What is Industrie 4.0 and how will it create the new growth?

TECHNISCHE UNIVERSITÄT DARMSTADT

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Overview

1. Introduction
2. Fundamental Approaches of Industrie 4.0 Technology
   - RAMI 4.0 – The Reference Architecture Model Industrie 4.0
   - Cyber-Physical Systems
   - Internet Technology
   - Manufacturing Objects as Information Carriers
   - Holistic Approach for Safety, Security, Privacy and Knowledge Protection
3. Use Case Scenarios
4. Transfering Industrie 4.0 to Industry
5. Conclusion

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Overview

Computer Integrated Design
Fachgebiet Datenverarbeitung in der Konstruktion (DiK)

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Overview:

- Computer Integrated Design
- Head: Prof. Dr.-Ing. R. Anderl
- 20 Research Assistants
- 5 Technical and Administrative Staff, ~ 50 Teaching Assistents

International Competence and Experience in the Fields of:

- Virtual Product Development based Smart Engineering,
- Sustainable Product Lifecycle Management (PLM)
- Process Integration / Optimization
- Industrie 4.0

acatech DEUTSCHE AKADEMIE DER TECHNIKWISSENSCHAFTEN | NATIONAL ACADEMY OF SCIENCE AND ENGINEERING

ACADEMIA SCIENTIARVM ET LITERARVM MOGVNTINA · GENIO LEIBNITII

PACE
Partners for the Advancement of Collaborative Engineering Education
GM Autodesk hp ORACLE SIEMENS

Wissenschaftliche Gesellschaft für Produktentwicklung WiGeP
Berliner Kreis & WGMK

The Impact of Information and Communication Technology(1)

Hypermedia Interlinked Documents	Multimedia Interlinked Media	Socialmedia (1) Interlinked People
World Wide Web	Java, UML, XML	Web Services
Web	**Web 1.0**	**Web 2.0**
1995	2000	2005

The Impact of Information and Communication Technology(2)

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Socialmedia (2) Interlinked Enterprises	Cyber-Physical Media Interlinked Systems	Future Media

Plattform INDUSTRIE 4.0

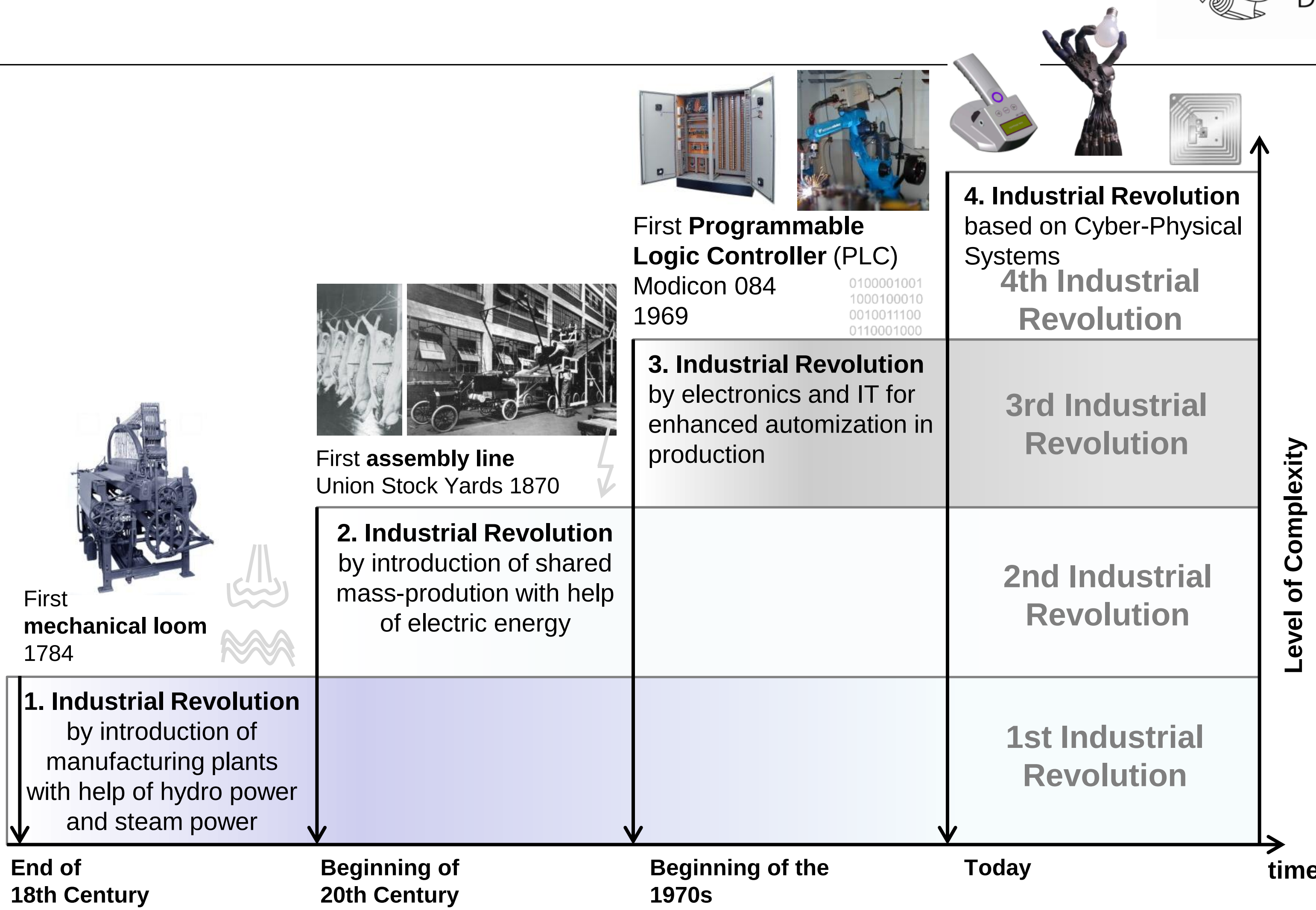
?

App Technologie

IoT, IoS, IoD, … Industrie 4.0 Components

Web 3.0	Web A.B	Web X.Y
2010	2015	2020

Industrie 4.0 – The 4th Industrial Revolution



Source: Kagermann, H.; Wahlster, W.; Held, J.; (Hrsg.) : Bericht der Promotorengruppe Kommunikation. Im Fokus: Das Zukunftsprojekt Industrie 4.0. Forschungsunion, 2012

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Approaches for Smart Systems

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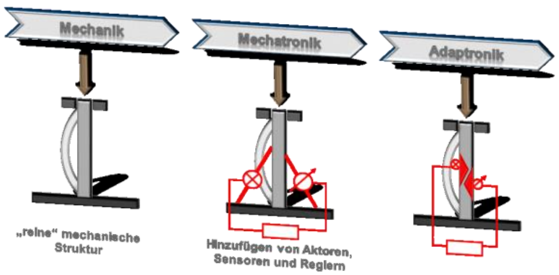
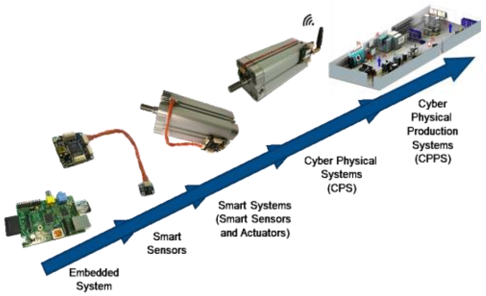
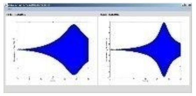
Functional integration

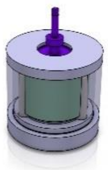


Integrated cyber-physical systems

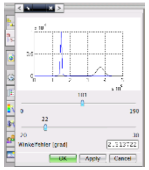


Condition Monitoring





Structural Health Monitoring



Remote Diagnosis

Remote Control

Communicating (self-)controled systems

Cyber-physical systems enable communication, monitoring, control

RAMI 4.0

Reference Architecture Model Industrie 4.0

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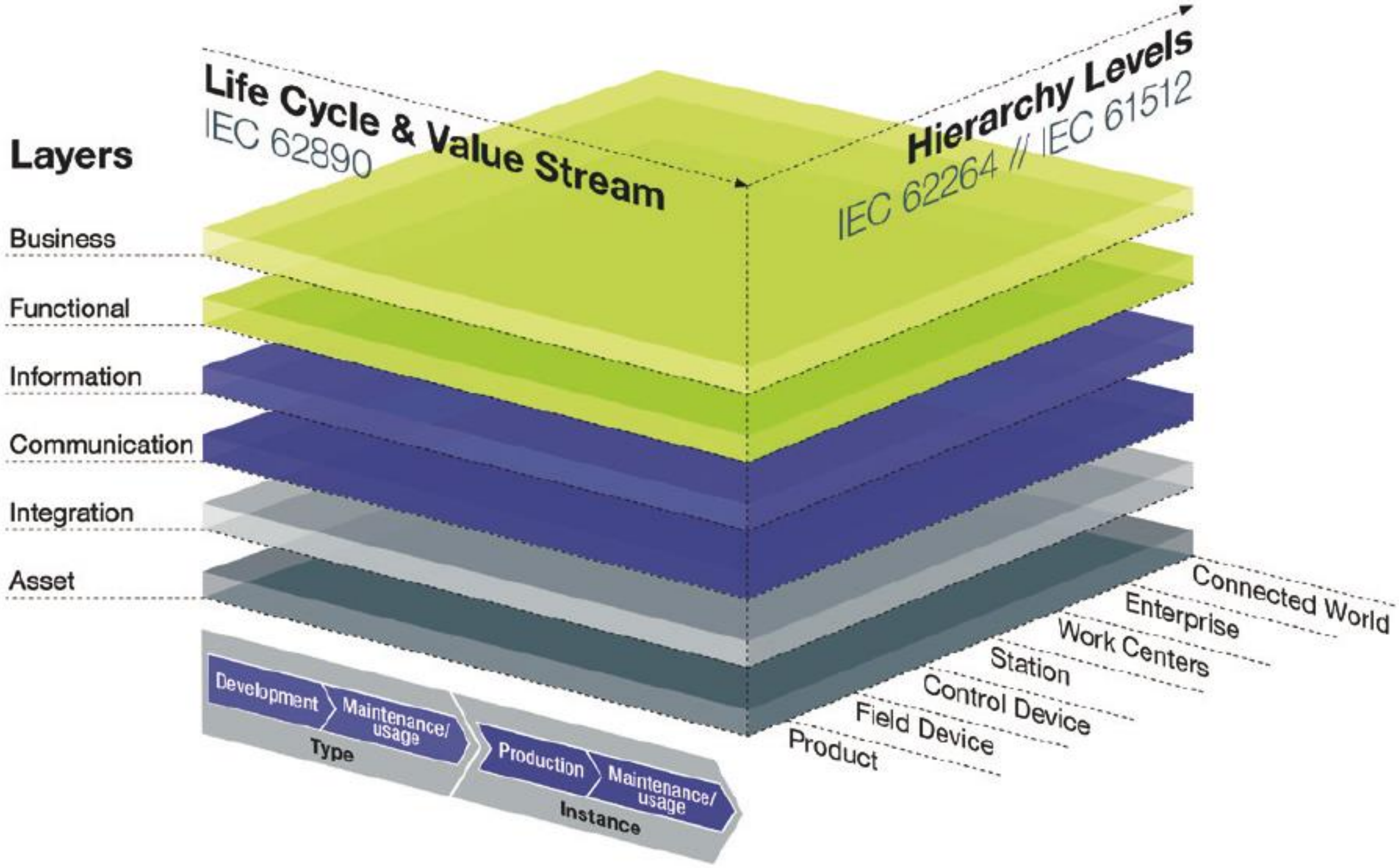
DARMSTADT



Source: Umsetzungsstrategie Industrie 4.0, BITKOM, VDMA, ZVEI; April 2015

RAMI 4.0
Reference Architecture Model Industrie 4.0

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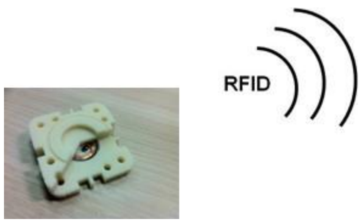

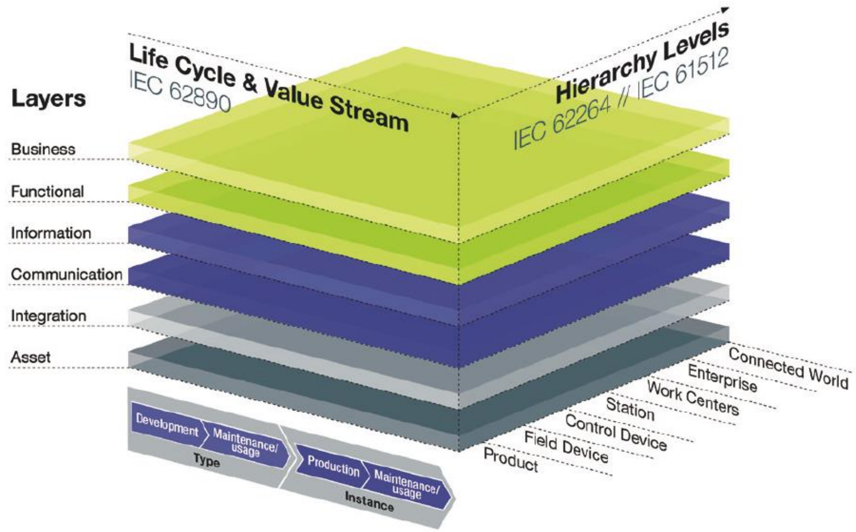

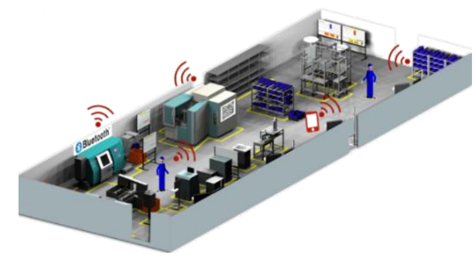

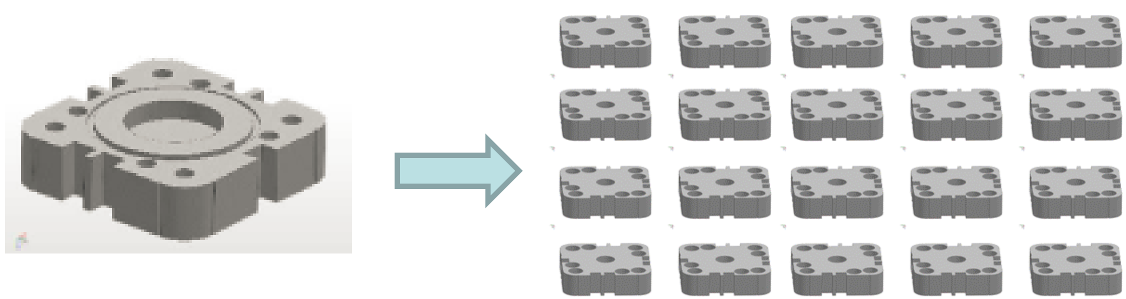

Quelle: nach Umsetzungsstrategie Industrie 4.0, BITKOM, VDMA, ZVEI; April 2015

Industrie 4.0 Component

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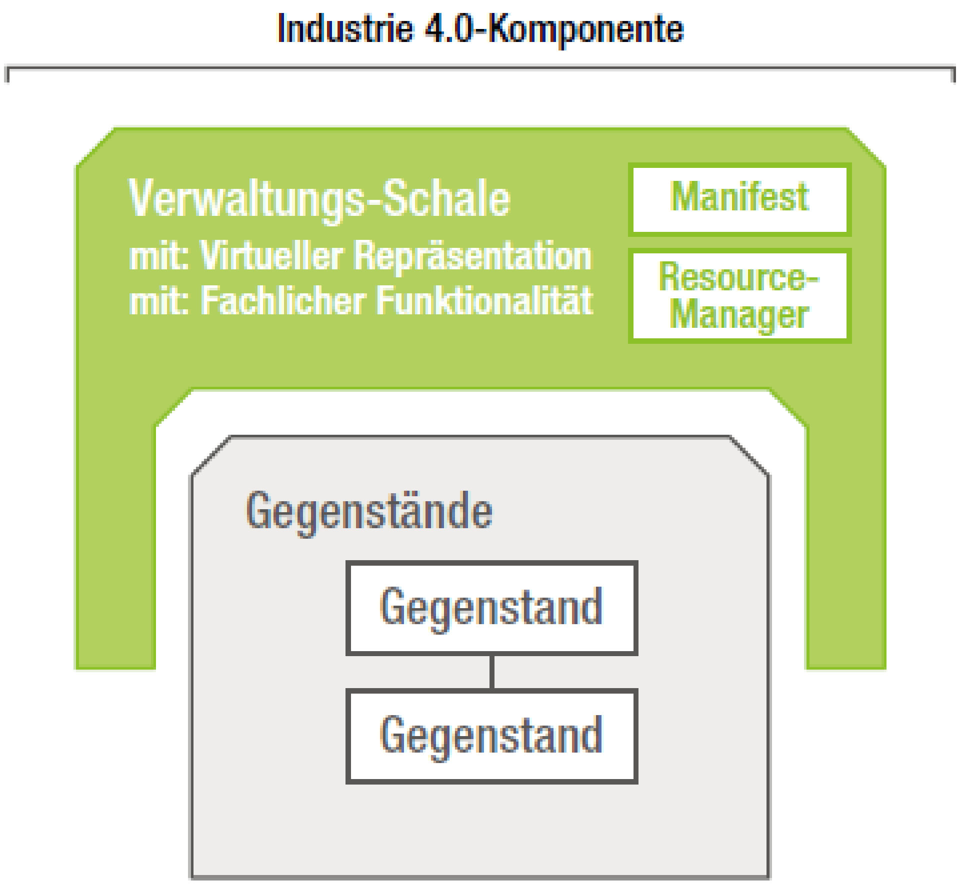

Quelle: Umsetzungsstrategie Industrie 4.0, BITKOM, VDMA, ZVEI; April 2015

Industrie 4.0: Cyber-Physical Systems
Embedded Systems enabling CPS and CPPS

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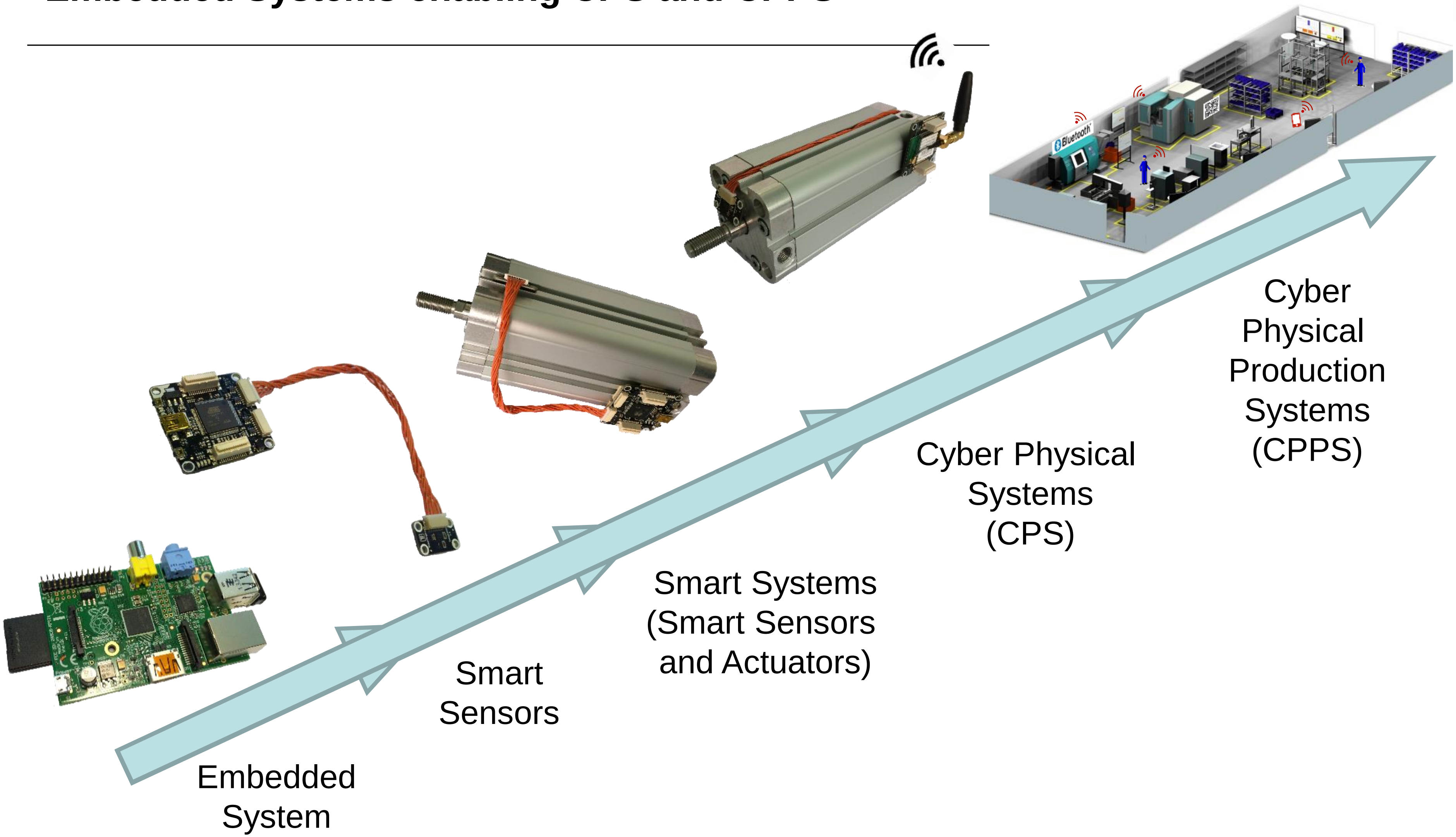
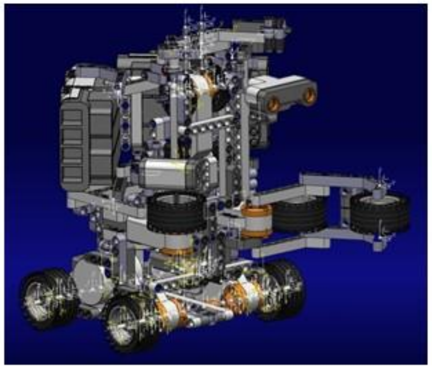
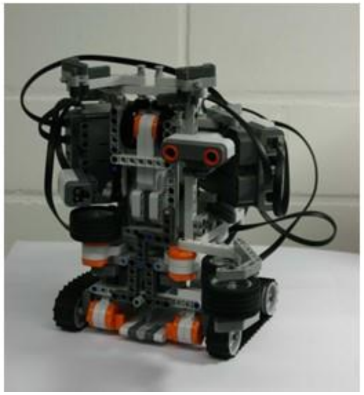


Cyber Physical Systems

Cyber Physical Systems are resulting from two views:

- "cyberizing the physical"
  for specifying physical subsystems with computational abstractions and interfaces and
- "physicalizing the cyber"
  for expressing abstractions and interfaces of software and network components to represent physical systems´ dynamics in time [LEE2010]





Source: [LEE2010] Lee, E. A.: CPS Foundations. In: Proceedings of the 47th Design Automation Conference (DAC). ACM/IEEE, June, 2010, S. 737 – 742

Industrie 4.0: Internet technologies

Internet of Things, Services and Data

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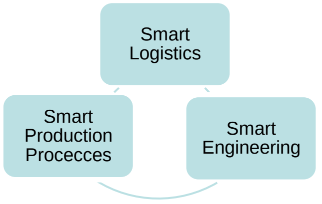
Internet of Things (IoT)

- Communicating objects based on internet technologies
- Detection and identification using IPv6-addresses (128 bit address space)

  Advantages:
- Detection, identification and location of physical objects
- Communication through connectivity

➢ **Every physical object might be equipped with an IPv6-address**

Internet of Sevices (IoS)



- New approach to provide internet based services
- Concepts for product specific services on demand, knowledge provision and services for controlling product behaviour
- Interaction between people, machines and systems to improve added value

➢ **Service based added value processes**

Internet of Data (IoD)

- Data is managed and shared using internet technologies
- Cyber-physical systems are producing big data
- Fundamental prerequisite: Development of a holistic security and safety culture → establish sustainable trusted environments

➢ **Manage big data: integrate product and production data**

Industrie 4.0: Components as Information Carriers
Identification, Localisation, Addressability, Connectivity

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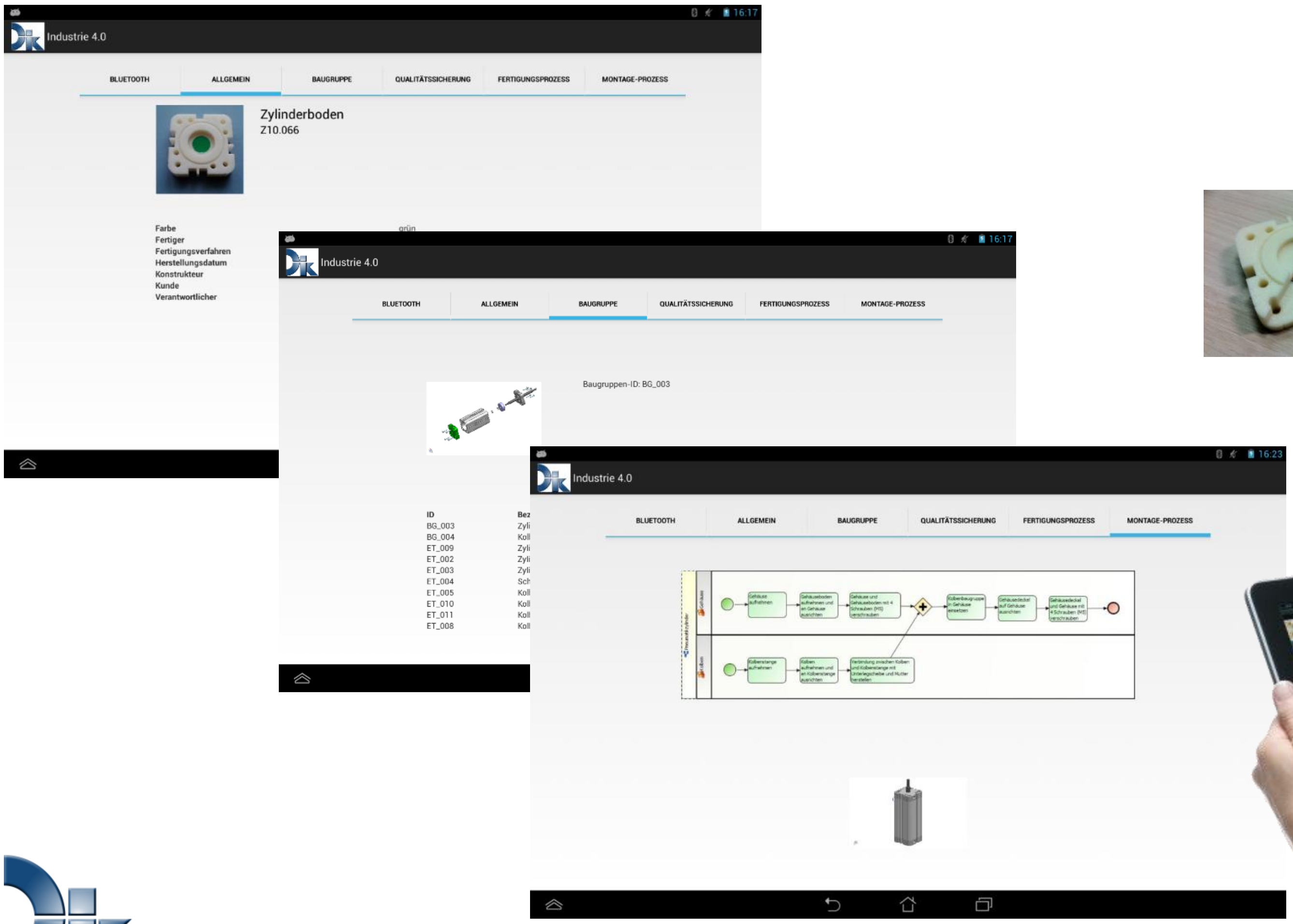

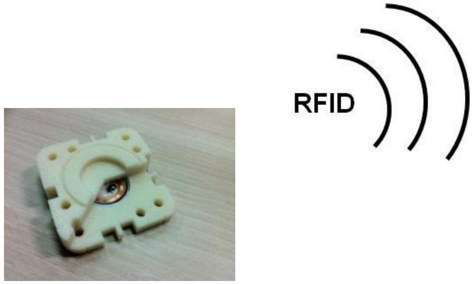

Holistic Approach for Security and Safety

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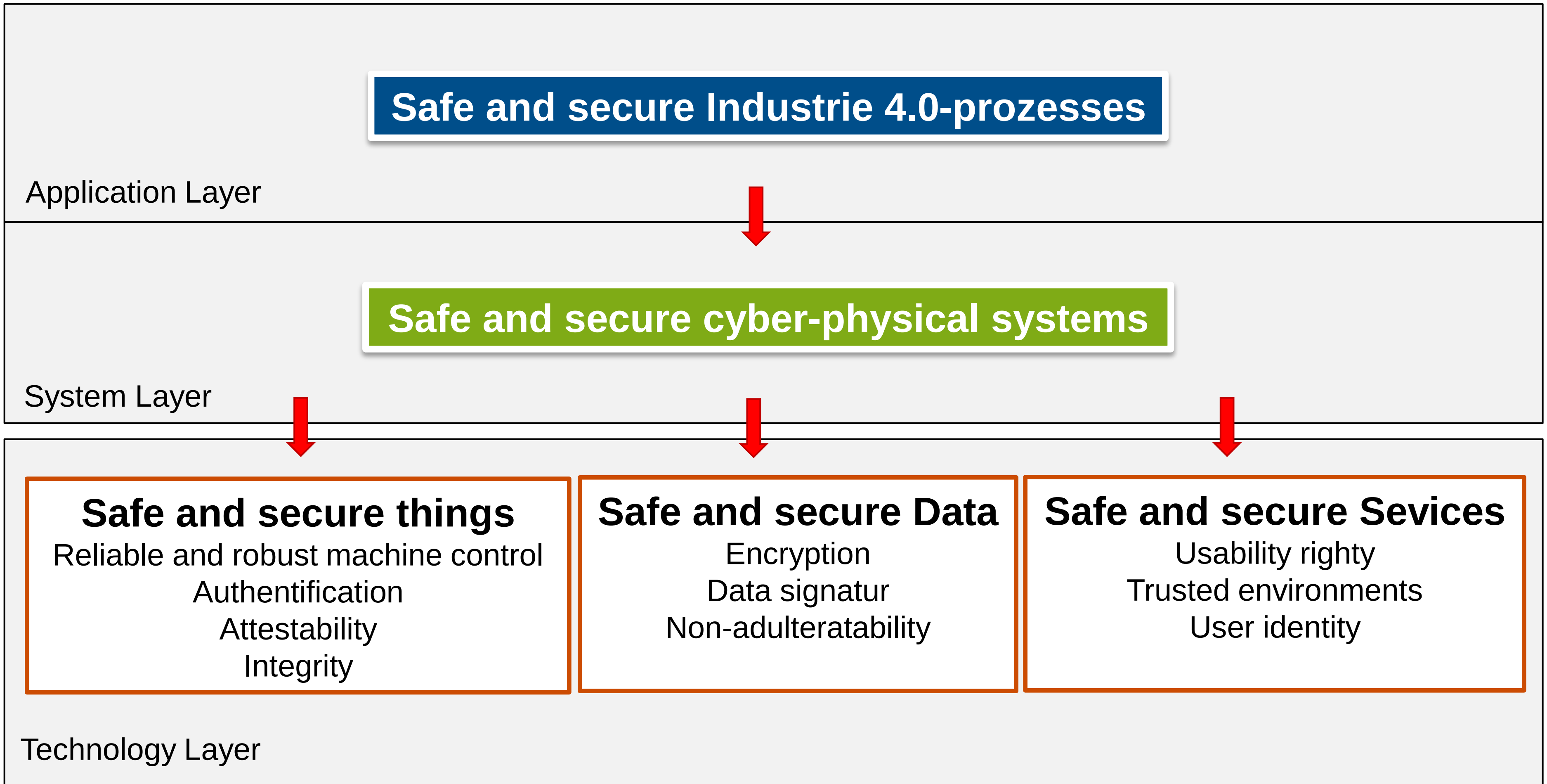

Implementation Strategy

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Information

- value added chain
- new business models
- interconnection and communication

Industrie 4.0 for the Enterprise

- value stream analysis and identification of improved value creation based on interconnection and communication

Spezification of Use Cases

- use cases specification for application szenarios
- detailed description of how to inprove flexibility and efficiency

Implementation Strategy

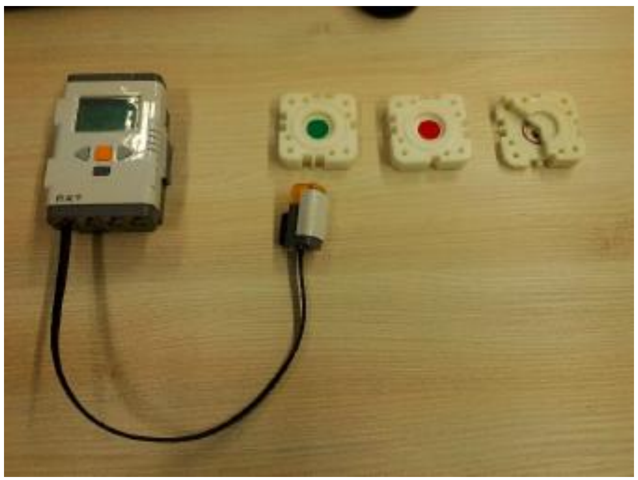
- implementation roadmap, connectivity
- spezification of the ICT-infrastructure,
- technology selection (e.g. web services),
- holistic security ans safety concept

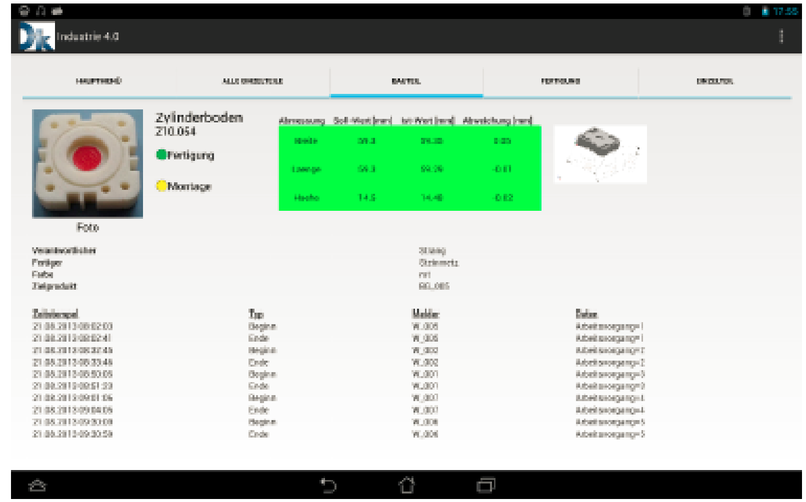
Implementierung of Use Cases

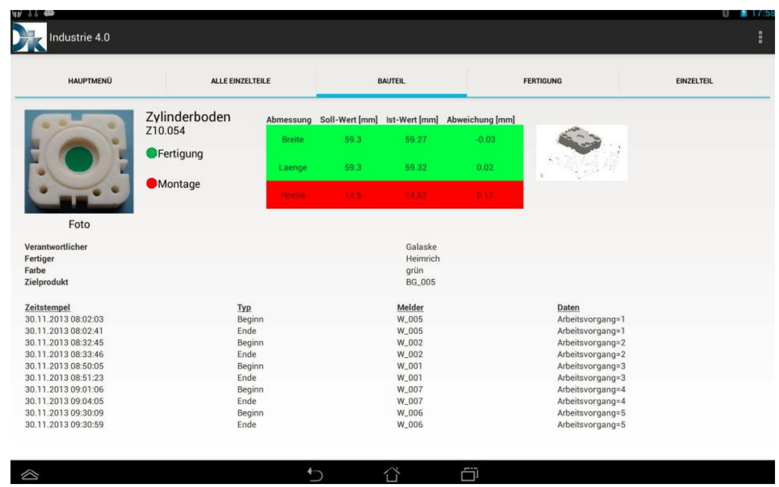
- implementation plan, production processes production data flows, control structures
- functional operations

Overview

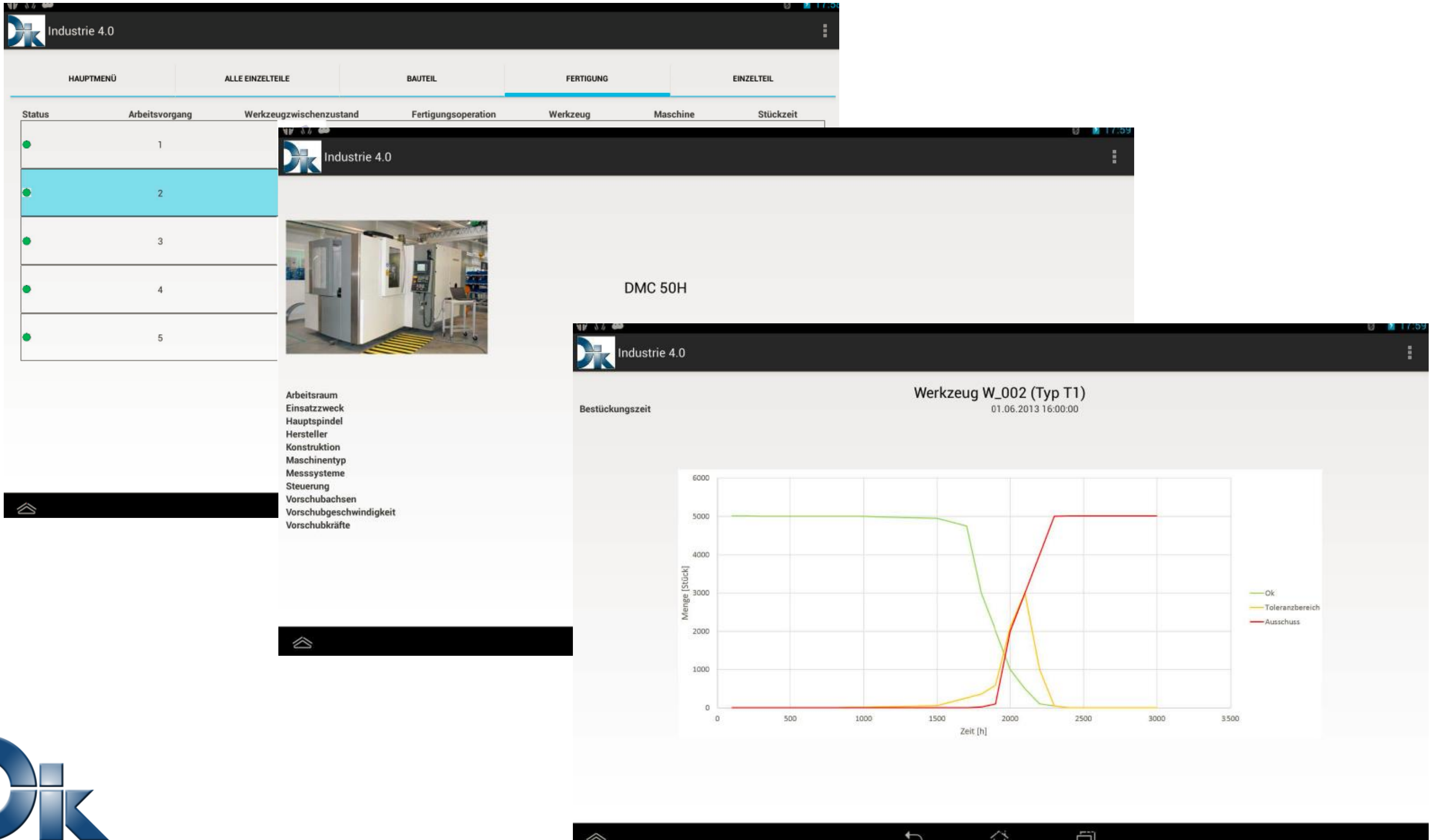
Use case 1:
Components as information Carriers (1)







Use case 1:
Components as information Carriers (2)



Uses Case 2 – Efficient Production

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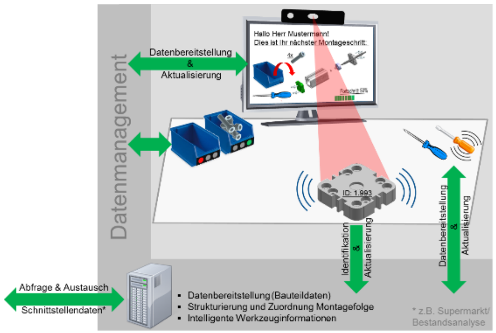
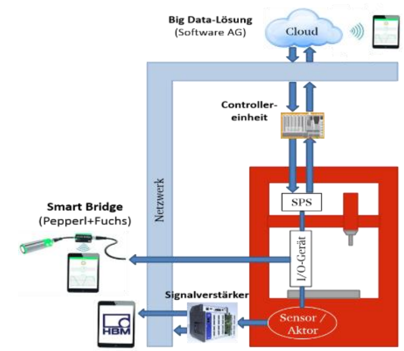


Use Case 4

- flexible intelligent Worker Assistance Systems



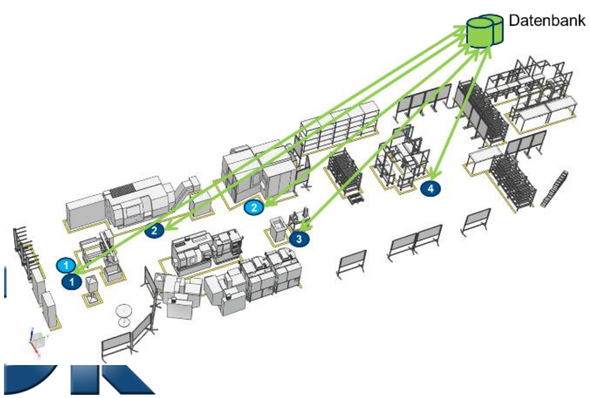
Use Case 1

- paperless integrated quality assurance

- component as information carrier
- uniform data management

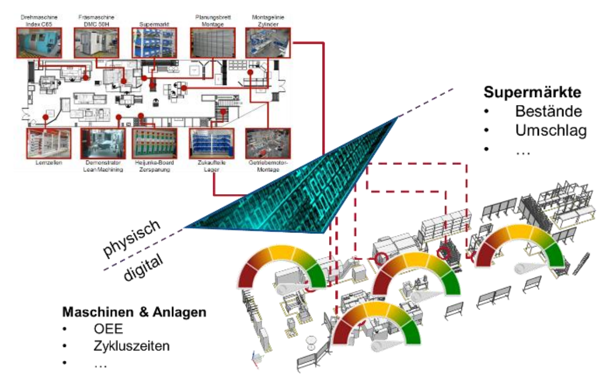
Use Case 3

- Condition and Energy Monitoring



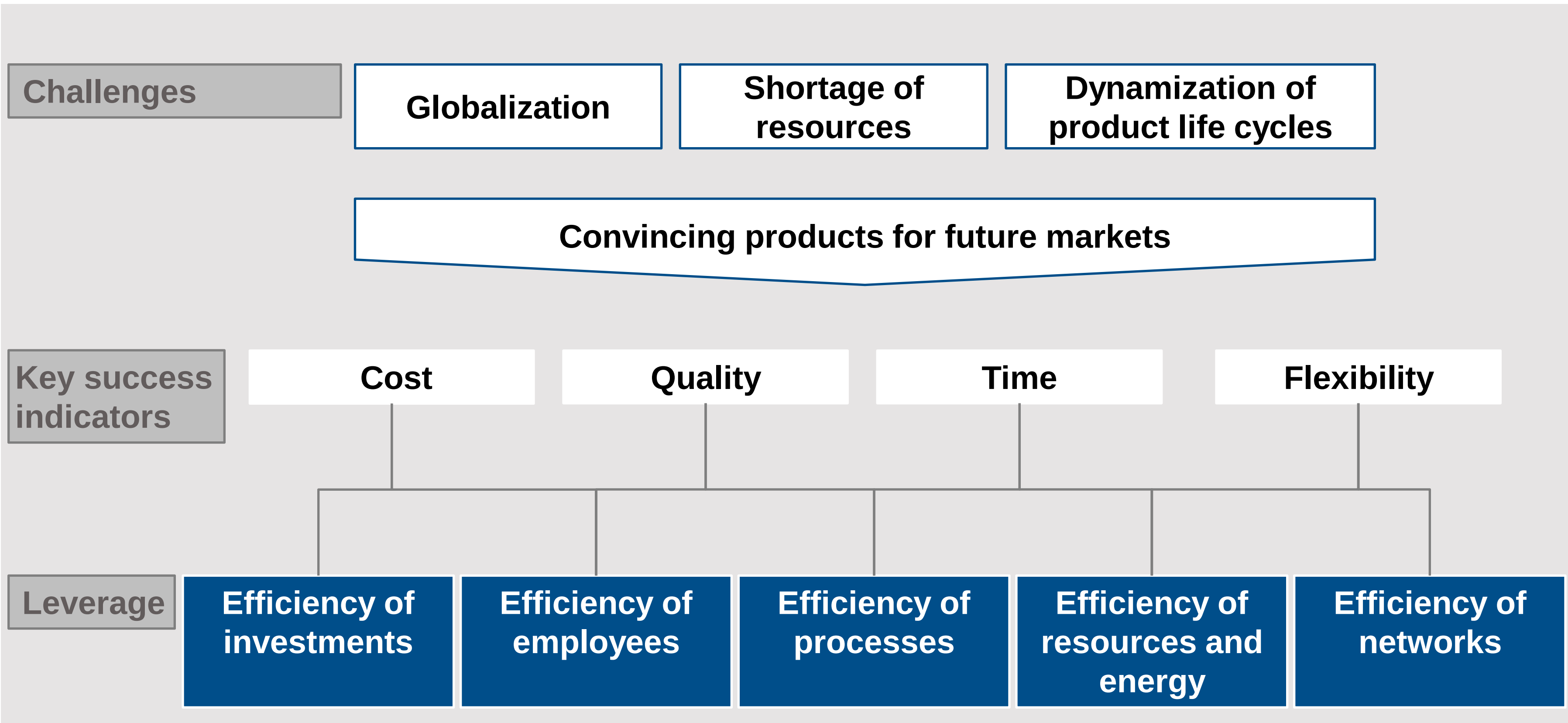
Use Case 2

- Value stream improvment
- real-time capable production controlling



Use Case 2 – Efficient Production

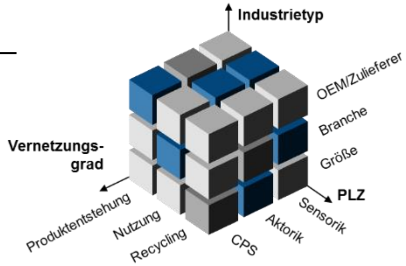
Environment of an offensive for increasing efficiency



Source: Abele, Reinhart; Zukunft der Produktion: Herausforderungen , Forschungsfelder, Chancen

Use Case 2 – Efficient Production
Project Structure & Goals

Project phase:	Content:	Goals:
Pilot study	Identification and Analysis of existing Good-Practice examples in the industry	Demonstration of potential and the particular benefit
Concept development	Development of a Concept of Implementation for selected Examples	Implementation concepts for experimental field build up on CiP
Demonstrator Implementation	Hard- and Software Implementation of the conceptualized examples and Validation of benefit	Experimental field in real production environment
Knowledge transfer	Didactic revision of the results. Buildup of expertises for industrial partners. Implementation of a workshop series	Provision of expertises and competence of methods of hessian companies



Use Case 3: Additive Manufacturing (1)

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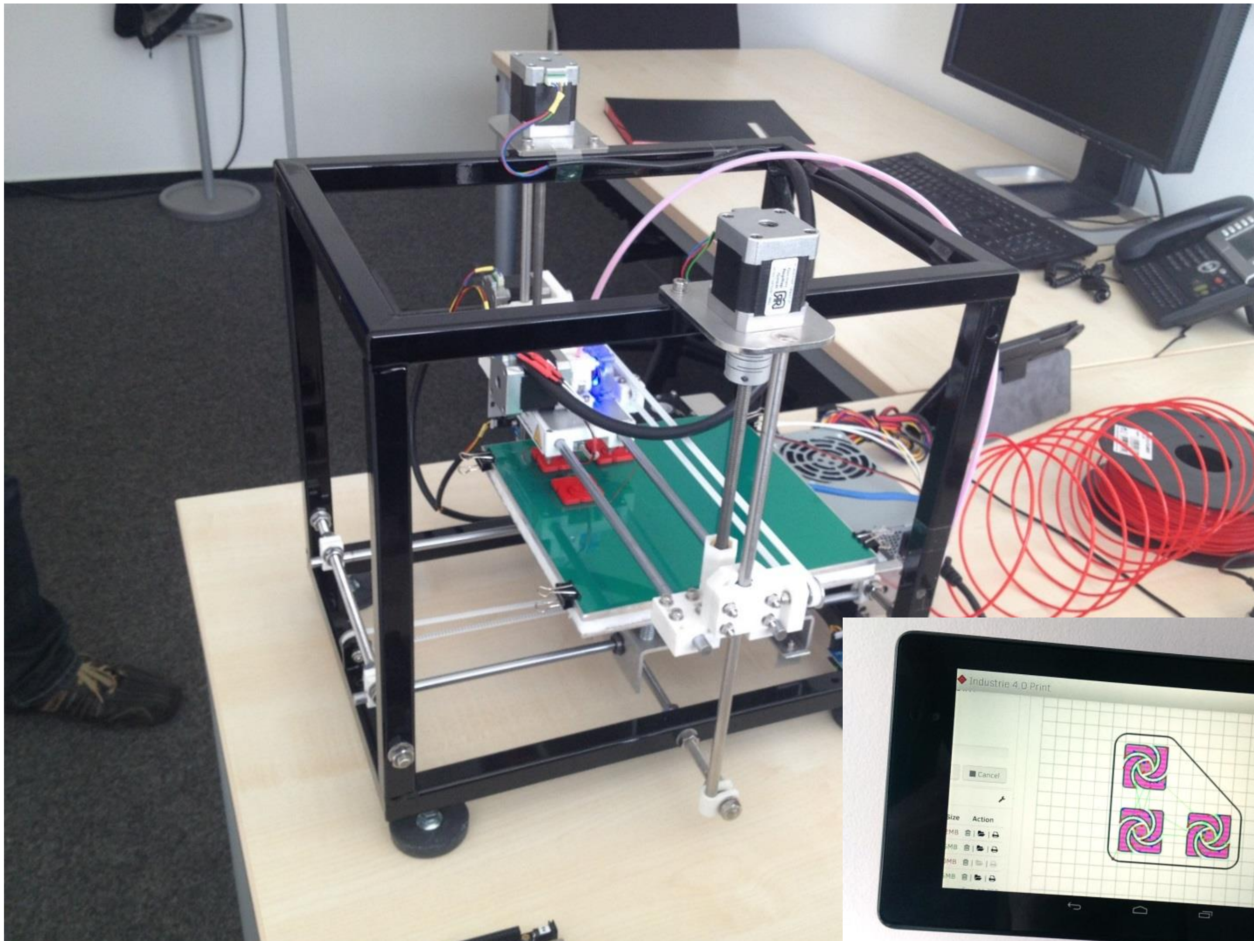
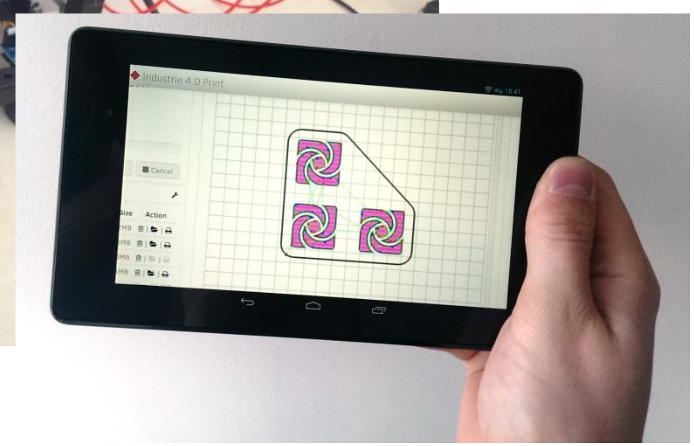
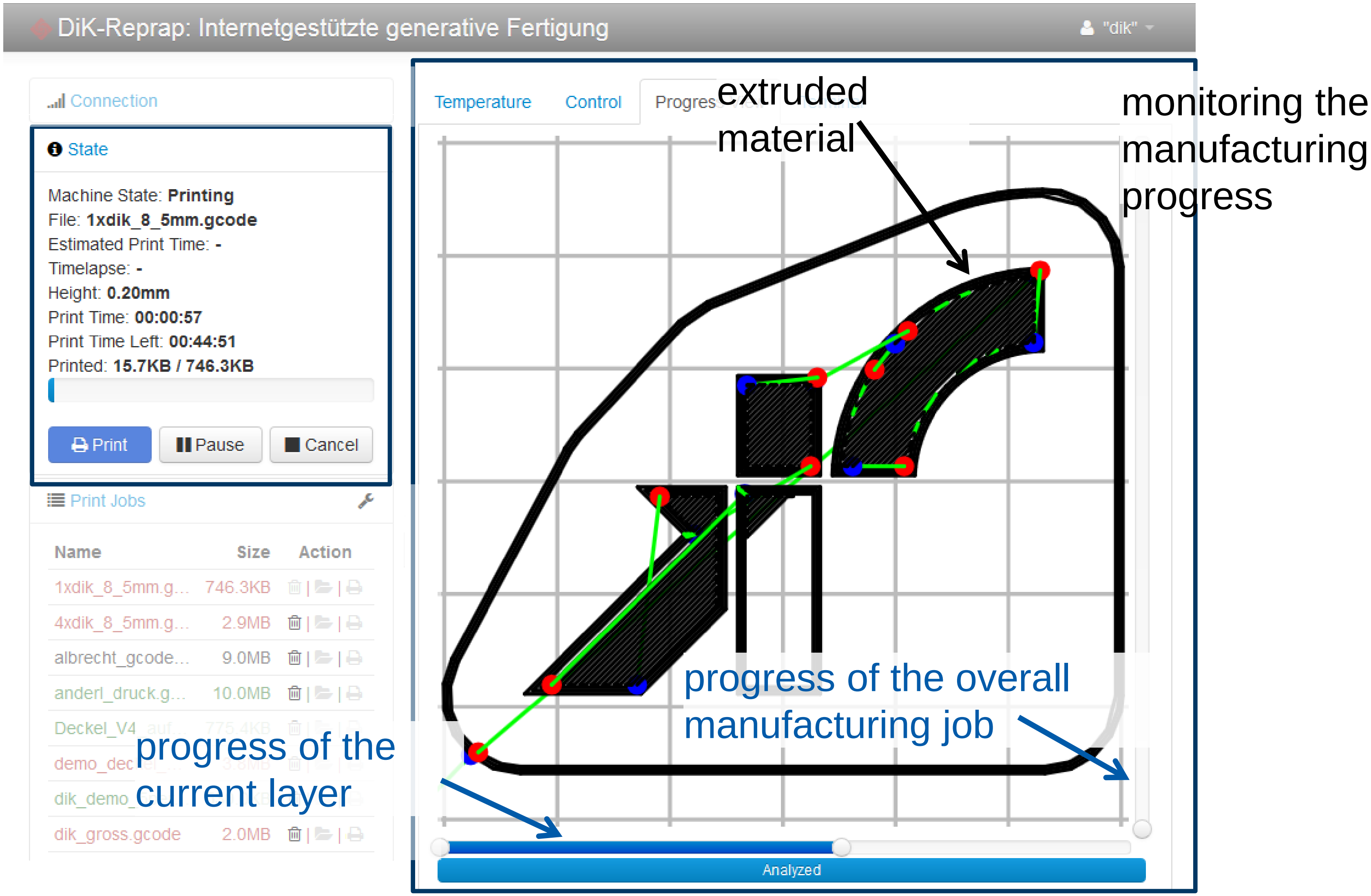




Use Case 3: Additive Manufacturing (2)
Monitoring a Manufacturing Process



Use Case 3: Additive Manufacturing (3)

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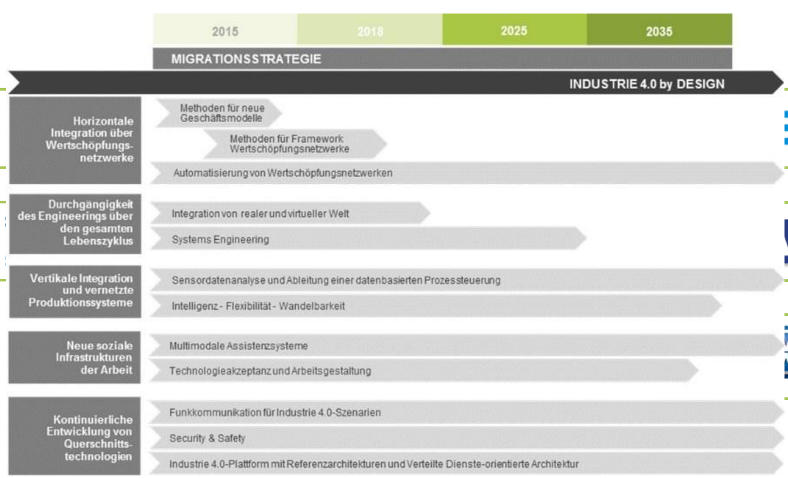
Overview

Platform Industrie 4.0

Gemeinsames Projekt der Verbände - ideelle thematische Zusan

Vorstandskreis (VK)

Geschäfts-
stelle (GS)



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Prof. Dr.-Ing. Reiner Anderl
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Universität Paderborn
Prof. Dr.-Ing. Jürgen Gausemeier

RWTH Aachen
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Prof. Dr.-Ing. Gunther Reinhart

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Helmut-Schmidt-Universität Hamburg
Prof. Dr.-Ing. Alexander Fay

Technische Universität Kaiserslautern, Prof. Dr.-Ing. Dr. h.c. Detlef Zühlke

Fachbereich Informatik
TU München
Prof. Dr. Dr. h. c. Manfred Broy

TU München
Prof. Dr. habil. Claudia Eckert

TU Kaiserslautern, Fraunhofer Institut Prof. Dr.-Ing. Peter Liggesmeyer

Universität Oldenburg
Prof. Dr.-Ing. Wolfgang Nebel

Alexander von Humboldt Institut für Internet und Gesellschaft gGmbH
Prof. Dr. oec. Dr.-Ing. Thomas Schildhauer

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH
Prof. Dr. rer. nat. Dr. h. c. mult. Wolfgang Wahlster

RWTH Aachen,
Prof. Dr.-Ing. Ulrich Epple

Fraunhofer-Institut für Materialfluss und Logistik IML
Univ.-Prof. Dr. Michael ten Hompel

Universität Passau
Prof. Dr. Gerrit Hornung, LL.M.

Technische Universität Dortmund,
Prof. Dr. Hartmut Hirsch-Kreinsen

The New Platform Industrie 4.0

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Plattform Industrie 4.0

Leitung
BM Gabriel, BM'in Wanka
Vertreter Wirtschaft, Gewerkschaft, Wissenschaft
Politische Flankierung

Technisch-praktische Kompetenz, Entscheidung

Lenkungskreis (Unternehmen)
- Leitung durch Unternehmer unter Beteiligung BMWi, BMBF
- AG-Leitungen und weitere Gäste/ Promotoren

Industrielle Strategieentwicklung, technische Koordinierung, Entscheidung und Umsetzung

Arbeitsgruppen
- Referenzarchitektur, Standardisierung und Normung
- Forschung und Innovation
- Sicherheit vernetzter Systeme
- Rechtliche Rahmenbedingungen
- Arbeit, Aus-/Weiterbildung
- Weitere nach Bedarf

Arbeitseinheiten mit technisch-praktischer Kompetenz; Beteiligte Ressorts BMWi, BMBF, BMI, BMJ, BMAS

Politische Steuerung, Gesellschaft, Multiplikatoren

Strategiekreis (Politik, Verbände, Gewerkschaft, Wissenschaft)
- Leitung StS Machnig, StS Schütte
- Vertreter Lenkungskreis
- Vertreter Bundeskanzleramt, BMI
- Vertreter Arbeitskreis Bundesländer
- Vertreter Verbände (VDMA, ZVEI, BITKOM, BDI, VDA, BDEW)
- Vertreter Gewerkschaft (IG Metall)
- Vertreter Wissenschaft (FhG)

Agenda-Setting, politische Steuerung, Multiplikatoren

Wissenschaftlicher Beirat

Aktivitäten am Markt

Industriekonsortien und Initiativen
Realisierung am Markt: Prüfstände, Anwendungsfälle

Internationale Standardisierung
Konsortien, Standardisierungsgremien, DKE u. ä.

Geschäftsstelle als Dienstleister
Netzwerkkoordination, Organisation, Projektmanagement, interne und externe Kommunikation

Stand: 13. März 2015

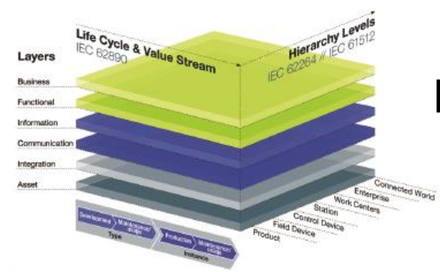
Stand: 13. März 2015

Implementation Strategy for Industrie 4.0

Status: 14. April 2015

Industrie 4.0 Components

Abbildung 23: Industrie 4.0-Komponente



RAMI 4.0

Research and Implementation Roadmap

Research and Implementation Roadmap of the Platform Industrie 4.0

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2015	2018	2025	2035

IMPLEMENTATION STRATEGY

y DESIG

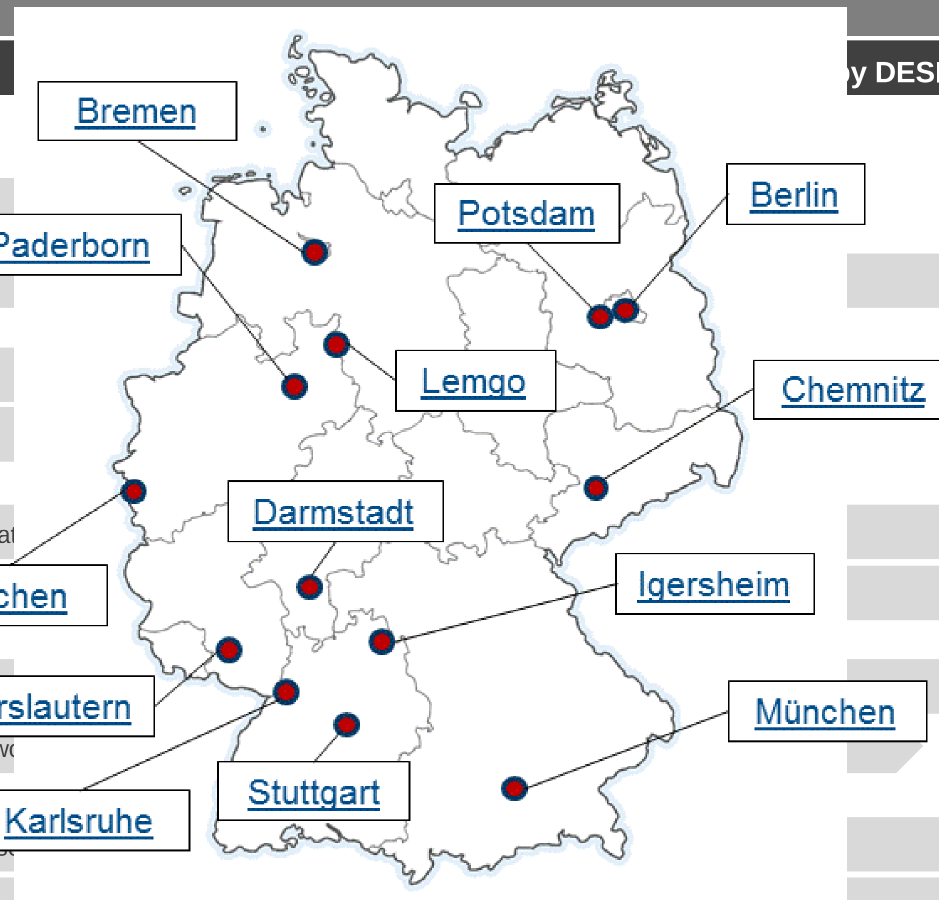
Horizontal integration via value creation networks
- Methods for new business models
- Methods for framework Value creation networ
- Automation of value creation networks

Seamless engineering throughout life cycle
- Integration of real and virtual worlds
- Systems Engineering

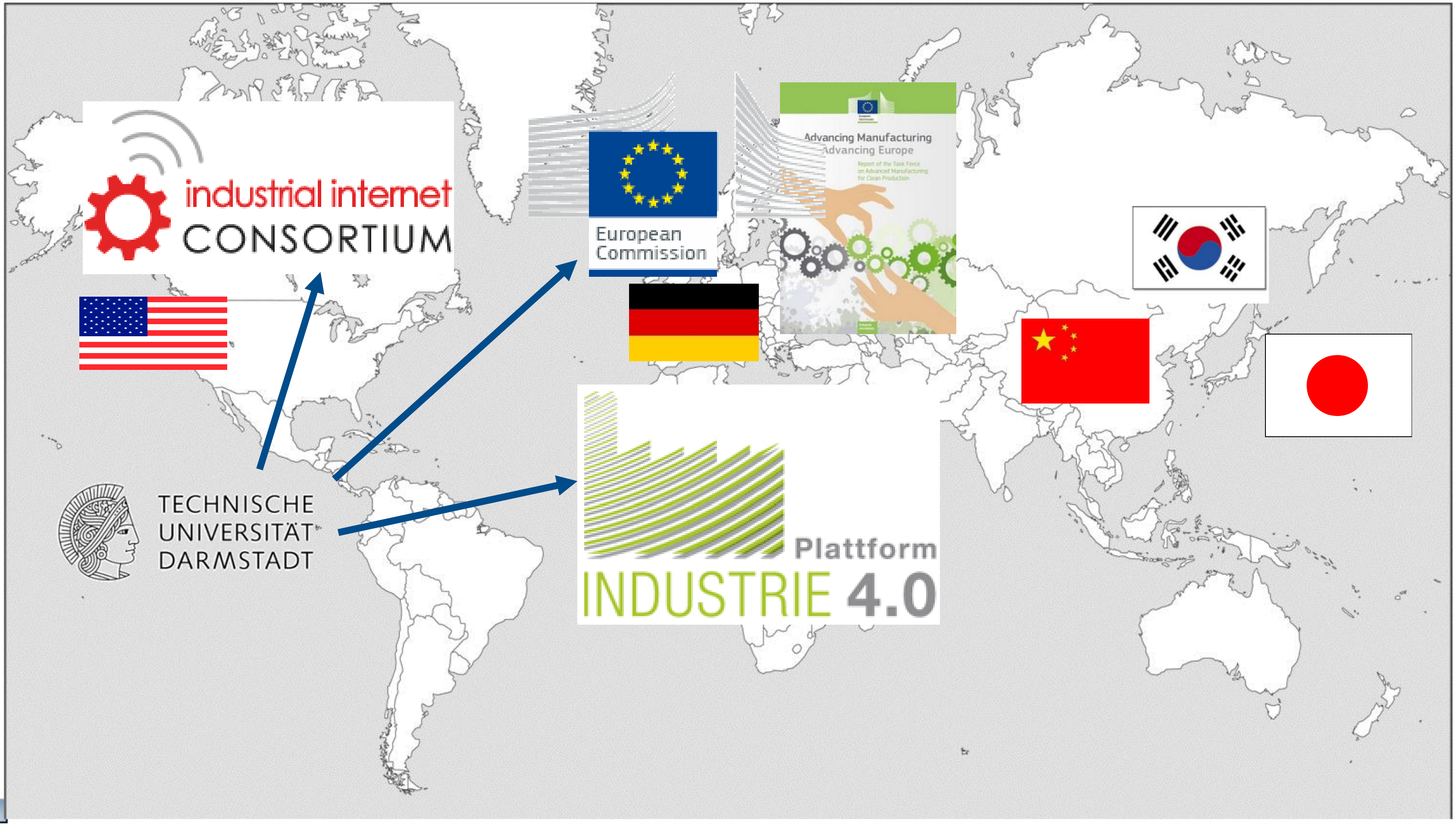
Vertical integration and networked production systems
- Sensor data analysis and derivation of dat
- Intelligence - Flexibility - Adapta

New social infrastructures for work
- Multimodal assistant systems
- Acceptance of technology and nature of w

Continuous development of hybrid technologies
- Wireless communication for Industry 4.
- Security & safety
- Industry 4.0 platform with reference architectures and decentralized service-oriented architecture



The Internationale Dimension



European Activities

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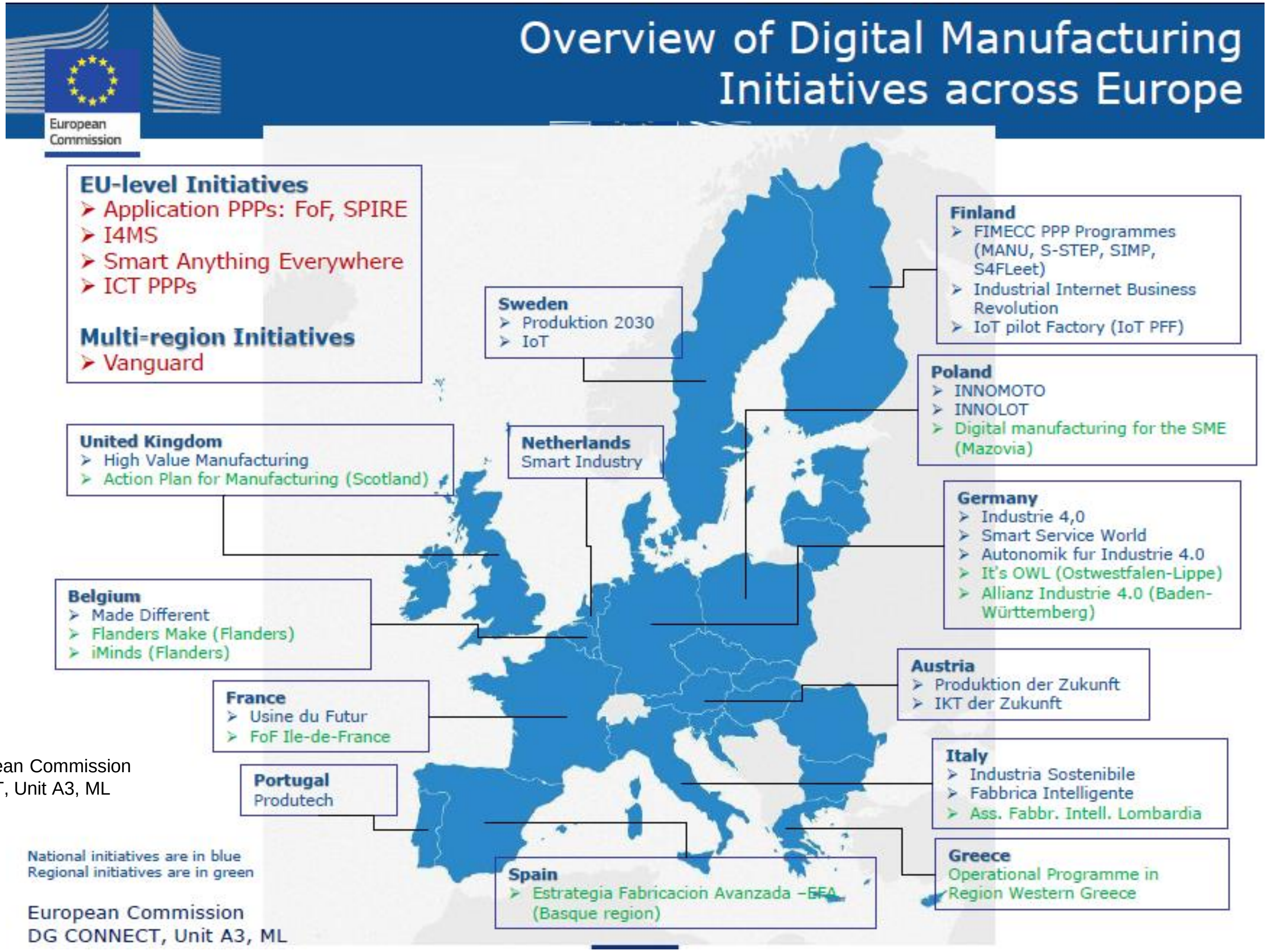

Quelle: European Commission
DG CONNECT, Unit A3, ML

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Conclusions

Industrie 4.0 is a key initiative of the German hightech strategy supported by the German government and to be implemented by industry.

Key strategy of Industrie 4.0 is the creation of new innovation for smart systems such as smart products, smart production systems, smart logistics or smart grids based on the integration of internet based communication and embedded control software to ensure sustainablity and environmental soundness.

Future research activities will also need to address

- safety, security, privacy and knowledge protection,
- new business models as well as
- human factors impact

New advanced engineering methods are required to support the developemnt of smart products able to self-control their functionality and to communicate with other smart systems as well as with humans.

Industrie 4.0 is a fscinating technology and each enterprise has to decide whether and if so how to implement Industrie 4.0.

Source: Potthast Fachschaftenkonferenz