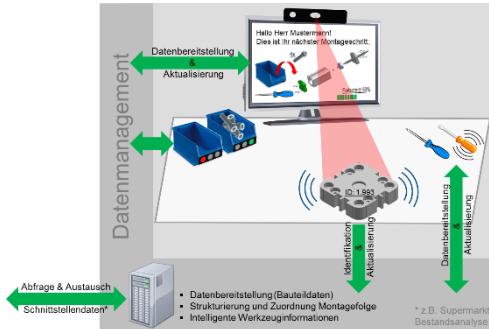


Use Case 2

- Digital value stream image
 - Real-time capable production controlling



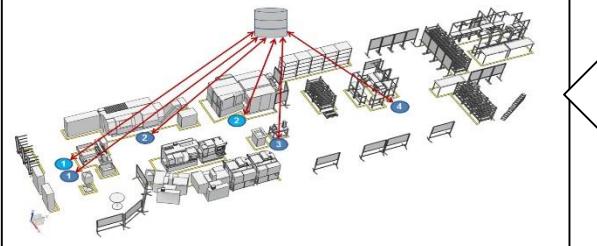
Uses Cases – Efficient Factory 4.0



Use Case 4

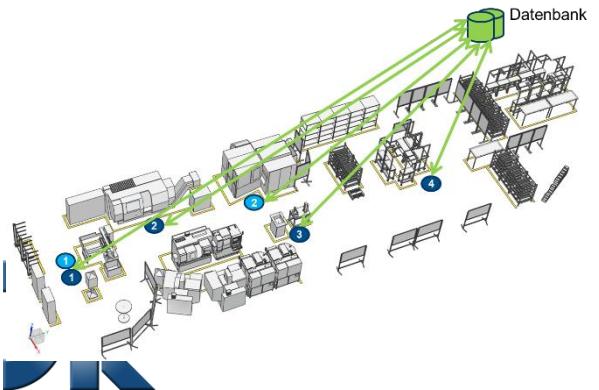
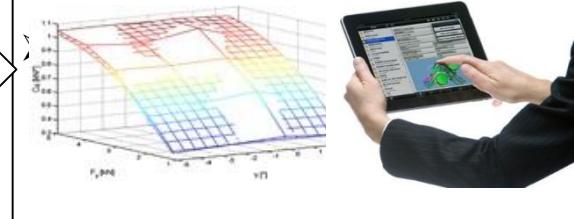


Use Case 1

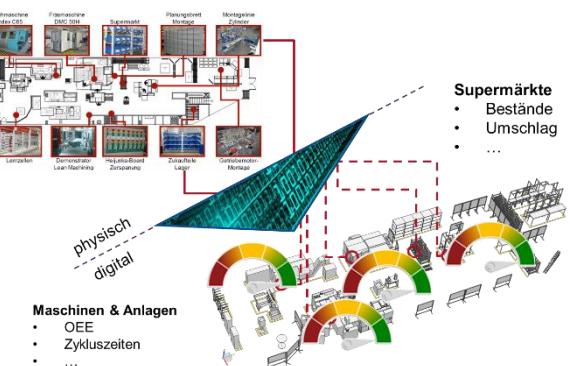
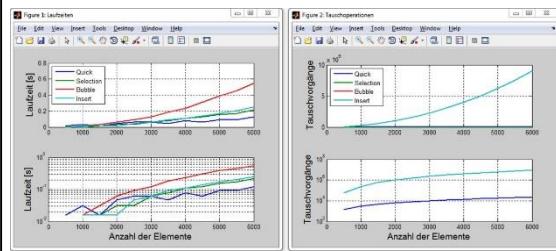


- Components as information carriers
- Unified data management

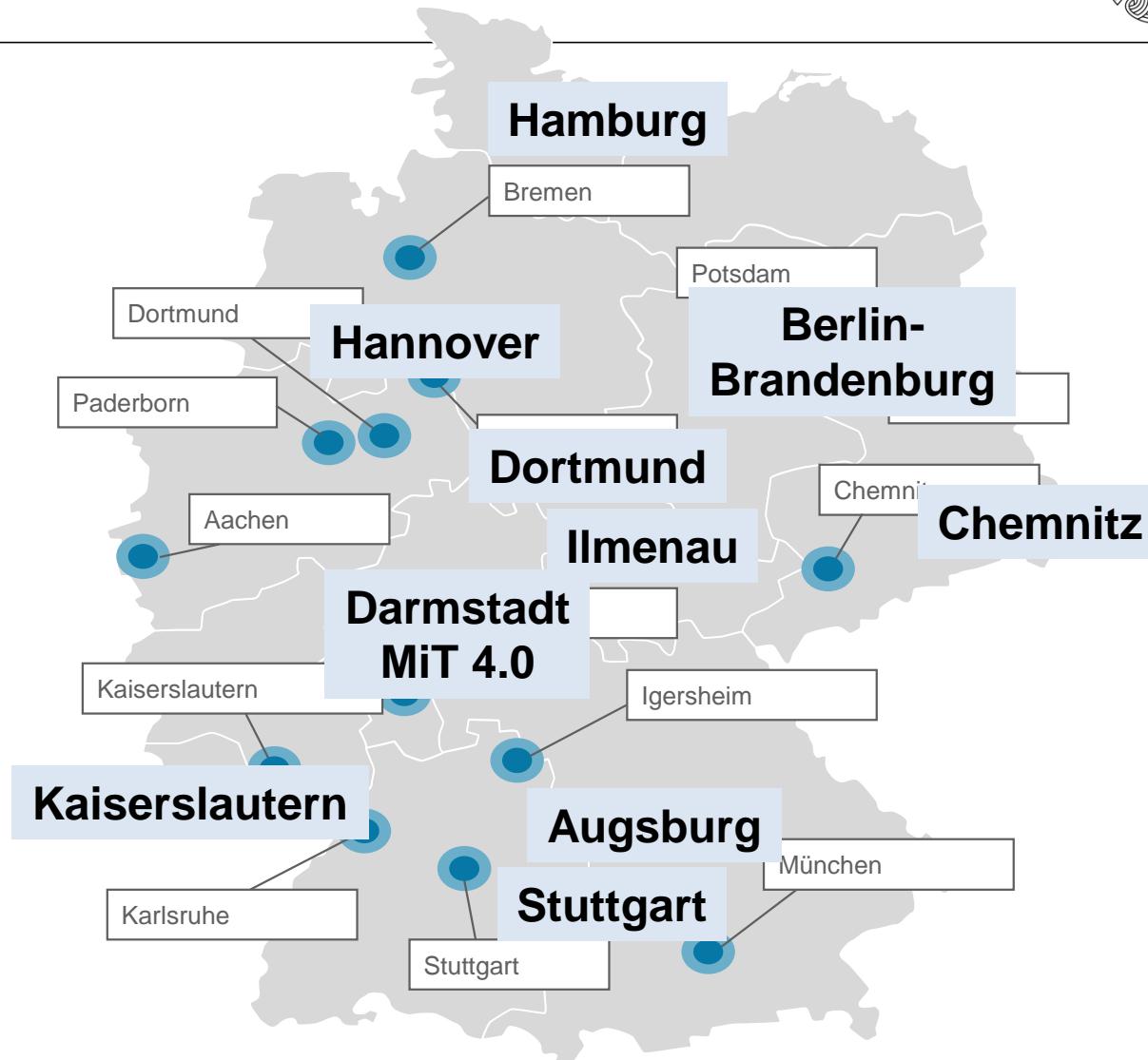
Use Case 3



Use Case 2



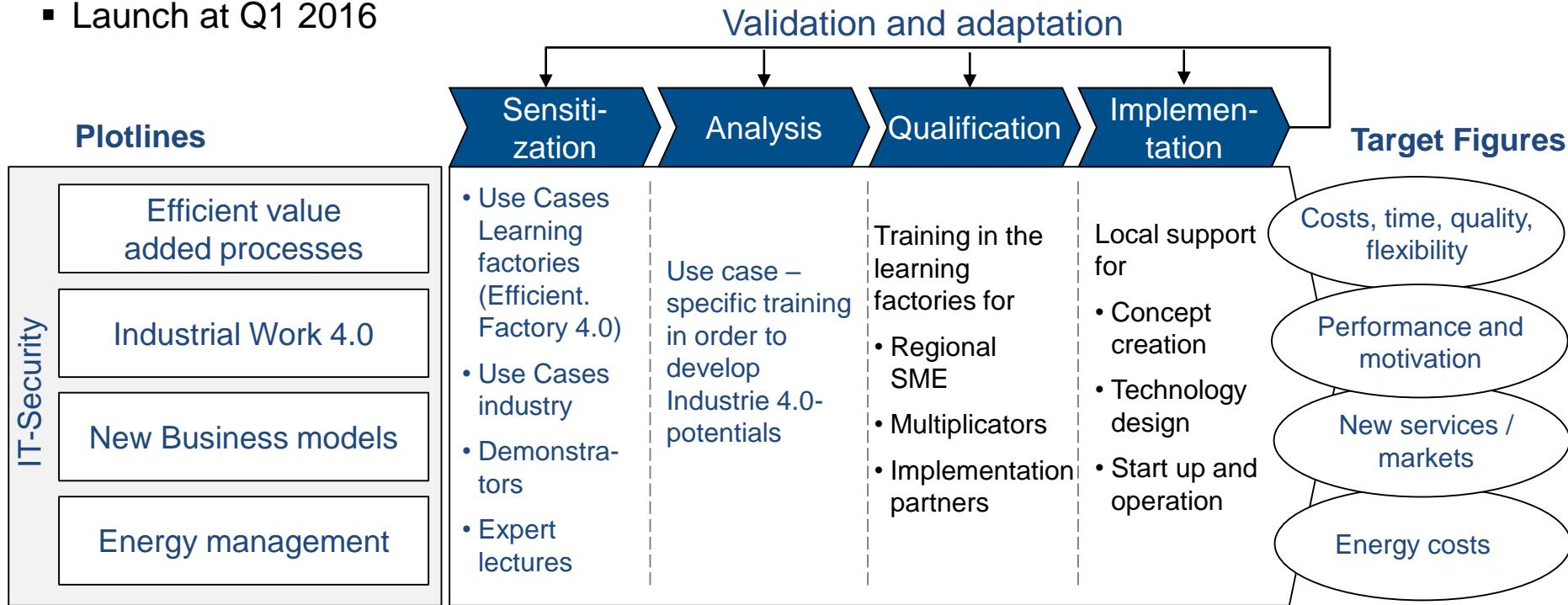
Competence Centers Industrie 4.0 in Germany



SME Technology Center for Industrie 4.0 (MiT 4.0)



- The service portfolio includes a target group-oriented competence development. For this purpose, different plotlines and instruments for SME-friendly exchange in MiT 4.0 are defined.
- Launch at Q1 2016





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- Business models

4. Summary





Initial situation:

- 86% of German SMEs have recognized the potential of Industrie 4.0
(Source: Commerzbank AG)
- Visions of Industrie 4.0 are intangible and too general for the industry
- Way to realize Industrie 4.0 is unknown for the industry

Objectives:

- Break down the visions of Industrie 4.0 on realizable development stages for product ideas and production improvements
- Understanding Industrie 4.0 as a pioneer of new business models
- Sketch and support path to successful implementation



VDMA guideline Industrie 4.0: Toolbox Industrie 4.0



- The key element of the guideline Industrie 4.0 is the **Toolbox Industrie 4.0**
- The Toolbox Industrie 4.0 is used to analyze the company's competences and to generate strategies for approaching Industrie 4.0.

Toolbox Industrie 4.0					
Industrie 4.0					
Products					
Integration of sensors / actuators					
No use of sensors' actuators	Sensors / actuators are integrated	Sensor readings are processed by the product	Data is evaluated for analyses by the product	The product can independently react to sensor data on the gained data	
Communication / Connectivity					
The product has no interfaces	The product sends or receives I/O signals	The product has field bus interfaces	The product has industrial Ethernet interfaces	The product has access to the Internet	
Functionalities for data storage and information exchange					
No functionalities	possibility of individual identification	Product has a passive data store	Product with data storage for selective information exchange	Data information exchange as integral part	
Monitoring					
No monitoring by the product	Detection of failures	Recording of operating condition for diagnostic purposes	Prognosis of the functional condition	Independently adopted control measures	
Product-related IT services					
No services	Services via online portals	Service execution directly via the product	Independently performed services	Centralized integration into an infrastructure of IT services	
Business models around the product					
Gaining profits from selling standardized products	Sales and consulting regarding the product	Sales, consulting and selection of the product to meet customer specifications	Additional sale of product-related services	Sale of excessed functions	

Toolbox Industrie 4.0					
Industrie 4.0					
Production					
Data processing in the production					
No processing of data	Storage of data for documentation	Analyzing data for process monitoring	Evaluation for process planning / control	Automatic process planning / control	
Machine-to-Machine-Communication (M2M)					
No communication	Field bus interfaces	Industrial ethernet interfaces	Industries have access to Internet	Web services (N2M services)	
Company-wide networking with the production					
No networking of production with other business units	Information exchange via main telecommunication	Uniform data formats and rules for data exchange	Uniform data formats and interdivisionally linked data servers	Inter-divisional, fully harmonized IT solutions	
ICT infrastructure in production					
Information exchange via main telecommunication	Central data servers in production	Internet-based models with data sharing	Automated information exchange (e.g. order tracking)	Suppliers / customers are fully integrated into the process design	
Man-machine interfaces					
No information exchange between user and machine	Use of local user interfaces	Centralized / decentralized production monitoring / control	Use of mobile user interfaces	Augmented and assisted reality	
Efficiency with small batches					
Rigid production systems and a small program range for identical parts	Use of flexible production systems and identical parts	Flexible production systems and modular designs for the products	Component-driven, flexible production of individual products within one company	Component-driven, modular production via cross-feeding networks	

Source: Leitfaden Industrie 4.0 – Orientierungshilfe zur Einführung in den Mittelstand, VDMA

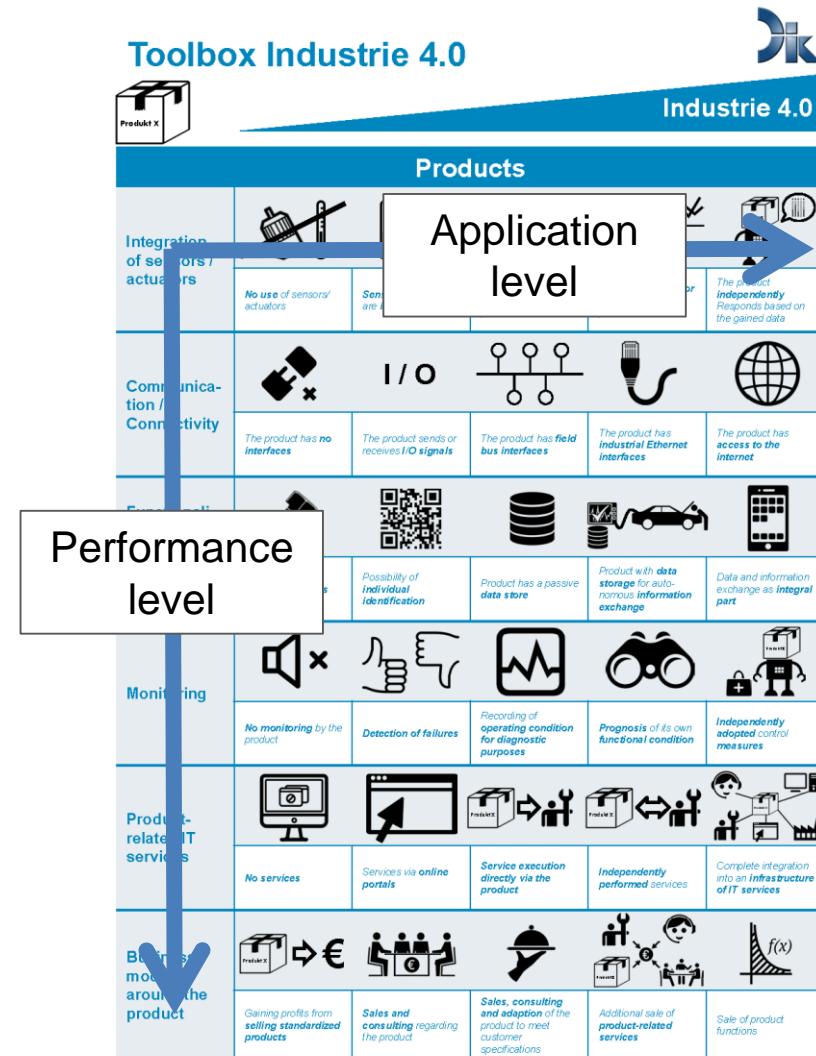


VDM guideline Industrie 4.0: Toolbox Industrie 4.0



Structure of the toolbox:

- Application level:
 - Six application levels to identify themes for ideas in the field of Industrie 4.0.
 - The combination provides the functionality.
- Performance level:
 - Five technological, building on one another performance levels for positioning and strategy development.
 - The highest level represents the vision Industrie 4.0.



Source: Leitfaden Industrie 4.0 – Orientierungshilfe
zur Einführung in den Mittelstand, VDMA

VDMA guideline Industrie 4.0: Toolbox Products



- Application levels:
 - Integration of sensors / actuators
 - Communication / Connectivity
 - Functionalities for data storage and exchange of information
 - Monitoring
 - Product-related IT services
 - Business models around the product

Toolbox Industrie 4.0

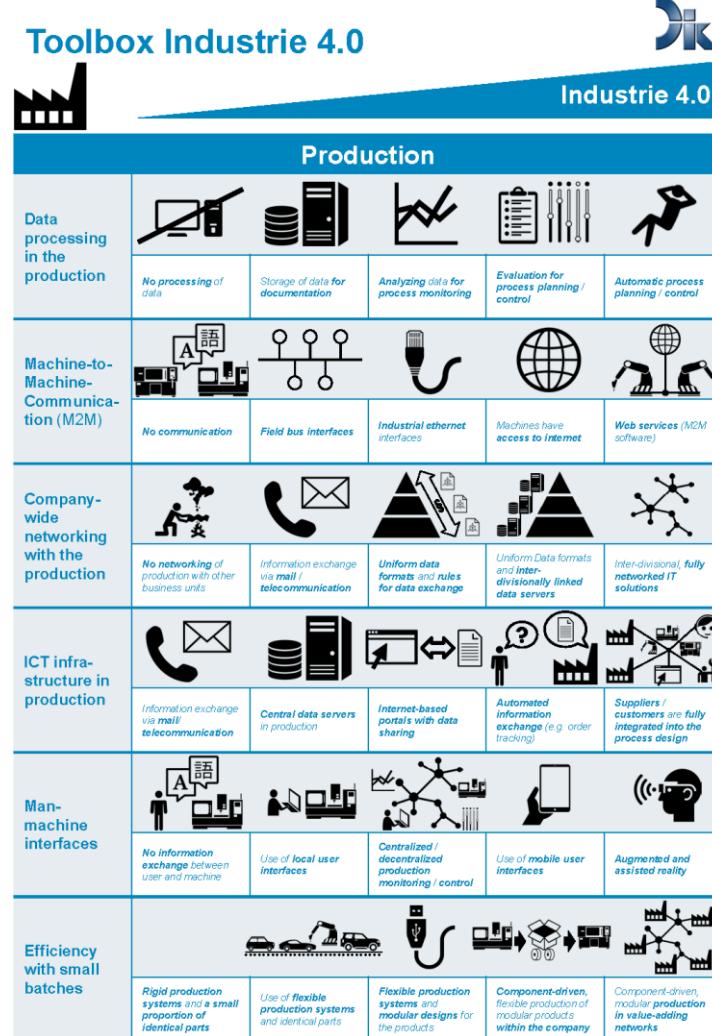
Products					Industrie 4.0
Integration of sensors / actuators					
Communication / Connectivity					
Functionalities for data storage and information exchange					
	No functionalities	Possibility of individual identification	Product has a passive data store	Product with data storage for autonomous information exchange	Data and information exchange as integral part
Monitoring					
	No monitoring by the product	Detection of failures	Recording of operating condition for diagnostic purposes	Prognosis of its own functional condition	Independently adopted control measures
Product-related IT services					
	No services	Services via online portals	Service execution directly via the product	Independently performed services	Complete integration into an infrastructure of IT services
Business models around the product					
	Gaining profits from selling standardized products	Sales and consulting regarding the product	Sales, consulting and adapting of the product to meet customer specifications	Additional sale of product-related services	Sale of product functions

Source: Leitfaden Industrie 4.0 – Orientierungshilfe zur Einführung in den Mittelstand, VDMA

VDMA guideline Industrie 4.0: Toolbox Production

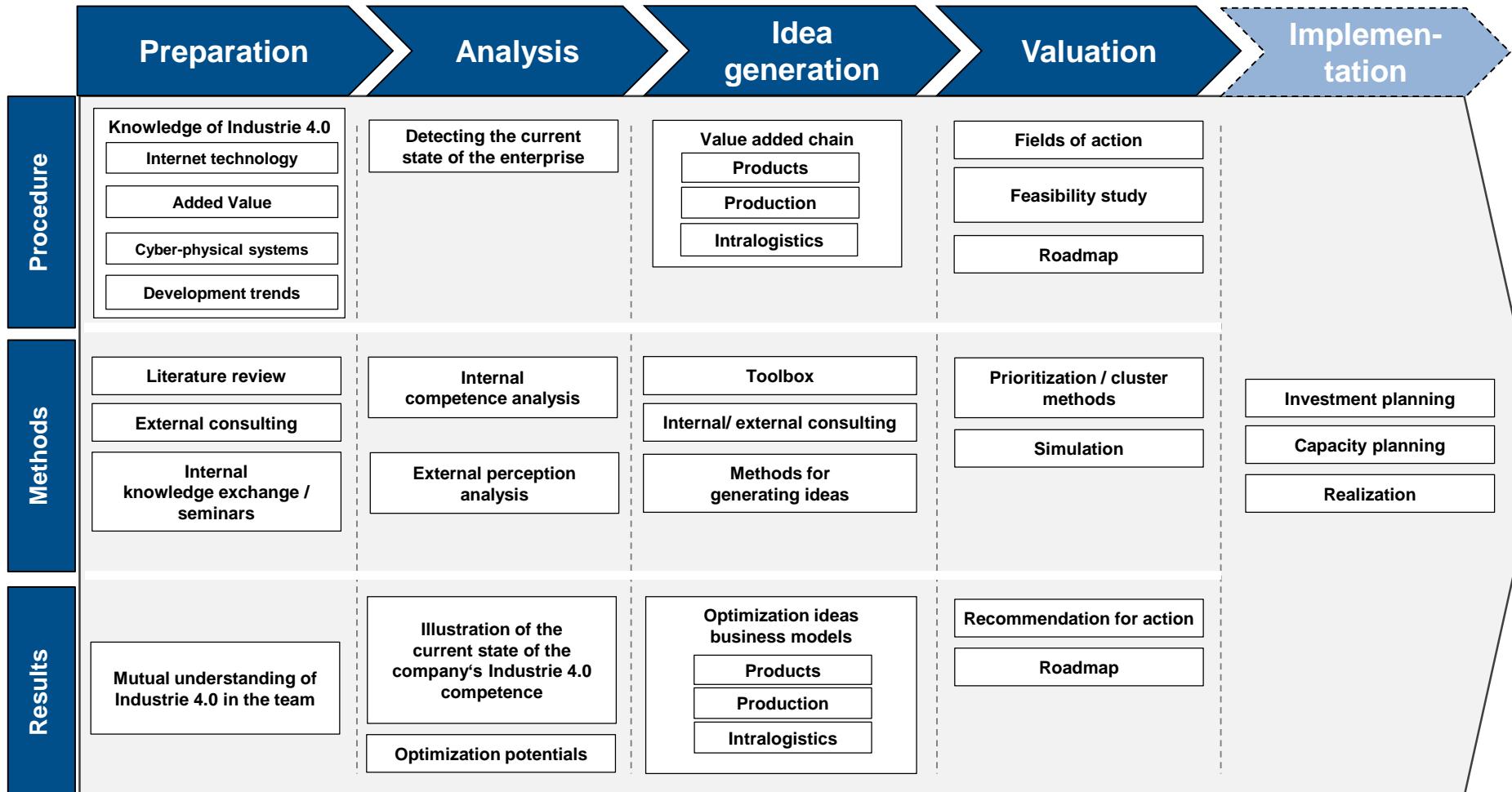


- Application levels:
 - Data processing in production
 - Machine-to-Machine- Communication (M2M)
 - Company-wide networking with the production
 - ICT infrastructure in production
 - Human Machine Interfaces
 - Efficiency for small batches



Source: Leitfaden Industrie 4.0 – Orientierungshilfe zur Einführung in den Mittelstand, VDMA

Generic Process Model



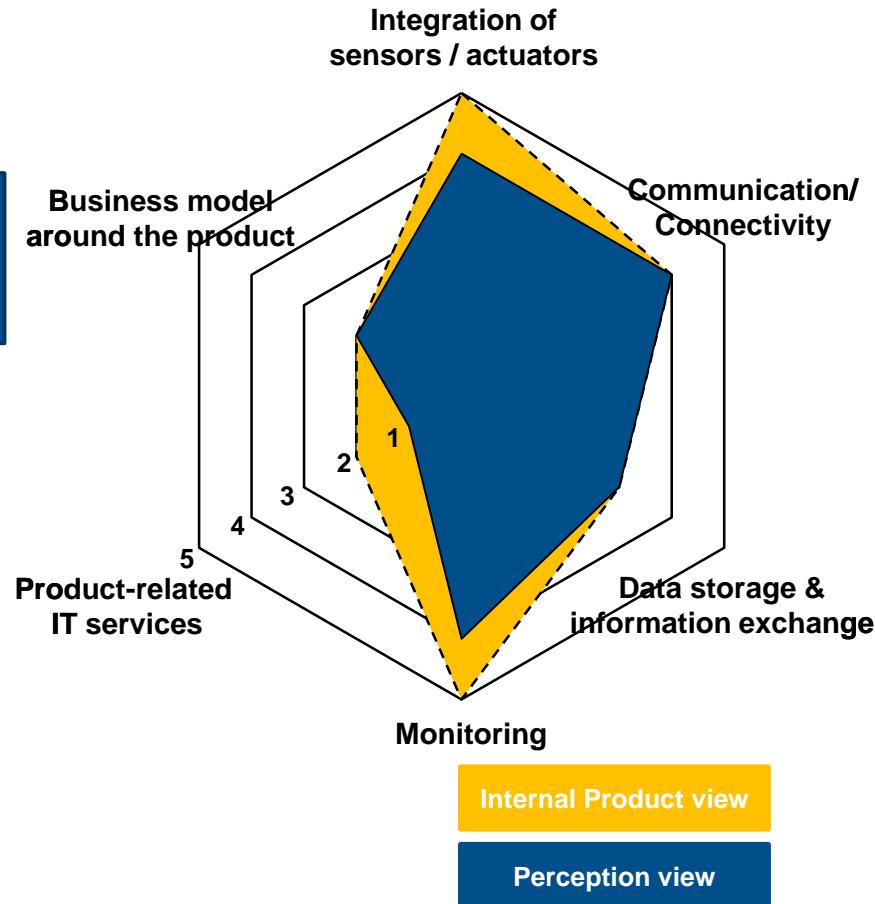
Internal Competence and External Perception Analysis



Objectives:

- Identification of already existing Industrie 4.0 competences
- External perception

Often competences for Industrie 4.0 approaches are already existing in the company



Procedure:

1. Classification into the stages of development of the Toolbox Industrie 4.0
2. Questionnaire and Interviews of product and production experts
3. External Perception (through analysis of products presented in media)
4. Graphical representation as a radar chart

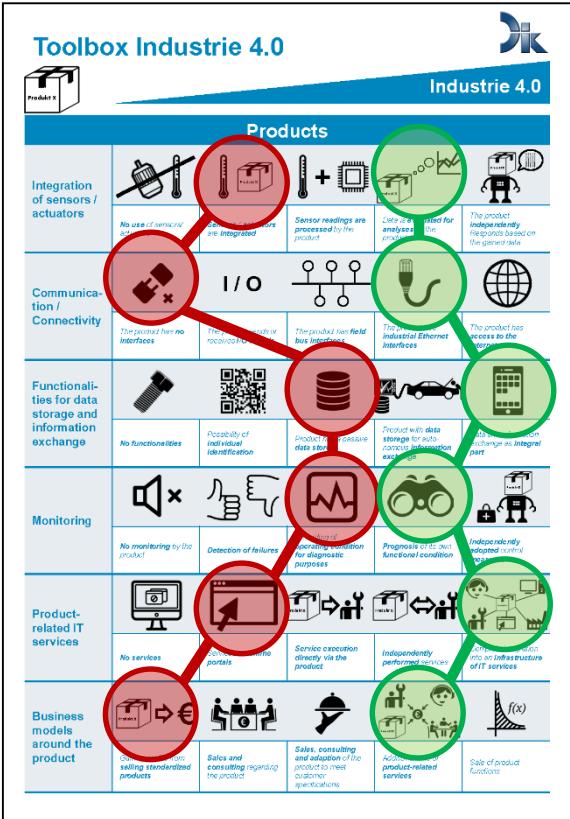
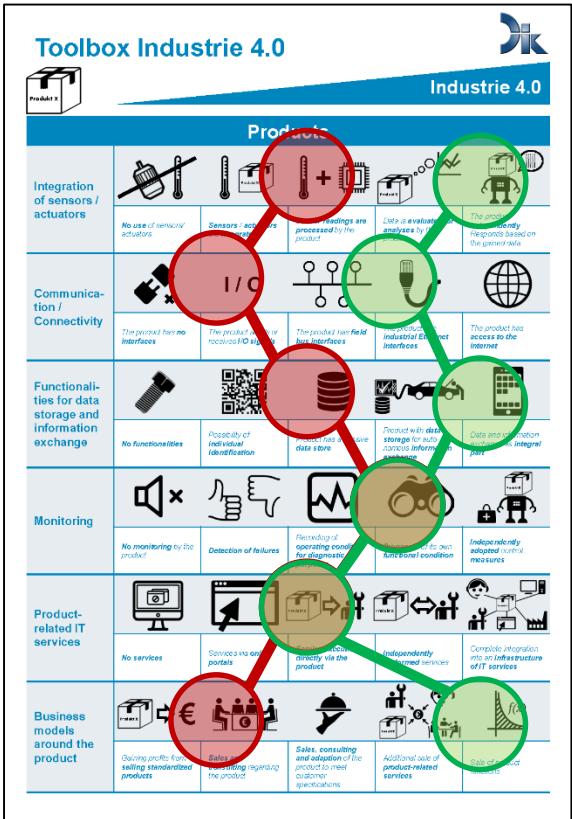


VDMA guideline Industrie 4.0: Results for products und production



Procedure:

1. Classification with respect to performance levels of the Toolbox Industrie 4.0
2. Identification of the existing performance profile in the toolbox
3. Definition of the target profile in the toolbox



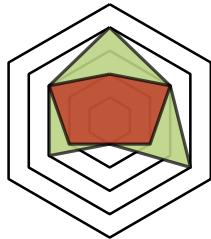
Definition of the target profile for the product portfolio



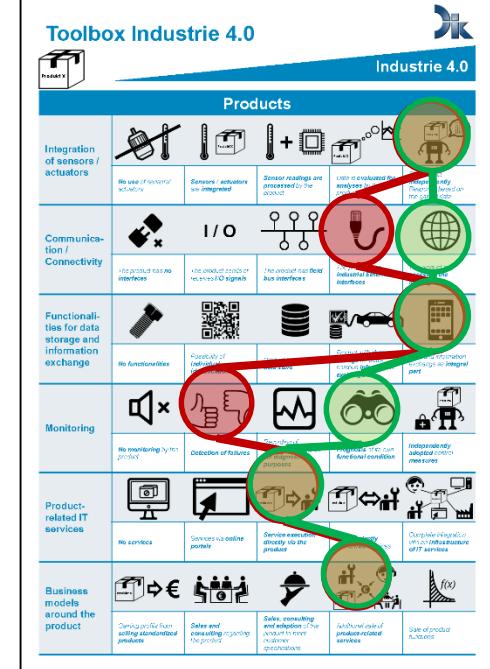
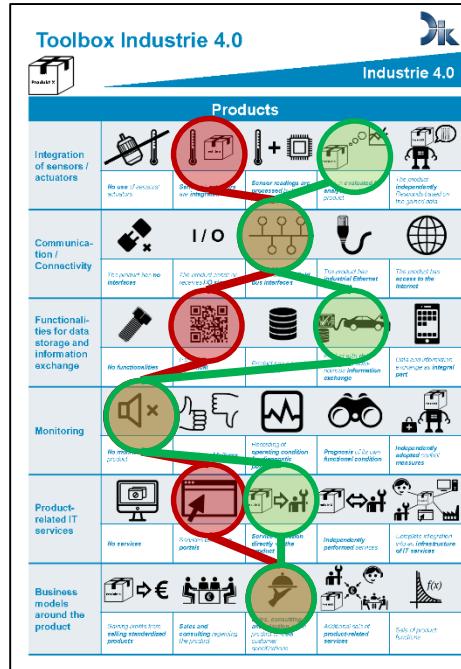
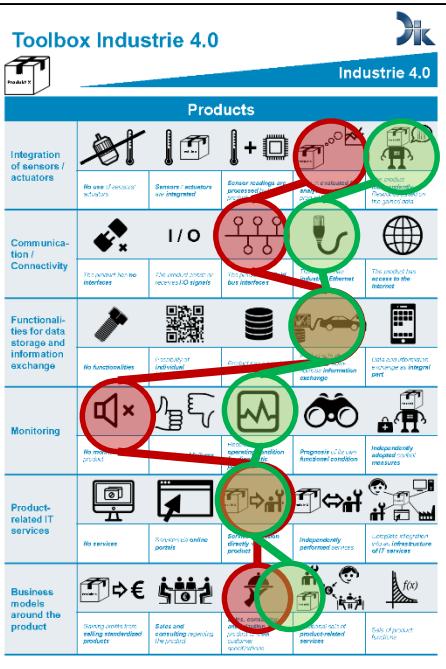
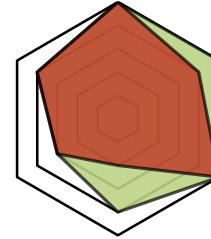
Product 1



Product 2



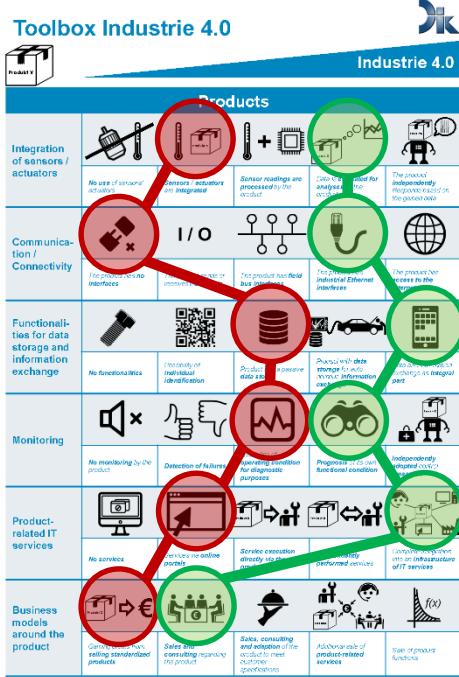
Product n



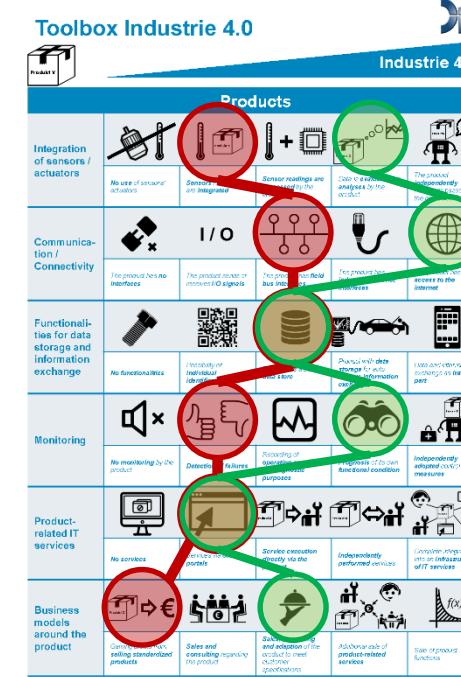
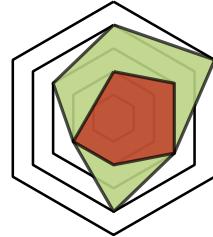
Definition of the target profile for the areas of production



Production



Intralogistics



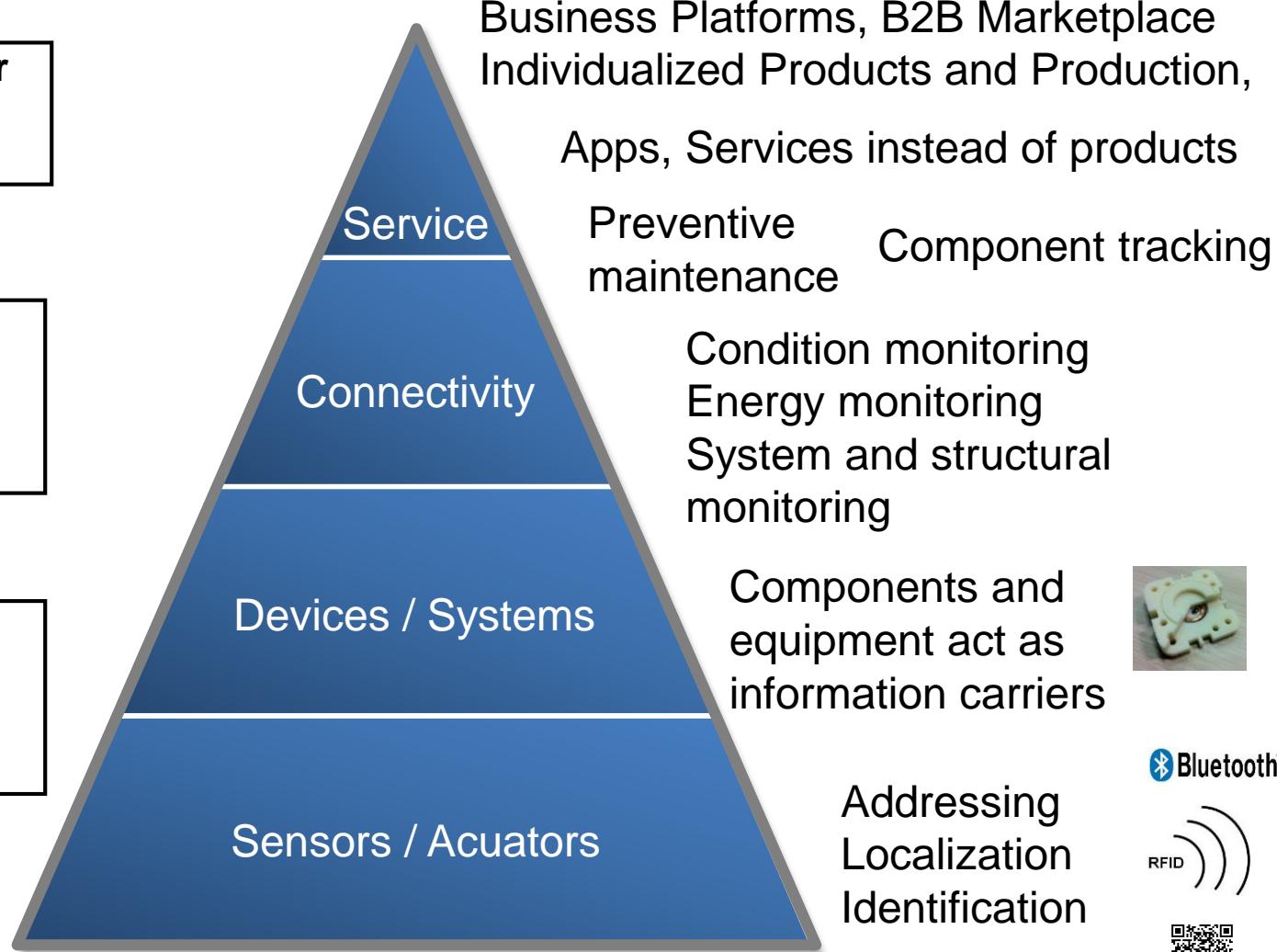
Production, products, business models: Industrie 4.0 development trends



New approaches for
internet-based
business models

New level of
organization and
management of the
value added chain

Interlinked and
communicating
systems





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4. Summary



- Industrie 4.0 provides new impulses for the development and application of cyber-physical systems on the way to the internet of things, of services and data.
- Industrie 4.0 still requires research and development initiatives, nevertheless applicable solutions are already visible.
- Impulses for the Industry:
 - Customization through customer and market interaction
 - New ICT infrastructures
 - Innovative business models through integrated product and service quality
- Current state of debate:
 - Politics: Politicians have recognized the importance of Industrie 4.0 at the federal level and the state level and became active (Plattform Industrie 4.0, IT summit, European initiatives)
 - Industry: The industry has organized itself through the platform industry 4.0
 - Society: Change of the working environment! Increasing digitization and computerization through Industrie 4.0 requires training and continuous qualification of employees



➤ ***Industrie 4.0 offers to companies a serious vision, that has to be evaluated and implemented company-specific.***

Thank you!



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**Thank you
for your
attention**

