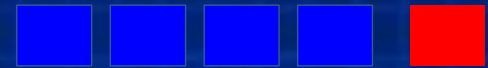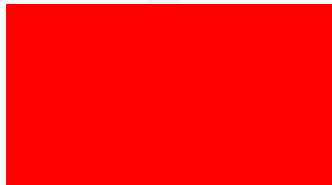# Industrie 4.0/ Digitalization Transformation in Germany

Uwe Merklein

Ib M Consulting, Ingenieurbüro Merklein

BUSIAD Bursa, February 2019

About Ib M Consulting
Company Founder

EDUCATION

FIELDS

BRANCHES

BOARDS

Education

Stuttgart University
1979 – 1985
Course of Study: Engineering
Graduation: Dipl.-Ing.

Aachen University (RWTH)
2014 - 2019
Doctoral Study - Technology Transfer
Graduation: Dr.-Ing. (to be confirmed)

Fields of Activity
Consultancy – Research - Production – Engineering – Technology
Transfer-Sales Strategy, Merger+Acquisition

Branches
PRODUCTION
Engineering, Plastics Industry, Textile, Special Vehicles Construction
RESEARCH
Technical Textiles, Automotive, Energy, Medicine, Building, ITC

Advisory Boards
Member of the Board of Directors, Business Network Aachen
Member of the External Trade Committee IHK Aachen
Designated Honorary Consul of the Turkish Republic
Member of the Board of Directors AC-Sariyer-Partnership Association
Member of the Board, Management Research' DITV MR (2006 bis 2010)
Chairman of the Scientific Advisory Board ITV Denkendorf (Stuttgart
University) (1997 bis 2008)
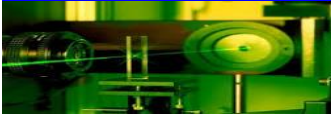Member of the Research Council, Frankfurt (bis 2008)

About Ib M Consulting
Professional Experience

CONSULTANCY

TECHNOLOGY TRANSFER

ENGINEERING

PRODUCTION

Ib M Consulting, Ingenieurbüro Merklein
Owner, Aldenhoven/Aachen , since 2002
Business Development, Restructuring, Sales, Market Strategies,
Franchising, Merger+Acquisition, Qualification

3T TextilTechnologieTransfer GmbH
Managing Partner, Aachen, 2008 - 2015

ITA Institut für Textiltechnik Aachen, Aachen University
Member of the Board of Directors, Aachen, 2009 – 2015

3T Bursa LtdS
Managing Director, Bursa, TR, 2014 – 2015

Sucker Müller Hacoba GmbH (SMH)/ Moenus AG
Managing Director (Chairman), Mönchengladbach,   2000 -2002
Turnover: 250 Mio. €, 1000 Employees, 5 Sites,Textille Machine Producer

SMH Technology GmbH, Engineering Company
Managing Director, Mönchengladbach, 2000 – 2008, 40 Employees

OESE (OTTO Environmental Systems Europe) BV
Chief Operation Officer Europe (7 Plants), Maastricht, 2003 – 2005
Turnover: 170 Mio. €, 750 Employees

Schoeller Textil GmbH&CoKG
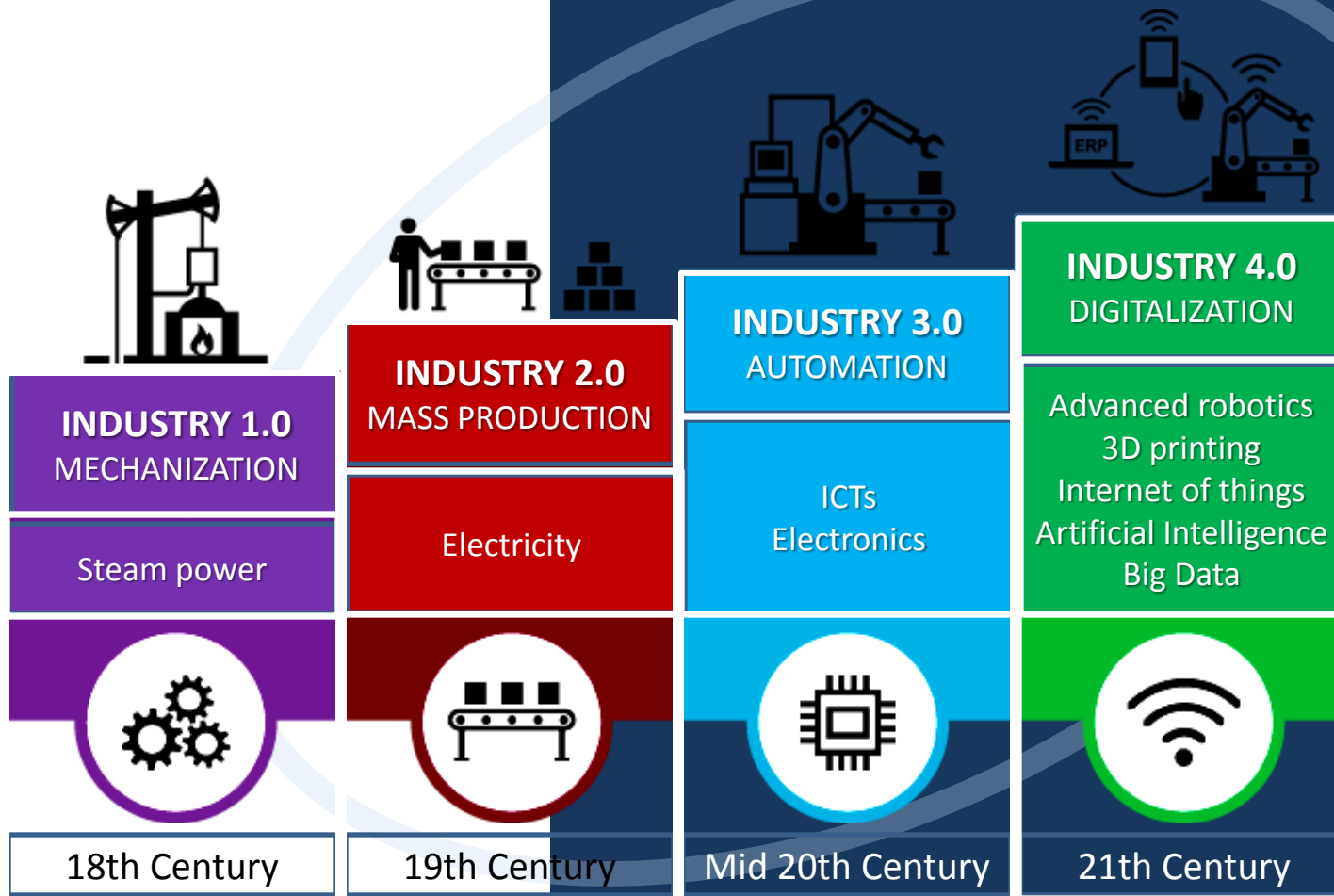Member of the Executive Board, Düren   1994 - 2000
Turnover: 100 Mio. €, 800 Employees

Lauffenmühle GmbH
Member of the Executive Board , 3 Plants, WT-Tiengen, 1985 - 1993
Turnover: 200 Mio. €, 2.500 Employees

Industrial Revolution

INDUSTRY 1.0
MECHANIZATION

Steam power

18th Century

INDUSTRY 2.0
MASS PRODUCTION

Electricity

19th Century

INDUSTRY 3.0
AUTOMATION

ICTs
Electronics

Mid 20th Century

INDUSTRY 4.0
DIGITALIZATION

Advanced robotics
3D printing
Internet of things
Artificial Intelligence
Big Data

21th Century

Industry 4.0
Architecture

Horizontal Integration

Vertical Integration

ERP

Manufacturing
Logistics
Machinery
Manufacturing

Maintenance

Design

Machine

Robot

Human operator

Device

MES

INDUSTRY 4.0

Human-Technology Synergy

Services
Production
Production Engineering
Production Planning
Product Design

Consistent Engineering
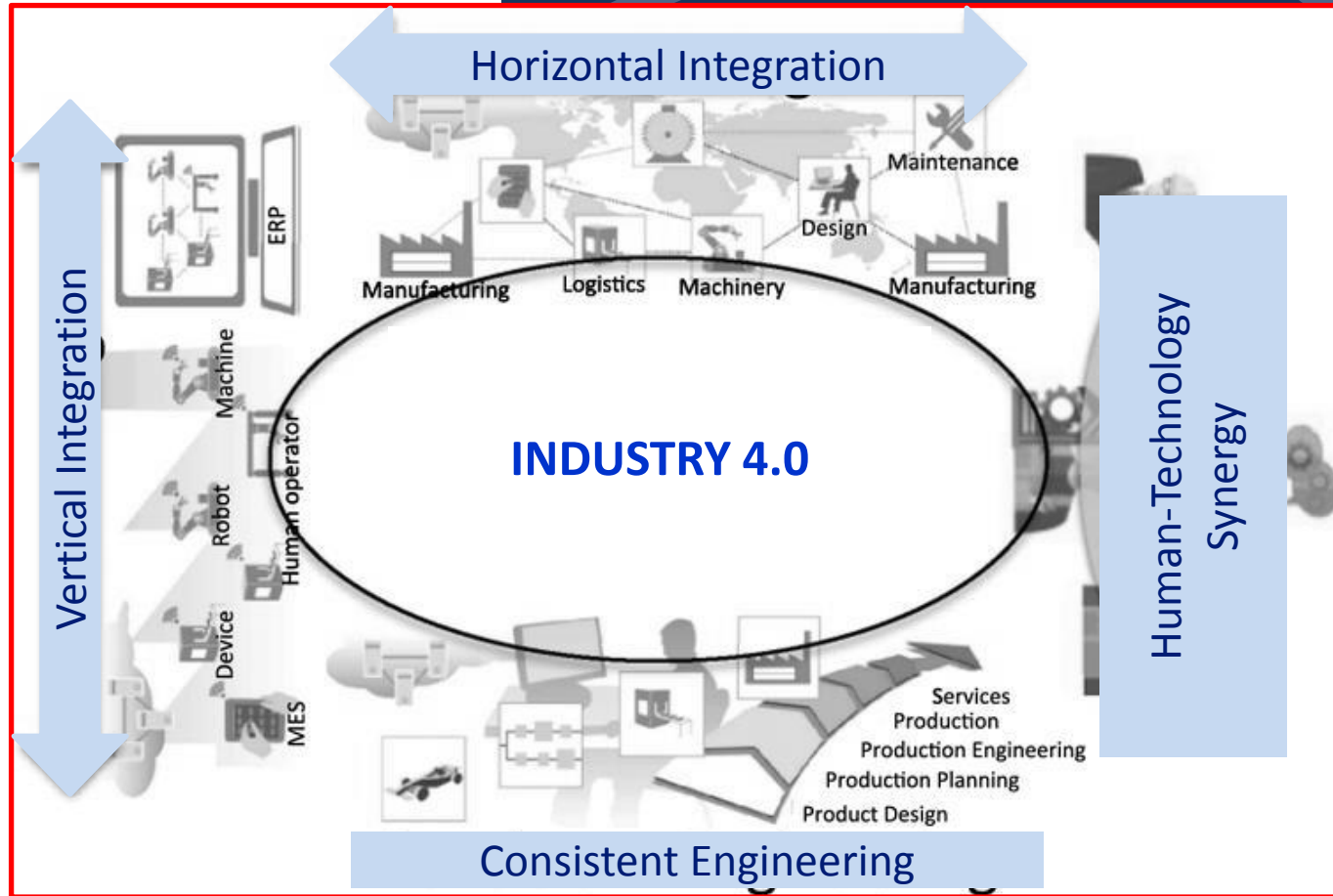
Industrie 4.0
Created in Germany

➤ The term **Industry 4.0** originates from a project in the high-tech strategy of the German government, which promotes the computerization of manufacturing.

➤ The term **Industry 4.0** was revived in 2011 at the Hannover Fair. In October 2012 the Working Group on Industry 4.0 presented a set of Industry 4.0 implementation recommendations to the German federal government.

➤ The Industry 4.0 workgroup members are recognized as the founding fathers and driving force behind Industry 4.0.

➤ On 8 April 2013 at the Hannover Fair, the final report of the Working Group Industry 4.0 was presented.

➤ This working group was headed by Siegfried Dais (Robert Bosch GmbH) and Henning Kagermann (German Academy of Science and Engineering).

➤ As Industry 4.0 principles have been applied by companies they have sometimes been re-branded, for example the aerospace parts manufacturer Meggitt PLC has branded its own Industry 4.0 research project M4.

Industrie 4.0 – Created in Germany
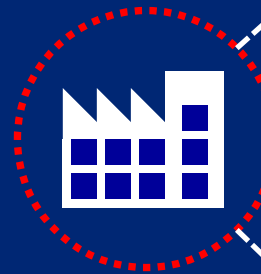
Industrie 4.0
Definition/Modules

What makes a Factory or Systems - INDUSTRY 4.0?

Machines,Devices and people are conected and communicate to each other

Systems create virtual copy of physical world through sensor data

Cypber-physical systems make simple decisions – should become as autonomous as possible

Systems to support humans in making decisions, solving problems and assist with tasks

INTEROPERABILITY

INFORMATION TRANSPARENCY

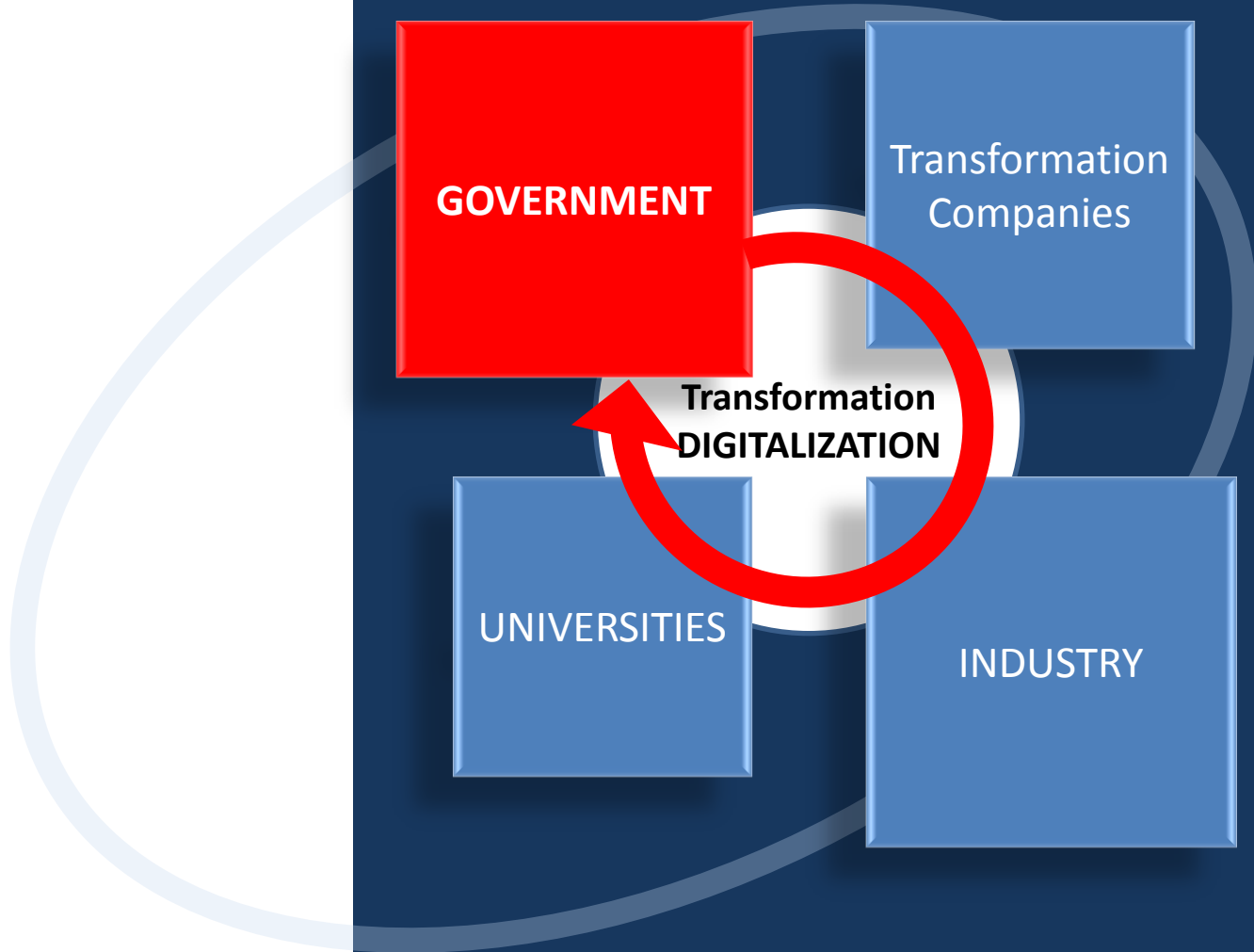DECENTRALIZED DECISION-MAKING

TECHNICAL ASSISTANCE

Industry 4.0
Technological pillars

Industry 4.0
Made in Germany

GOVERNMENT

Transformation
Companies

**Transformation
DIGITALIZATION**

UNIVERSITIES

INDUSTRY

Industrie 4.0
Government I

The
Federal Government

Digital retreat

The Digital Strategy of the German government

The German government intends to shape the digital revolution and prepare the country as well as possible for the future. To this end the government has put together a package of measures which is summed up in an implementation strategy. The aim is to further improve the quality of life for everybody in Germany, to develop economic and environmental potential, and to ensure social cohesion.

https://www.bundesregierung.de/breg-en/news/the-digital-strategy-of-the-german-government-1550216

The strategy embraces five fileds of action

digital skills | infrastructure and equipment | innovation and digital transformation | society in digital change | modern state

Photo: Bundesregierung

The Digital Strategy with its five fields of action: specific responses to the challenges posed by the digital revolution

Industrie 4.0
Digital Skills

EDUCATION + QUALIFICATION

- The German government wants everybody to be able to make use of the opportunities afforded by digitalisation.

  - > More digital technology in everyday life, to the digital working and economic world and to the digital knowledge society.

- The federal government's 'Digital Pakt Schule' (Digital Compact for Schools) for instance is ensuring that fast internet connections are installed at some 43,000 schools in Germany along with an effective digital learning infrastructure.

Industrie 4.0
Infrastructure + Equipment

HIGH SPEED INTERNET

- Effective infrastructure is the lifeblood of our society, particularly digital networks.

  -> The aim is for everyone to have a connection – everywhere at all times.

- It is the goal to see all of Germany served by the new high-speed net by 2025. Germany is to become the leading market for 5G applications.

Industrie 4.0
Innovation and Digital transformation

Force to SHAPE CHANGE!

- The German government aims to ensure that technology and innovations are in line with the legal framework and the values of Germany and Europe.

  -> Target is to become better at taking excellent technical research and using it to make and market excellent technological products in Germany and in Europe

- The Artificial Intelligence (AI) Strategy is to bring research and development, and application of AI in Germany, to a leading level worldwide.

Industrie 4.0
Society in digital change

**Improve the
LIVES OF PEOPLE!**

- Digitalization needs values.

  -> People must be at the heart of all of the government's considerations and projects.

- Positive progress can only be made if digital transformation is strongly anchored in society, if it is embraced by all sections of society and if the opportunities it offers are open equally to all sections. These are the framework conditions the government aims to put in place, at national European and global levels.

Industrie 4.0
Modern State

Make PEOPLE and COMPANY's LIVES easier!

- Authorities should make people and company's lives easier not more complicated.

  -> Target is to make dialogue with the authorities, and requests for services simple and secure for everyone.

  By end of 2022, all of the services offered by authorities will be offered online.

- Naturally, digital access to the authorities will be barrier-free, so that more people with disabilities can also be reached in this way.

Industrie 4.0 Plattform
Map of Industry 4.0

Use Cases

Locations where Industrie 4.0 is already in practical use in Germany

Baden Wurttemberg (67)

Bavaria (33)

Berlin (6)

Bremen (1)

Hesse (14)

Mecklenburg-Western Pomerania (1)

Lower Saxony (12)
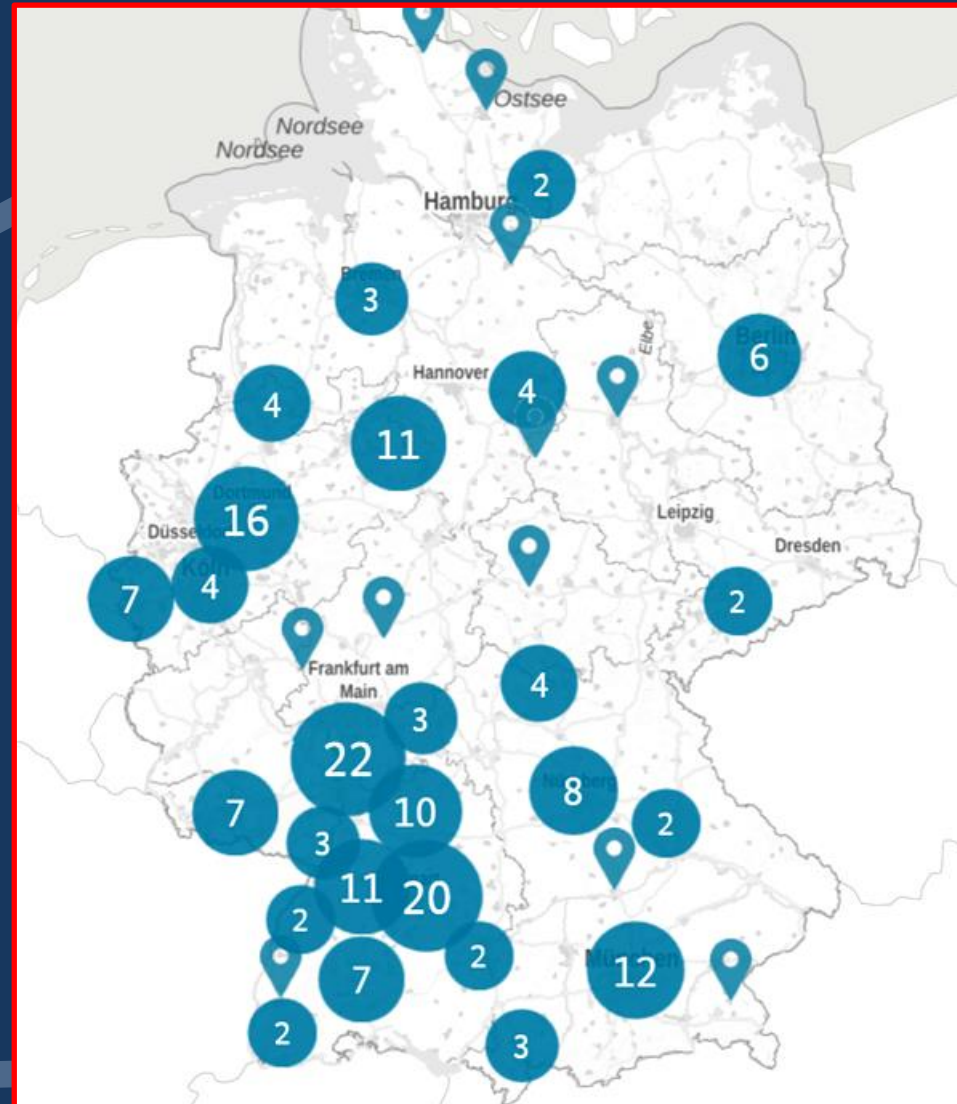
North Rhine-Westphalia (37)

Rhineland-Palatinate (4)

Saarland (5)

Saxony (2)

Saxony-Anhalt (2)

Schleswig-Holstein (3)

Thuringia (2)

https://www.plattform-i40.de/I40/Navigation/EN/InPractice/Map/map.html

Industrie 4.0 Plattform
Facts and Figures

Application examples — 148

- Education and training (17)
- Infrastructure (10)
- Logistics (14)
- Manufacturing industry (99)
- Other (8)

Company size — 190

- 1 - 250 employees (65)
- 250 - 5000 employees (48)
- 5000 - 15,000 employees (35)
- more than 15,000 employees (42)

Value creation — 277

- Design & Engineering (43)
- Production & supply chain (143)
- Service (39)
- Logistics (33)
- Other (19)

Development stage — 208

- R&D project (20)
- Demonstrator (33)
- Market launch/piloting (39)
- Market-ready/productive use (116)

Product examples — 169

- Automation components (50)
- Advisory services (10)
- Mechatronic systems (20)
- Production services (17)
- Manufacturing industry (2)
- Software solutions (64)
- Other (6)

Industry 4.0
Dialogue/Workinggroups

Federal Ministry for Economic Affairs and Energy

Federal Ministry of Education and Research

Plattform Industrie 4.0 is drawing up recommendations for action through dialogue with all social stakeholders.

Fields of Dialog:
- ➢ WORK
- ➢ SECURITY
- ➢ NORMS and STANDARDS
- ➢ LEGAL FRAMEWORK
- ➢ RESEARCH and INNOVATION

WORK   (-> Affect to work)
- Production is becoming more dynamic, efficient and technologically complex through Industrie 4.0.
- Working conditions need to be redesigned, education and training need new content.

SECURITY   (-> New concepts)
Information and data security are becoming increasingly important in a digital world (sabotage, espionage or attacks on know-how and intellectual property)

NORMS AND STANDARDS   (-> Common Language)
Standardization is the key for intersectoral and cross-sectoral Industrie 4.0 projects when machines interact with machines or production parts within a factory .

LEGAL FRAMEWORK   (-> Data protection and supporting innovation)
Legal provisions have to keep up with the development of new business models toensure security, create acceptance and encourage innovation.

RESEARCH AND INNOVATION (-> Incubator for Knowledge transfer)
Interdisciplinary cooperation is the basis for complex Industrie 4.0 technologies. Research and innovation act as important incubators for knowledge transfer: From user research to practical testing.

Industrie 4.0
Working groups

Working Groups of the Plattform Industrie 4.0

Six working groups stand for the technical and content-related results of the platform. Experts from businesses, associations, works councils and academia develop pre-competitive concepts, solutions and recommendations on key topics of Industrie 4.0 – from standardisation and IT security to economic, legal and social dimensions.

Neue Veröffentlichungen:

Verwaltungsschale im Detail: Von der Idee zum implementierbaren Konzept
April 2018 | Faktenpapier

Relationships between I4.0 Components – Composite Components and Smart Production – Continuation of the Development of the Reference Model for the I4.0 SG Models and Standards
April 2018 | Ergebnispapier
http://bit.ly/2HgPSfL

Verwaltungsschale konkret: Wie Unternehmen Daten in der Industrie 4.0 standardisiert nutzen und verwalten können – ein Anwendungsszenario
April 2018 | Faktenpapier
http://bit.ly/2JdItj5

Welche Kriterien müssen Industrie-4.0-Produkte 2018 erfüllen?
April 2018 | Ergebnispapier
http://bit.ly/2HO6Ns6

Sprache für I4.0-Komponenten – Nachrichtenstruktur und Teilmodell-„Ausschreibung"
April 2018 | Diskussionspapier
http://bit.ly/2qO7J7D

Online Library

- ➢ **Working Group „Reference Architectures, Standards and Norms"**
- ➢ **Working Group on „Technology and Application Scenarios"**
- ➢ **Working Group "Security of Networked Systems"**
- ➢ **Working Group on the „Legal Framework"**
- ➢ **Working Group on "Work, Education and Training"**
- ➢ **Working Group on "Digital Business Models in Industrie 4.0"**

Industrie 4.0
Strategy/Projects

The characteristics given for the German government's Industry 4.0 strategy are:

The strong customization of products under the conditions of highly flexible (mass-) production.

The required automation technology is improved by the introduction of methods of **self-optimization**,

self-configuration,

self-diagnosis,

cognition and

Intelligent support of workers

Largest projects in Industry 4.0:

➢ BMBF leading-edge cluster

"Intelligent Technical Systems Ostwestfalen-Lippe "

➢ BMBF project RES-COM

Cluster of Excellence "Integrative Production Technology for High-Wage Countries".

➢ European Commission Horizon 2020
Research Project CREMA

Providing Cloud-based Rapid Elastic Manufacturing based on the XaaS and Cloud model as a major initiative to foster the Industry 4.0 topic.

Implementation of Industry 4.0
Challenges

- ➤ **IT security issues**
- ➤ **Reliability and stability** needed for critical machine-to-machine communication (M2M)
- ➤ Need to maintain the **integrity of production processes**
- ➤ Need to **avoid any IT snags**
- ➤ **Need to protect industrial know how**
- ➤ **Lack of adequate skill-sets**
- ➤ **Threat of redundancy** of the corporate IT department
- ➤ General reluctance to change by stakeholders
- ➤ **Loss of many jobs due** to automatic processes and IT-controlled processes
- ➤ **Low top management commitment**
- ➤ Unclear legal issues and data security
- ➤ **Unclear economic benefits**/ Excessive investment
- ➤ **Lack of regulation**, standard and forms of certifications
- ➤ **Insufficient qualification of employees**

Industrie 4.0
Big Data Analytics

Big data analytics consists of 6Cs in the integrated Industry 4.0 and cyber physical systems environment.

- ➤ Connection (sensor and networks)
- ➤ Cloud (computing and data on demand)
- ➤ Cyber (model & memory)
- ➤ Content/context (meaning and correlation)
- ➤ Community (sharing & collaboration)
- ➤ Customization (personalization and value)

In this scenario and in order to provide useful insight to the factory management, data has to be processed with advanced tools (analytics and algorithms) to generate meaningful information.

Industrie 4.0
Digital Economy in GERMANY
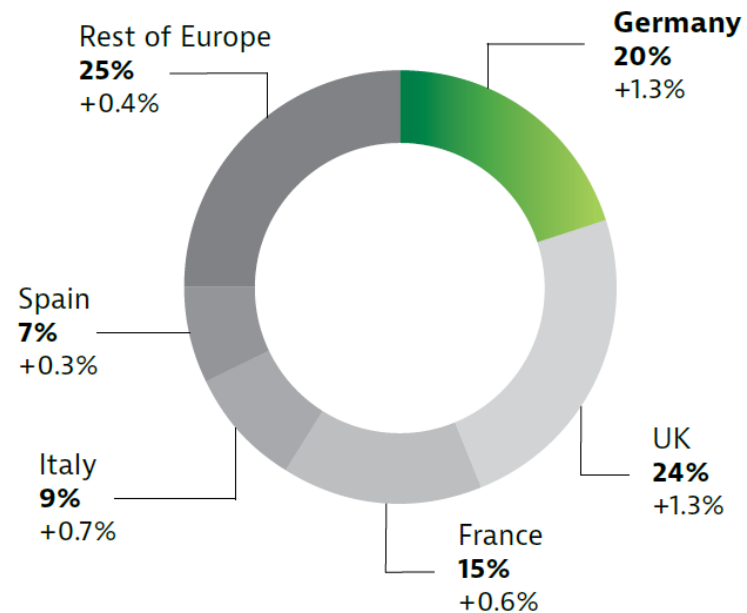## Facts and Figures

Goal
Germany has the goal of becoming number one country in Europe in terms of digital growth.

➢ **ICT** in Germany   160 bn €   (2017)
Fifth biggest ITC Market in world

➢ **Digital transformation**   20 bn devices   (2015)
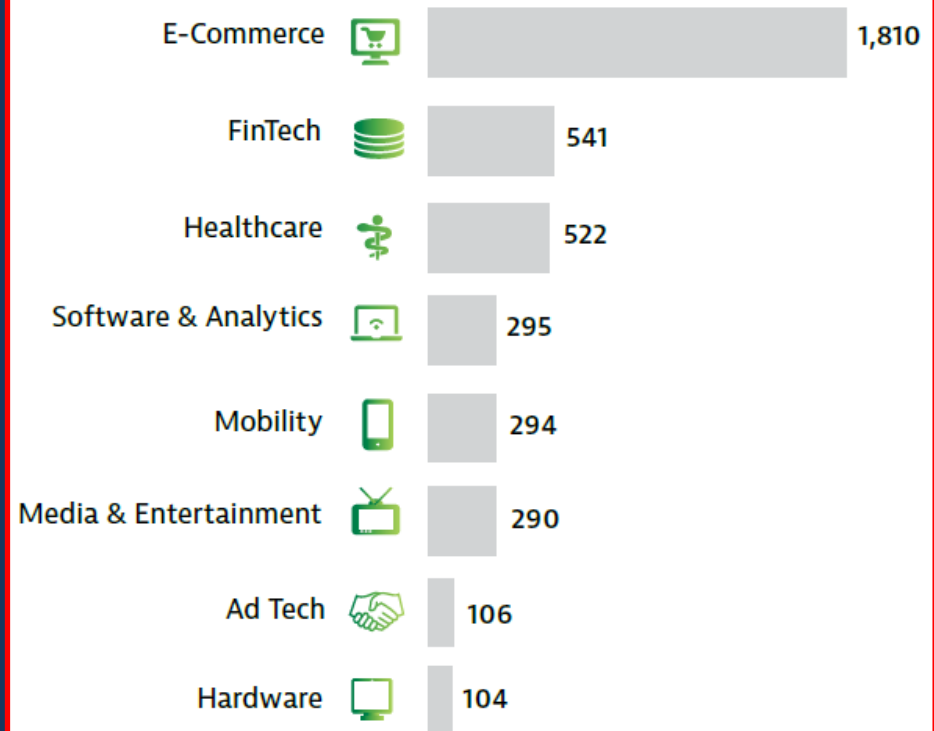
Worldwide

European ICT Market 2017 and Predicted Growth Rates 2018

Rest of Europe
25%
+0.4%

Germany
20%
+1.3%

Spain
7%
+0.3%

UK
24%
+1.3%

Italy
9%
+0.7%

France
15%
+0.6%

https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Fact-sheets/Business-services-ict/fact-sheet-digital-en.pdf?v=3

Digital Economy Markets I

The product and services of the new digital economy give rise to delivery models (f.e. AdTech and Fin Tech) that rely on innovative web-based data management solutions (Big Data and Cloud Computing)

Investment in German Start-ups 2017
in EUR million

Category	EUR million
E-Commerce	1,810
FinTech	541
Healthcare	522
Software & Analytics	295
Mobility	294
Media & Entertainment	290
Ad Tech	106
Hardware	104

Source: Ernst & Young Start-up-Barometer 2018
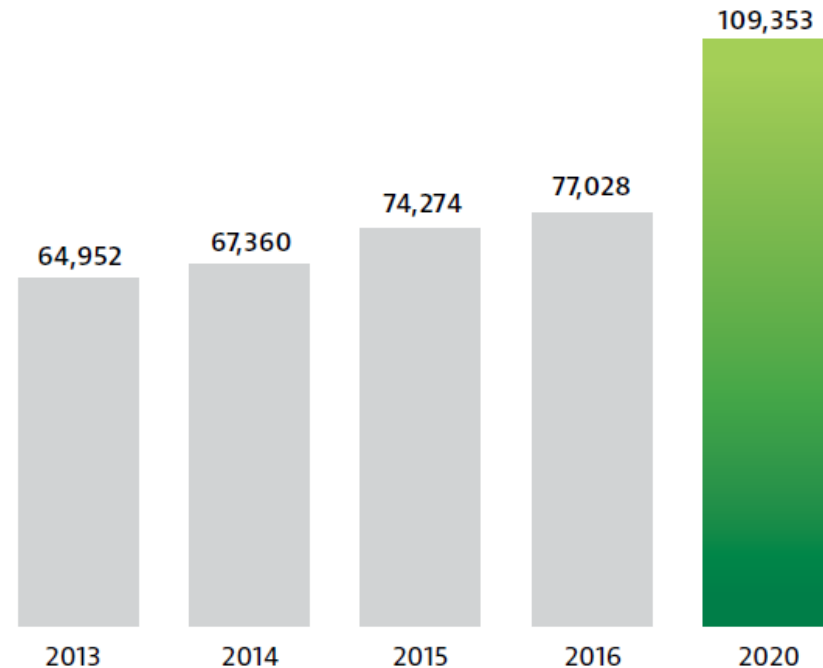
Digital Economy Markets II

Big Data
Information is the most variable commodity of the digital.
(-> cloud computing and digital age)

The German Data Economy 2013-2020
turnover in EUR million

Year	Turnover
2013	64,952
2014	67,360
2015	74,274
2016	77,028
2020	109,353

Source: IDC/European Commission 2017

Facts and figures on digitalisation

25 — Percentage of commercial enterprises that are already highly digitalised (2017)

19 — Percentage of commercial enterprises using Big Data in 2017

4,3 — Amount in billion euros that businesses and individuals invested in start-ups in 2017

53 — Percentage of German companies that have already fallen victim to cyber crime (2017)
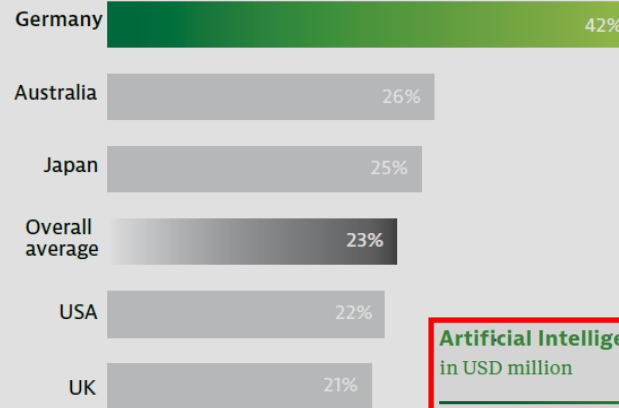
Digital Economy Markets III

Cybersecurity
Tightened regulations, increased awareness of emerging threats and the move to digital business strategies are driving forecast incraeses in international security spending!

Artificial intelligence AI
AI and digital technology developments have already transformed the way humans interact with machines.
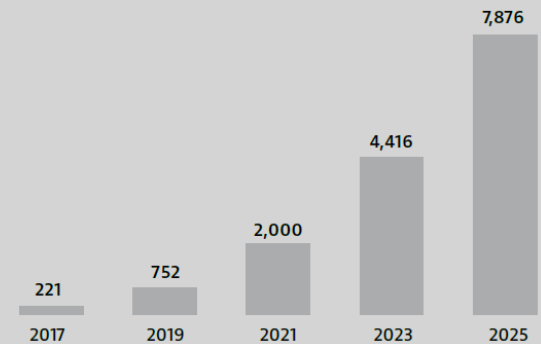
Increase of Cyber Crime Costs 2016-2017

Country	%
Germany	42%
Australia	26%
Japan	25%
Overall average	23%
USA	22%
UK	21%

Source: Accenture 2017

Global security spending
96 bn USD

Artificial Intelligence Market Revenue in Europe
in USD million

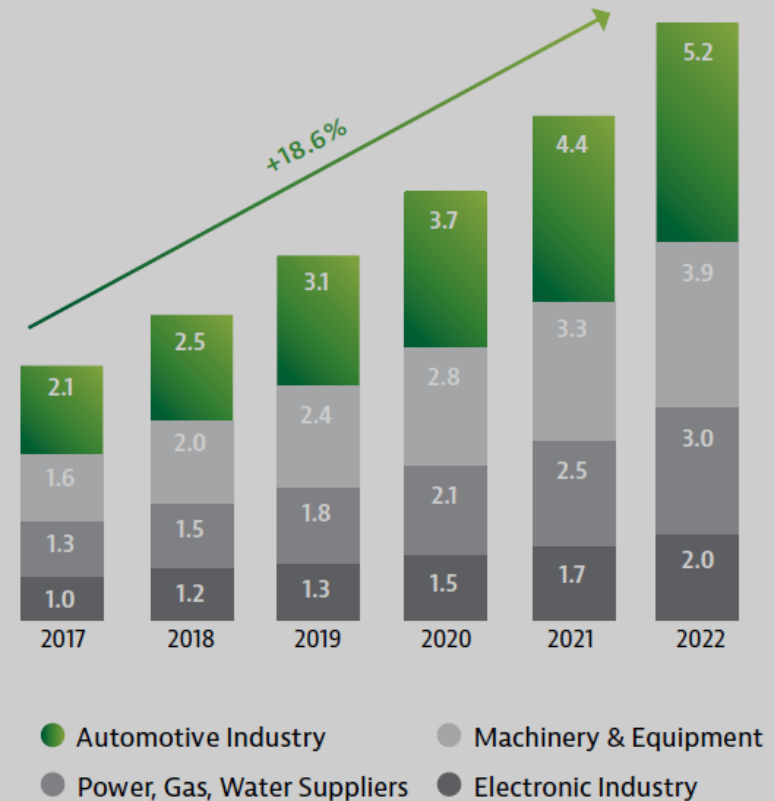| 2017	2019	2021	2023	2025
221	752	2,000	4,416	7,876

Source: statista.de 2018

Digital Economy Markets III

Industrie 4.0

Germany's technological leadership in the fields manufacturing, automation and software-based embedded systems forms the cornerstone for the longterm success of the Industrie 4.0 project.

Within Germany IoT-generated turnover is expected to double in just two years from a forecast level of 24,5 bn € to 50 bn € in 2020 (according Deloitte
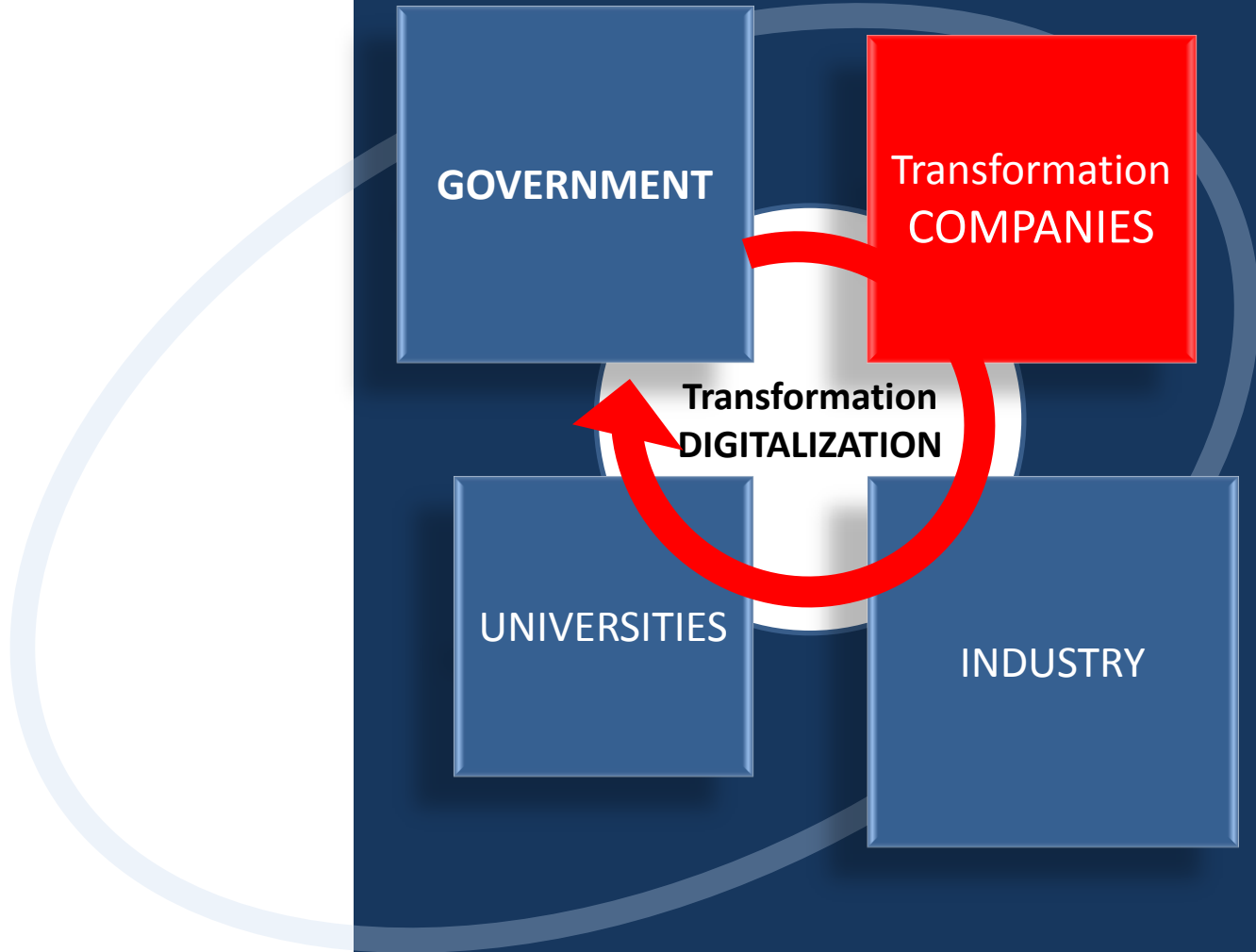

German Industrial IoT Turnover
in EUR billion

+18.6%

Year	Automotive Industry	Machinery & Equipment	Power, Gas, Water Suppliers	Electronic Industry
2017	2.1	1.6	1.3	1.0
2018	2.5	2.0	1.5	1.2
2019	3.1	2.4	1.8	1.3
2020	3.7	2.8	2.1	1.5
2021	4.4	3.3	2.5	1.7
2022	5.2	3.9	3.0	2.0

● Automotive Industry ○ Machinery & Equipment
● Power, Gas, Water Suppliers ● Electronic Industry

Source: Eco/Arthur D. Little 2017

Industry 4.0
Germany

GOVERNMENT

Transformation
COMPANIES

**Transformation
DIGITALIZATION**
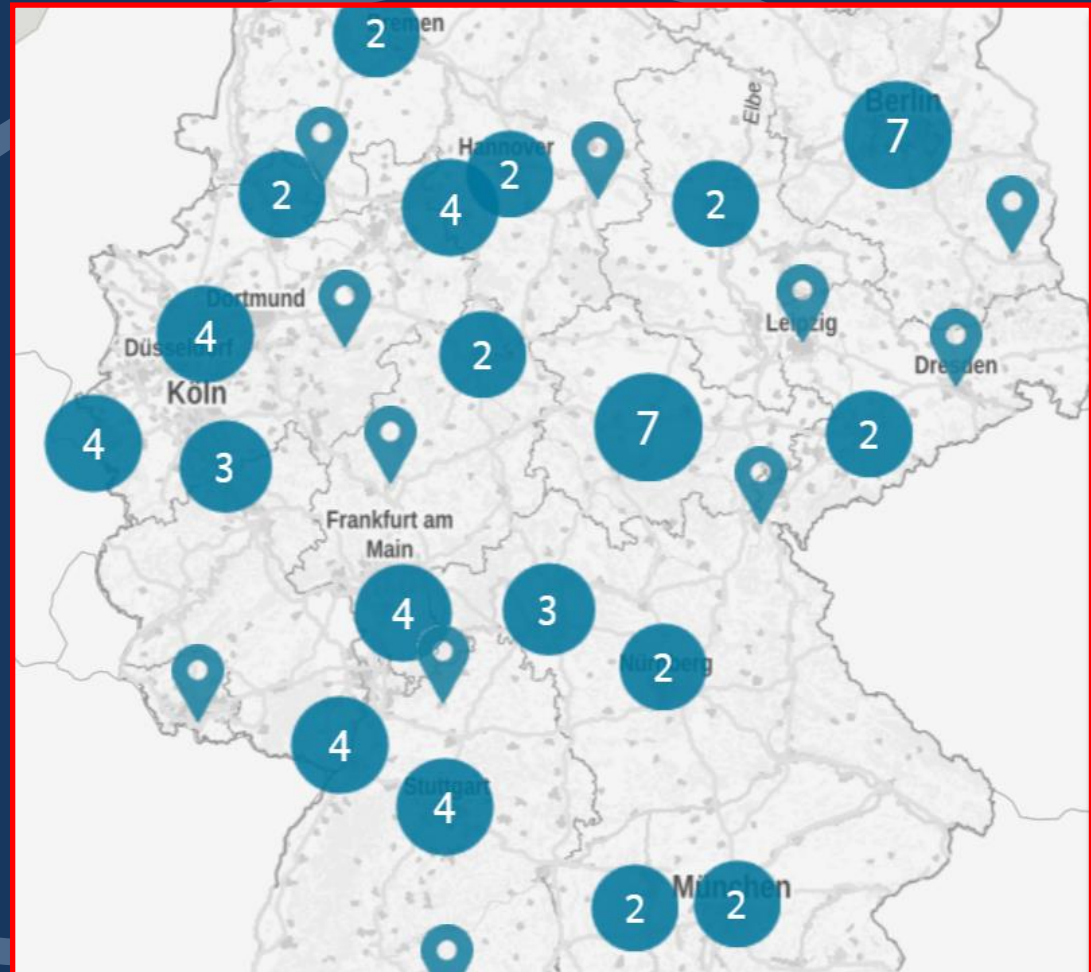
UNIVERSITIES

INDUSTRY

Industrie 4.0
Test beds in Germany

Testbeds for SMEs

There are a number of testbeds at dedicated centres at universities and research institutions in Germany where complex production and logistics systems are being assessed, tested and enhanced under real-life conditions.
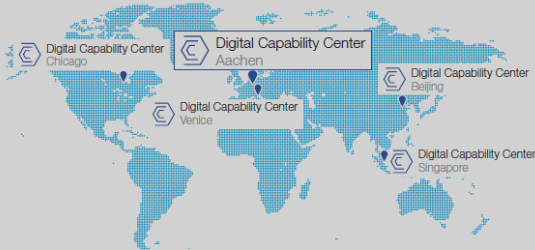
Transformation
Companies
F.e. McKinsey

Our Digital Capability Centers – an unparalleled network

DCC Aachen is part of a worldwide network that gives you access to the latest knowledge of our international technology experts.

Digital Capability Center Chicago

Digital Capability Center Aachen

Digital Capability Center Beijing

Digital Capability Center Venice

Digital Capability Center Singapore

Digital Capability Center (DCC) Aachen

The DCC Aachen is the leading experience and learning center for digital manufacturing and supply chain. The DCC features a model factory with real machines, products, and operators. We teach our participants the technical, management, and people skills required to start, scale, and sustain their digital manufacturing transformation.
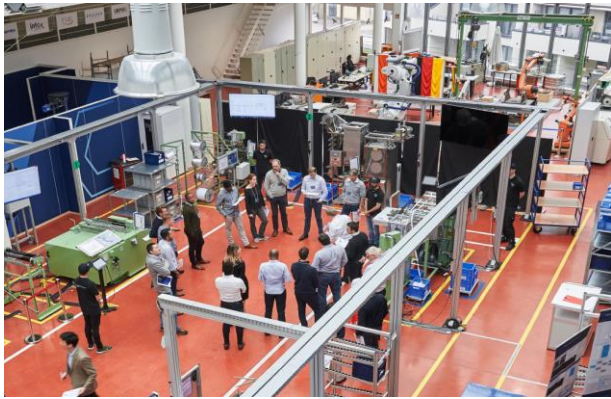
Motto: explore, try, and apply.

Digital Capability Center DCC
Aachen

Technology

Leverage disruptive technologies along your value chain and use state-of-the-art analytics tools to enhance your operational performance.

Management

Install digital performance management in your organization and solve problems by drawing on real-time data and expert systems.
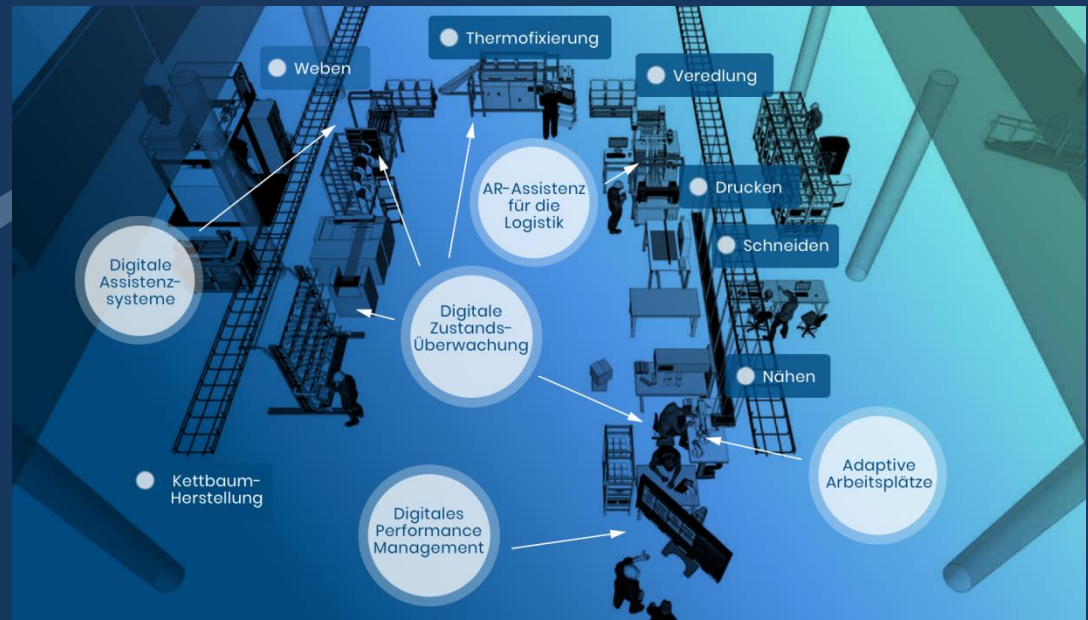
People

Empower people to take ownership and make data-driven decisions. (Digital skills)
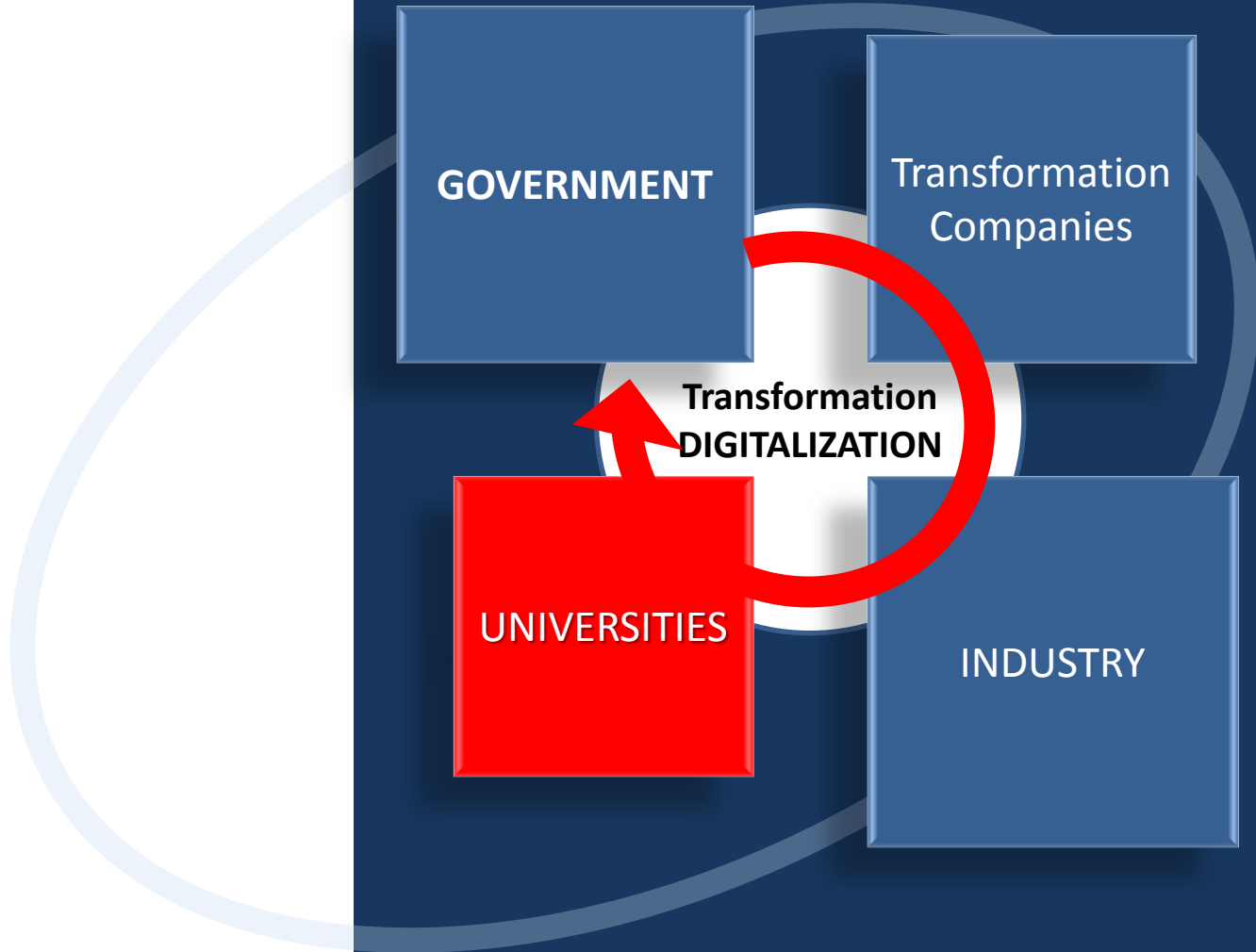
Ib M CONSULTING

Ingenieurbüro MERKLEIN

Industry 4.0
Germany

University

Role:

- Research
- Transfer to Industry
- Application of digital strategies

Digitalization Strategy for Teaching

2nd Phase 2018 to 2023

Between 2014 and 2017, that is in the first phase of the digitalization strategy for teaching, the Rector's Office's provided funds for the faculties to experiment with innovative teaching, learning, and assessment formats. Additional human and financial resources were granted in order to expand the offer of central service units, which support instructors in the integration of technologies and media in their courses.

The faculties were given free rein to decide which formats and methods they prefer to apply in their respective subject areas.

http://www.rwth-aachen.de/cms/root/Studium/Lehre/Blended-Learning/~hjgq/Digitalisierungsstrategie-der-Lehre/?lidx=1

Universities
Service Units

- Media for Learning
- Qualification and Network
- Innovative Learning Technology
- Teaching and Learning Platform
- Blended Learning (online tutorials, Webinars)
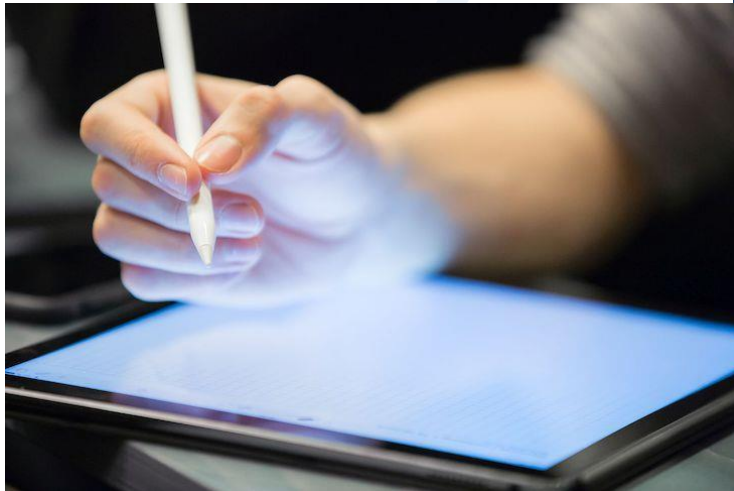
Digitalization is starting already with a mind change in education!

Service Units

The following institutions at Aachen University can offer you advanced education, trainings, workshops, and advising:

➢ Media for Learning – MfL

➢ Center of Excellence in Academic Teaching – ExAcT

➢ Center of Excellence in Academic Teaching Center for Innovative Learning Technologies – CiL

➢ Center for Innovative Learning Technologies Audiovisual Media Center – AVMZ

➢ Audiovisual Media Center (Medicine)

➢ University Library – UB

RWTH Aachen
Cluster

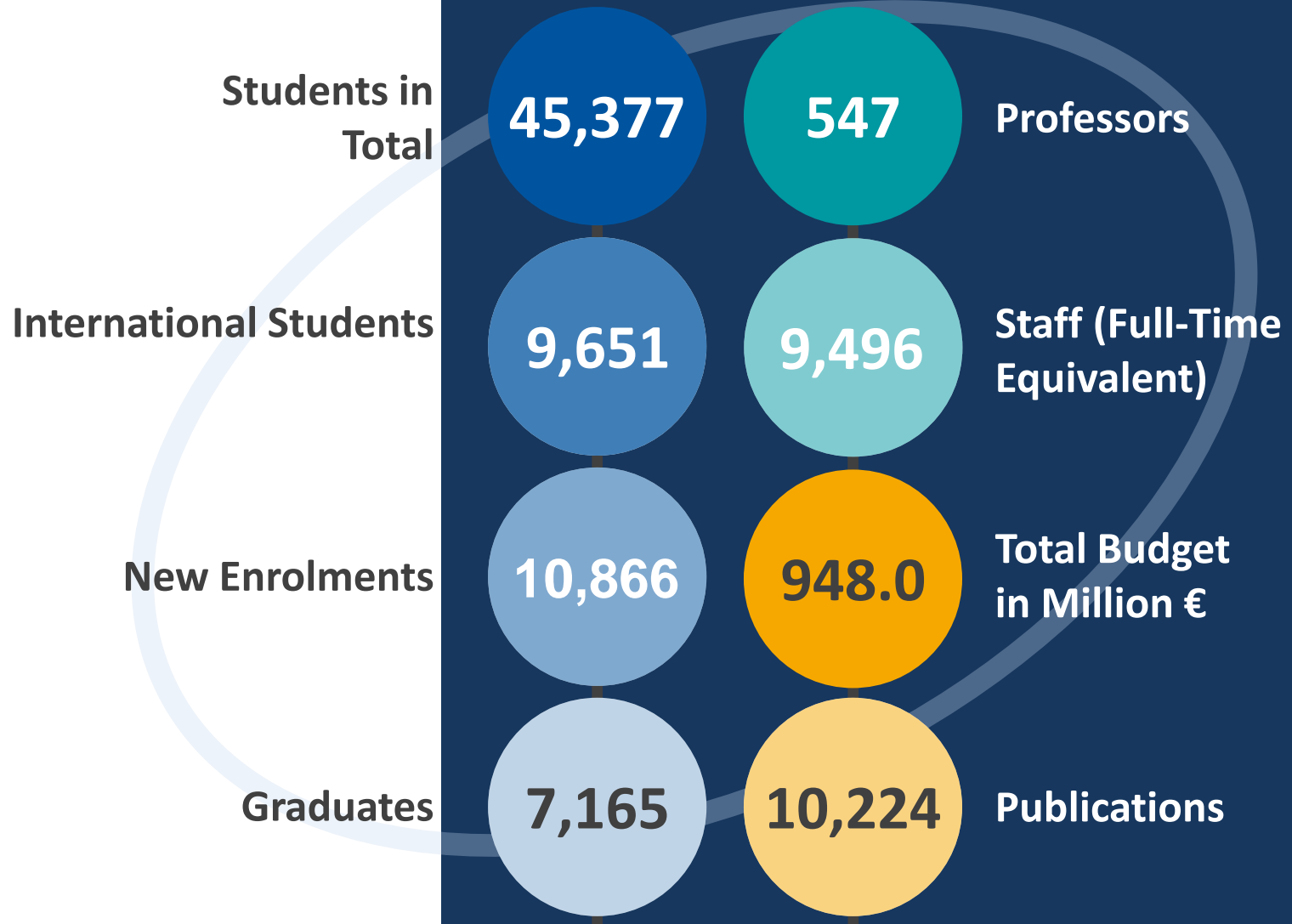

1,5 million m² for development, research and transfer!

RWTH Aachen
Cluster

Campus West

Campus Melaten

Campus Mitte

Aachen University
Facts and Figures

Students in Total — 45,377

547 — **Professors**

International Students — 9,651

9,496 — **Staff (Full-Time Equivalent)**

New Enrolments — 10,866

948.0 — **Total Budget in Million €**

Graduates — 7,165

10,224 — **Publications**

Research Area
Technology,
Innovation, Marketing,
Entrepreneurship
TIME

RWTH AACHEN UNIVERSITY

Dr. rer. pol.,
Universitätsprofessor

Frank Thomas Piller

Professor and Head of Group

Industry 4.0 is often discussed from a technological perspective of machine learning, algorithms, smart sensors, and connected assets.

But the truth is, its biggest impact will be on **company business models**, especially those of well-established companies.

Fundamentally of a business model is a management hypothesis about:

- What customers want?

- How they want it?

- How a company can satisfy these wishes and make profit on it?

Prof. Dr. Frank Piller

Industrie 4.0
Barriers + Challenges

Most companies are yet to capitalize on new business models developed as a result of digitisation.

This can be attributed to the following barriers:

➢ **Missing awareness**
➢ **Missing processes**
➢ **Missing resources**

The development of digitisation offers a variety of opportunities for established companies.

Whereas short-term successes can be realized via process optimisation,

a long-term stable strategy requires the development of new products and services as well as new business models, which use the potentials of digitisation in a new way and add value in the process.

Innovative companies should address and implement all three dimensions of innovation within a holistic, flexible and dynamic strategy of digitisation.

Industry 4.0
Germany

GOVERNMENT

Transformation
Companies

Transformation
DIGITALIZATION

UNIVERSITIES
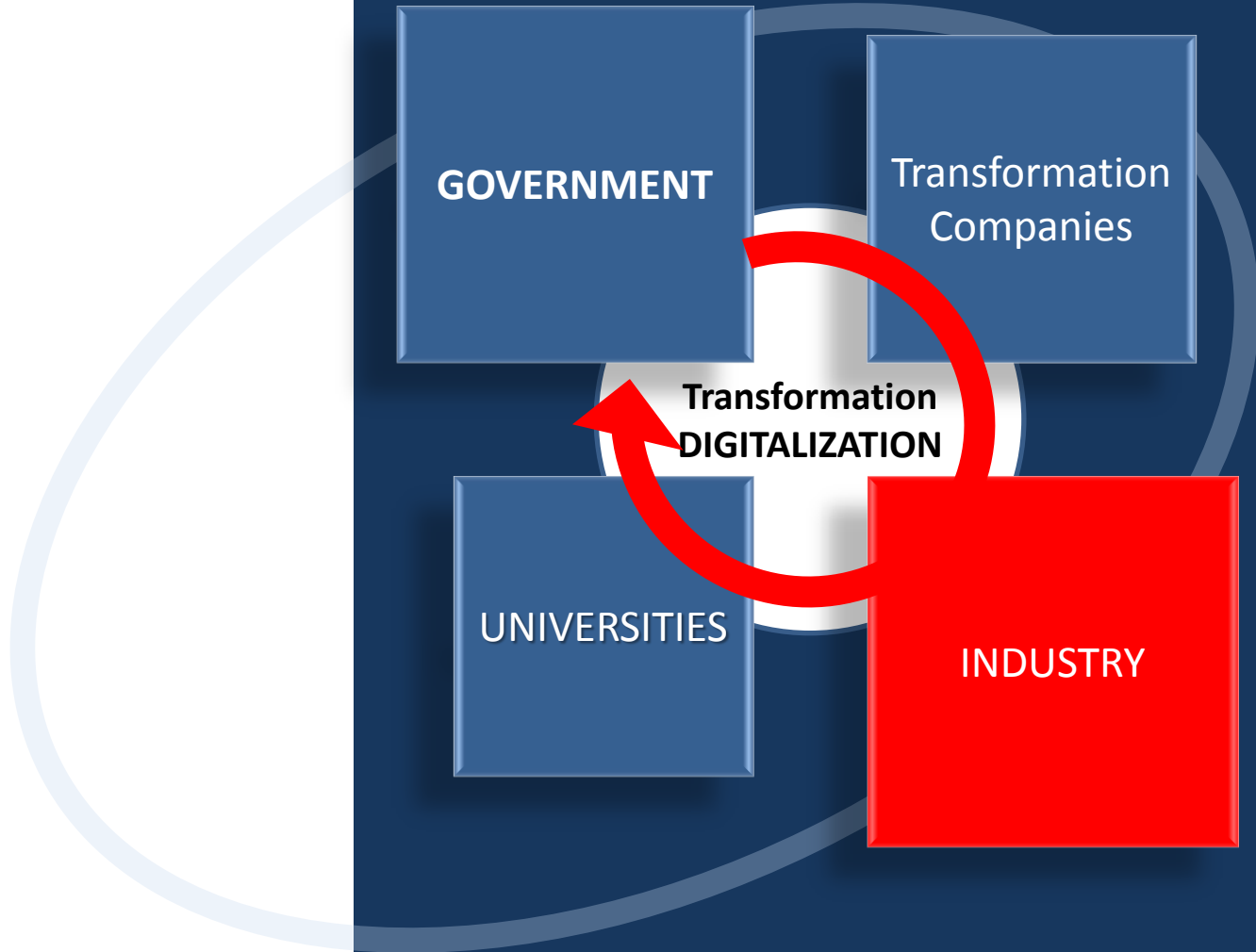
INDUSTRY

Industry 4.0
History in Germany

Industrie 4.0 started already more than 3 years ago!

1985 **AUTOMATION** in Warehouses + Transportation, Automated machines

-> Reduction of Personnel Expenses (7th day)

1990 **DATA COLLECTION** Machine level

-> Quality, Productivity

1995 **ENTERPRISE PLANNING** ERP, MES,…

Integrated Manufacturing (Automotive, Electronic Industry, Textile)

-> Planning, Time to Market

2000 **Internet**

2005 IoT

2011 Start of Term ‚**Industrie 4.0**‘

2015 Transformation to Industry

- Advanced robotics
- 3D printing
- Internet of things
- Artificial Intelligence
- Big Data

Today Global trend in different application fields

Transformation Companies SIEMENS

Four core elements to create the Digital Enterprise

Industrial software and automation

Software needs to be seamlessly integrated into the automation components, because optimizing just the automation process is no longer enough. Only intelligent software makes it possible to further improve production.

Industrial communication

Industrial communications networks must ensure not only that machines communicate with each other, but also that all relevant data can be shared with the management level and other locations. Identification systems increase transparency and efficiency of the complete production and supply chain.

Industrial security

Much stronger security is needed in the automation process, because increased networking opens up more fronts for cyber attacks.

Industrial services

Business-specific industrial services offer new opportunities to unleash hidden potential and increase the performance of machines and plant equipment.
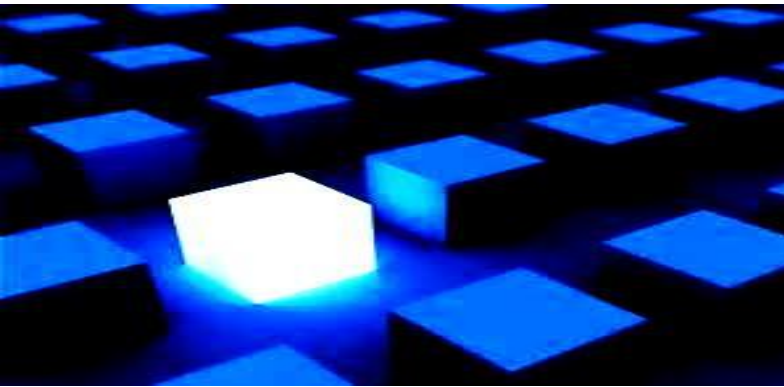
https://new.siemens.com/global/en/company/topic-areas/future-of-manufacturing/digitalenterprise.html

Thank you very much

for your attention!

Teşekkür ederim!

Questions?

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What can we do for you?
Do you need information or support?

Please don't hesitate to contacting me!