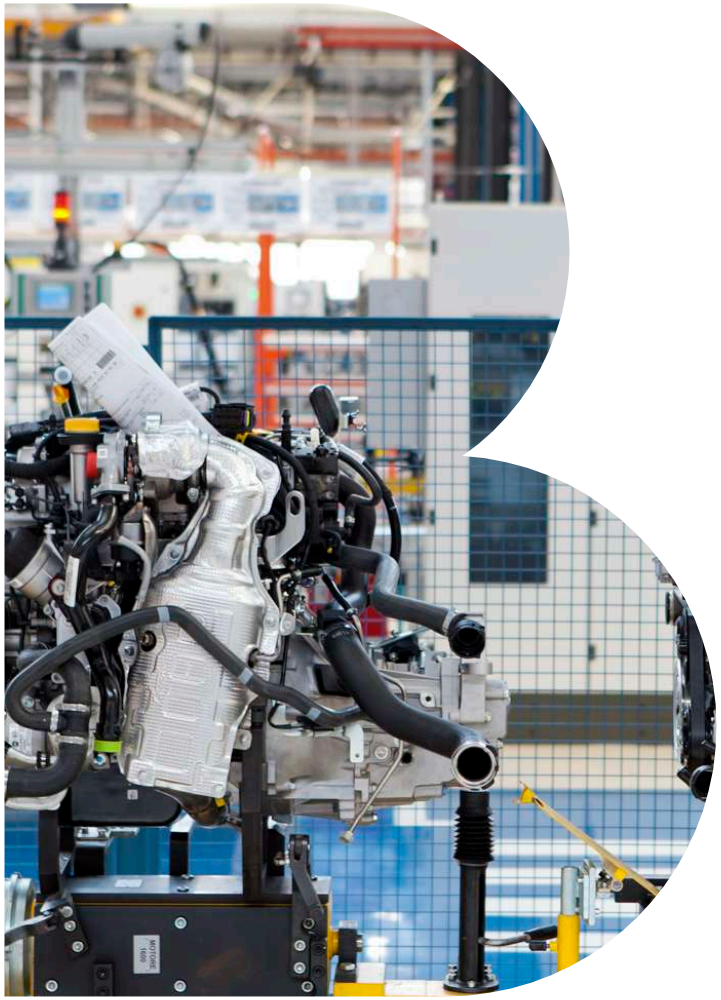
Industry 4.0

Dr. Crapelli speech



Milan, October 19, 2016

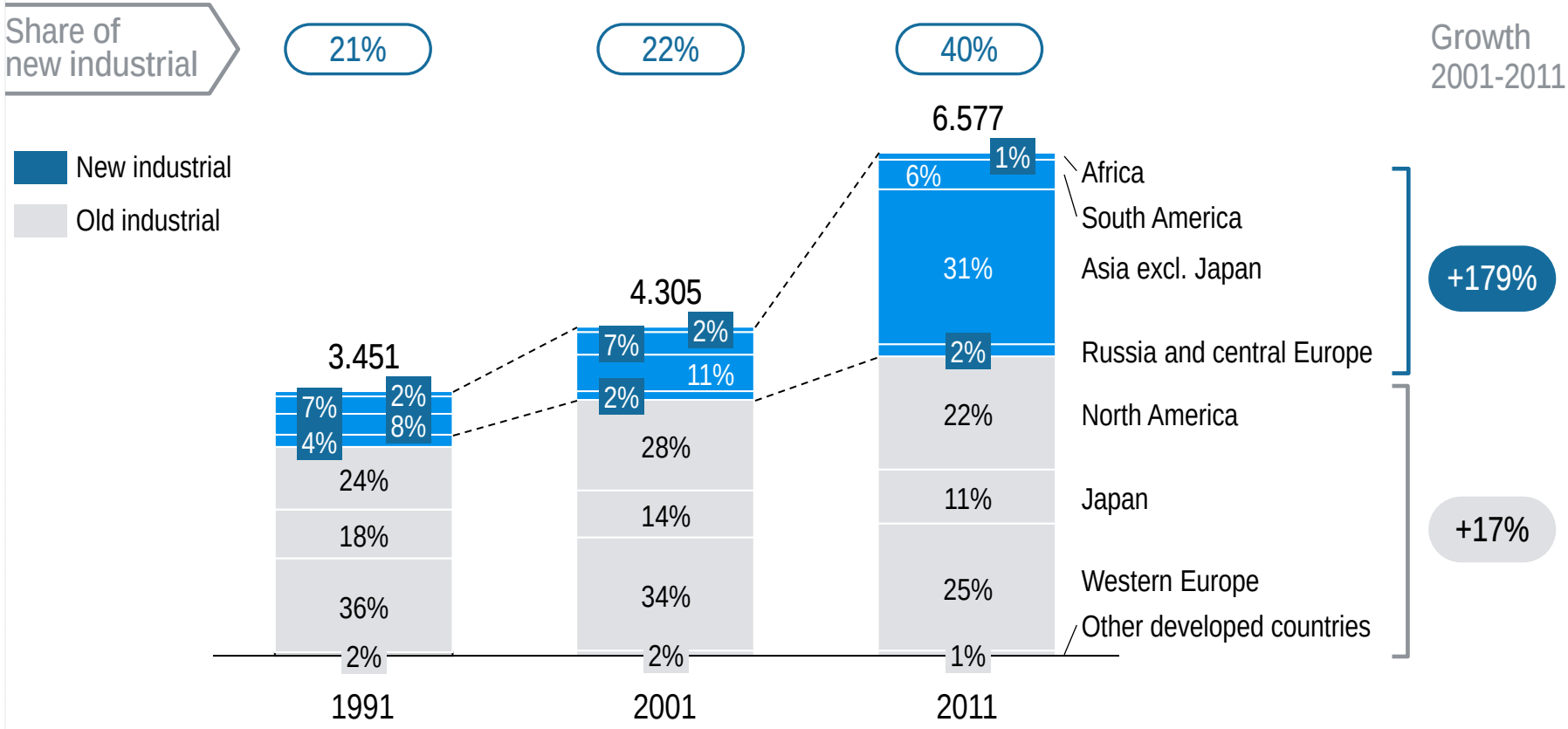
Contents

Page

A. The global industrial scenario: key trends to consider

New industrial countries capture 50% of global industrial added-value

Global Manufacturing added value[1] [EUR bn]

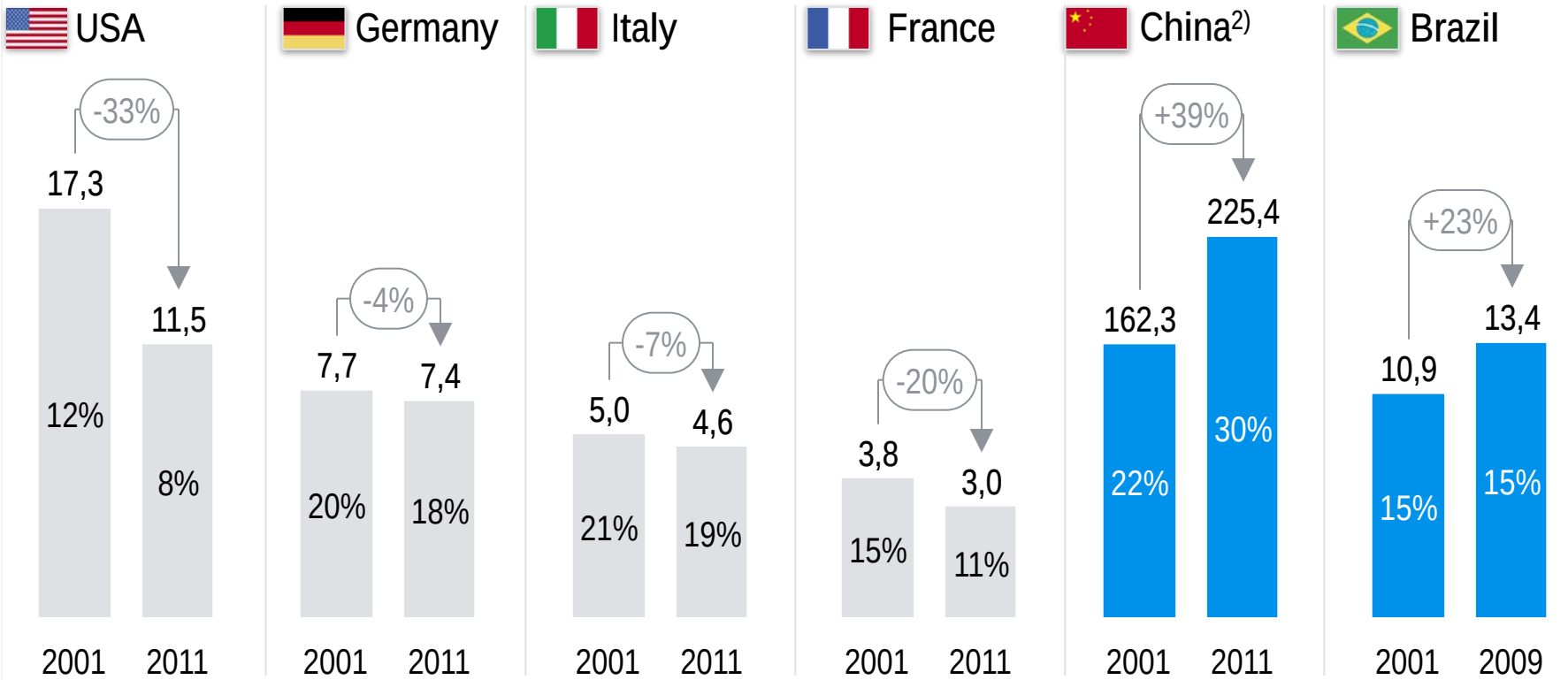


1) UNCTAD data in constant USD (2005 rate), converted in EUR (2005 exchange rate)

Source : UNCTAD, Oanda

Industry related employment is decreasing in developed countries, while increasing in developing ones

Industry[1] related employment in selected countries [2001-2011; m employs]

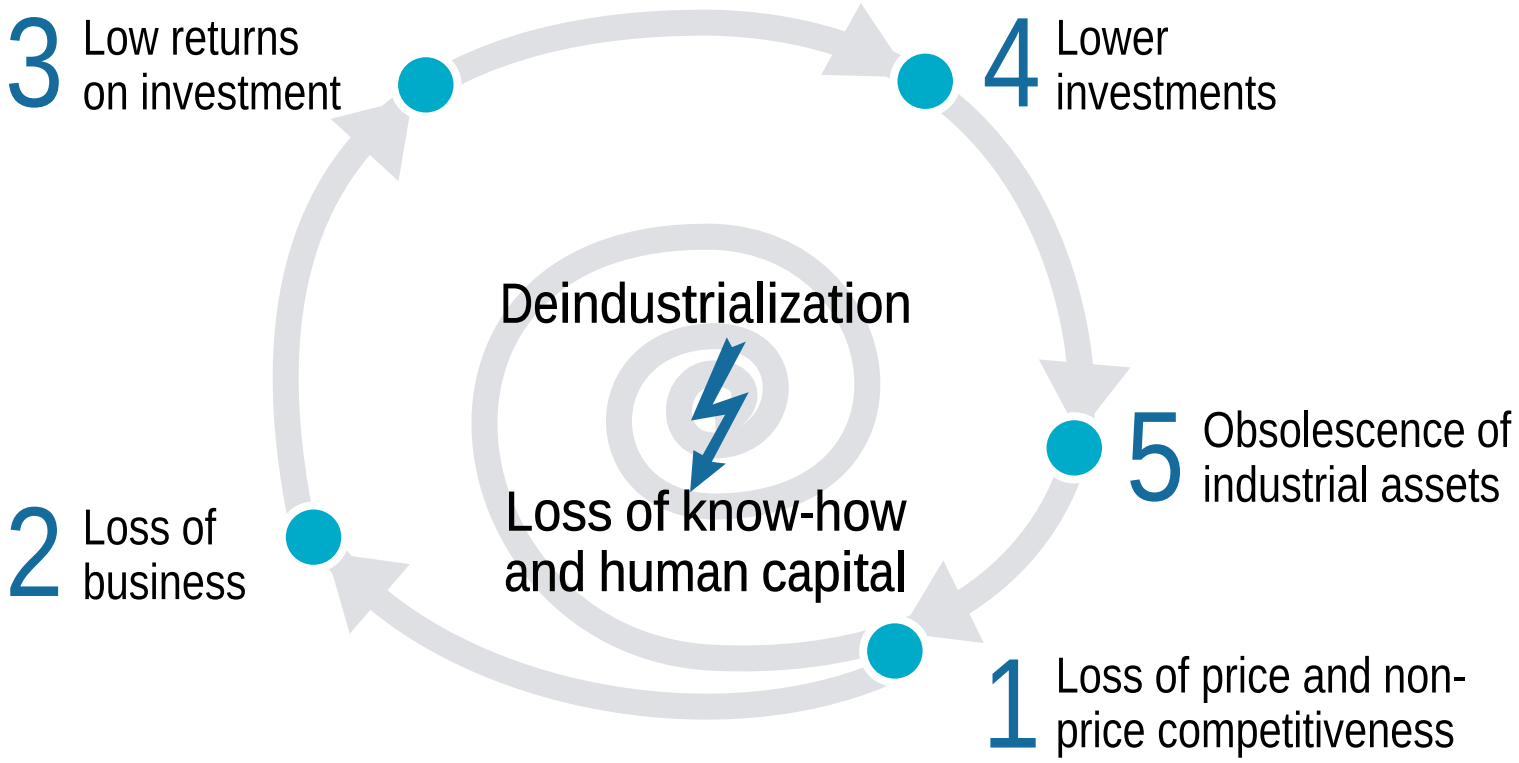


1) Excluding electricity, mining and quarrying for Europe, including for China and Brazil; 2) Including construction in China

Source: Eurostat; BRICS report; MOHRSS; World Bank; U.S. Bureau of Labor Statistics

Without a serious initiative towards reindustrialization, developed countries risk being pulled into a vicious circle

The vicious circle of deindustrialization



> Price and non-price competitiveness are therefore the problems to be addressed!

Source: Roland Berger

B. Industry 4.0: the new revolution

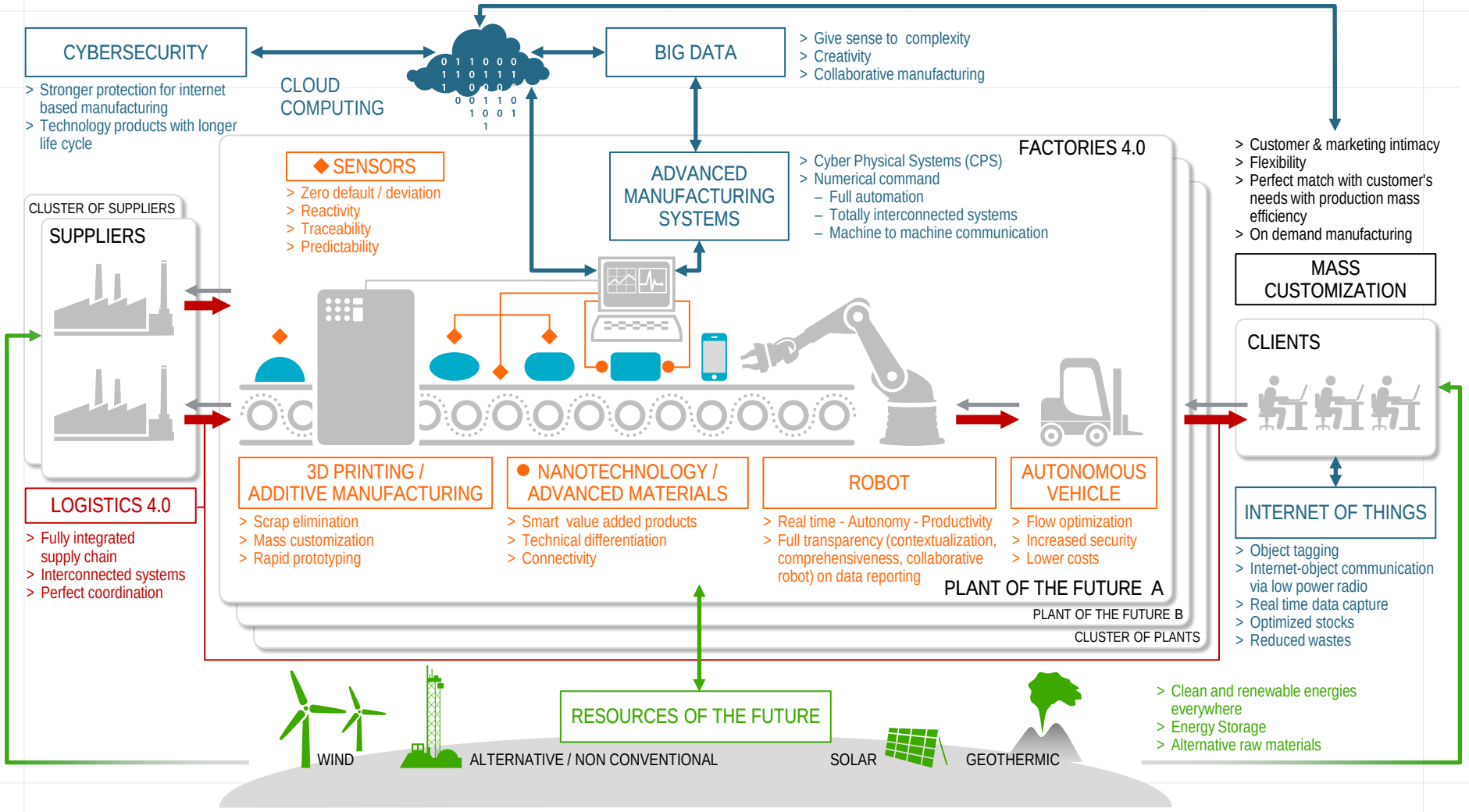
German-led concept of Industry 4.0 competes with the "Industrial Internet" proposed in the US in philosophy & standards

Industrial Internet vs. Industry 4.0

	Industry 4.0	Industrial Internet
Term first coined in	> Germany, 2011	> USA, 2012
Coined by	> acatech (National Academy of Science and Engineering), Bosch	> General Electric
Propagated by	German Government, acatec > Industry 4.0 is part of the federal High-tech-Strategy Action Plan, roll-out in cooperation with Industry, non-profit R&D institutions and universities	Industrial Internet Consortium > founded in March, 2014 by GE, Cisco, AT&T, Intel and IBM > Only few German players active – Bosch as lighthouse
Key focus	> Industrial policy: "the German strategic initiative to take up a pioneering role in industrial IT"	> Interoperability:"establishing interoperability in various industrial environments"
Key aspects	> Engineering driven – focus on Smart Manufacturing enabled by Cyber-Physical Production Systems > Full vertical integration along the technology stack	> Slightly more IT driven: "break down the barriers of technology silos to support better access to big data with improved integration of the physical and digital worlds to unlock business value

Source: Industrial Internet Consortium, acatech, Press research

Industry 4.0 designates a complex, interconnected global system



Source: Roland Berger

Industry 4.0 implies new skills and more collaborative and cross-cultural competencies to work sustainably in network environment

Overview of Industry 4.0 new skills [selection]

CYBERSECURITY

> Technologies, processes and standards (ISO 27001) enabling organizations to protect computers, networks and data from unauthorized access

BIG DATA

> Refers to data so large, complex or rapid that it is difficult to process using traditional database and software techniques

CLOUD COMPUTING

> The capacity to share computing resources – typically through the Internet – rather than having local servers or personal devices to handle applications

AUGMENTED REALITY

> Real-world environment digitally enhanced by computer-generated sensory input such as sound, video, graphics or GPS data

ROBOTICS

> Technology dealing with the design, construction, operation, and application of robots in order to improve productivity, product quality and worker safety

INTERCONNECTION and DIGITIZATION

RAPID PROTOTYPING

> Group of techniques using in particular 3D computer aided design data to rapidly and efficiently turn innovative ideas into scale models

RADIO FREQUENCY IDENTIFICATION (RFID)

> Automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders

PLANTS SUPER-CONNECTION

> Connection of machines, work pieces and systems, to create intelligent networks along the entire value chain that can control each other autonomously

3-D PRINTING (or ADDITIVE MANUFACTURING)

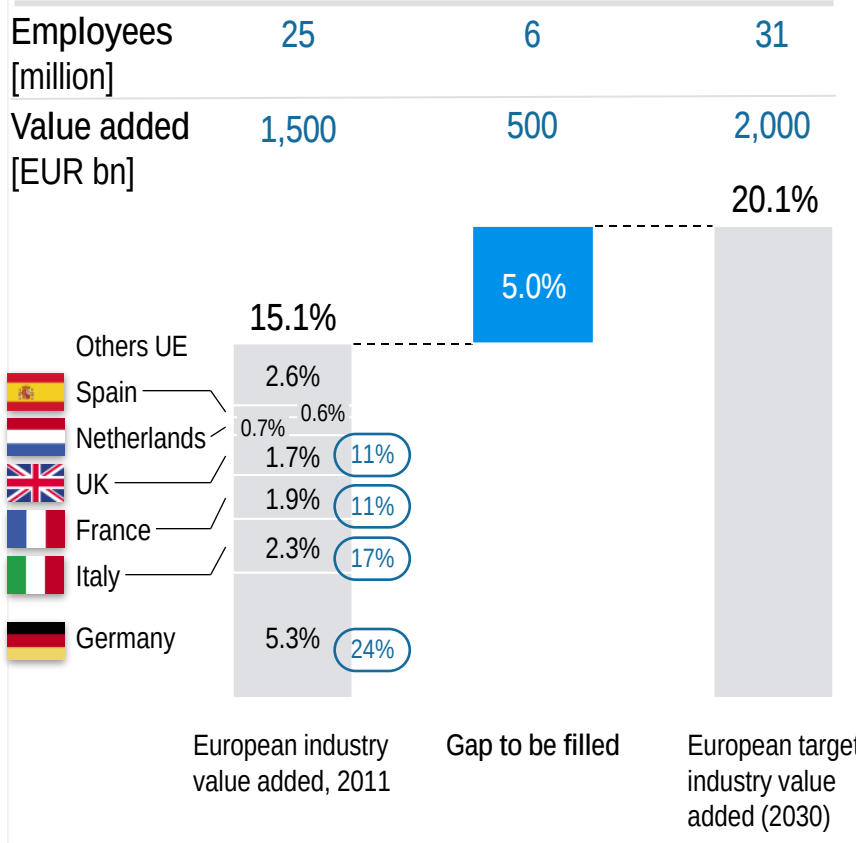
> A process of making a three-dimensional solid object of virtually any shape from a digital model

> Allows customizable,one-off production with virtually no waste

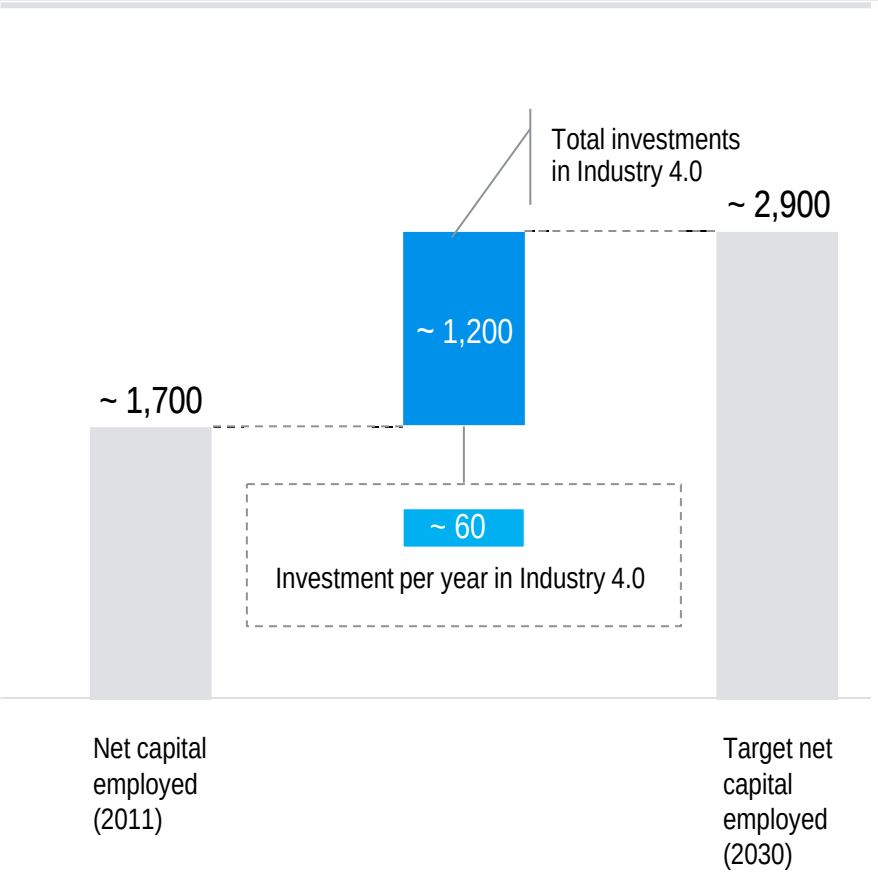
Source: Roland Berger

Industry 4.0 will require ~60 B€ extra investment per year in Europe until 2030 and can generate 500 B€ of value-added and 6M jobs

Industry weight in Europe[1)]
[as a % of total Europe value added]



Investment plan
[EUR bn]



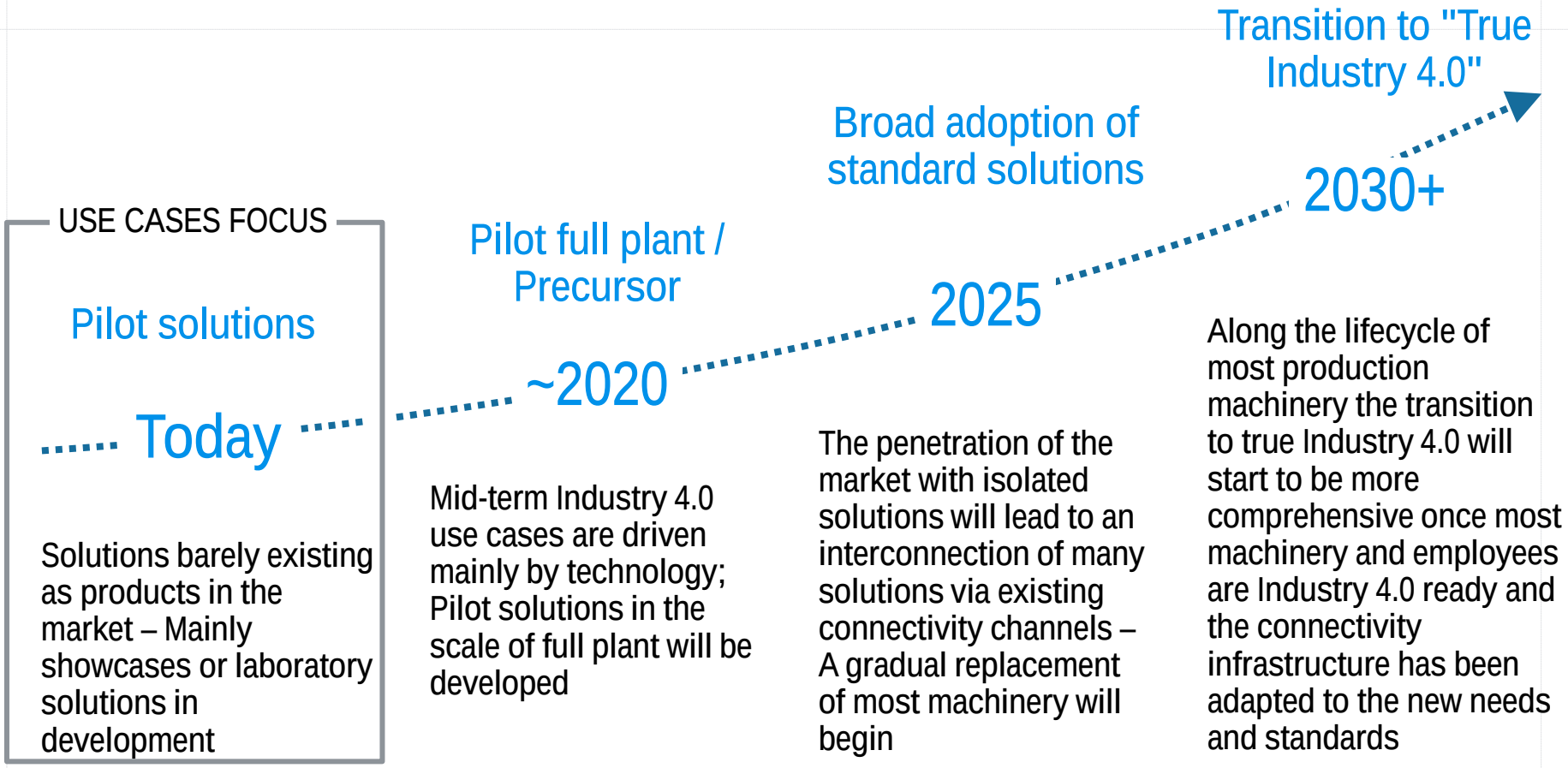
x% Manufacturing Industry value added as a % of country total value added

1) EU 15, Industry excluding Energy and Mining

Source: Roland Berger analysis

Industry 4.0 is a long journey and technologies will take 10~15 years to reach maturity in the market

Industry 4.0 roadmap



Source: Roland Berger

C. Future scenario: impacts on industrial enterprises

Industry 4.0 is potentially changing the paradigm

Characteristics of new Industry 4.0

Traditional industry approach	New Industry 4.0 paradigm
> Economies of scale through volume	> Economies of scale through knowledge
> High hidden complexity cost through product variants proliferation	> Affordable product diversity – "cost of one = cost of thousand"
> Make to stock based on product forecasts and economical order quantity	> Make to order based on adaptive production planning and pricing (yield management)
> New product launch is a source of launch cost	> Seamless product launch is a source of value
> LCC footprint localization with large size plants	> Proximity footprint localization
> Large size plant with one roof concept	> Network of decentralized and small production units by technology
> Medium / low capital intensity – Low margin	> High capital intensity – High margin
> Blue collar driven workforce	> White collar driven workforce

Source: Roland Berger

Realizing highly flexible production lines - A new plug & produce standard has been introduced by the Fraunhofer Society

Fraunhofer IOSB

social machines

Augmented operators

Smart products

Virtual production

Plug & produce

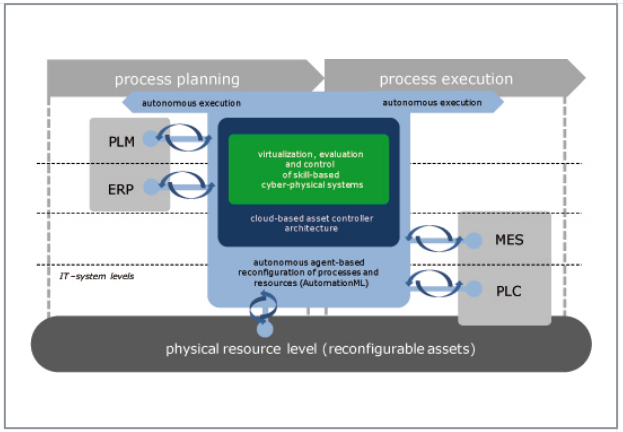
> Although products, production systems and IT are the core elements of a modern factory, they are currently not interlinked – a communication between these three elements does just not exist

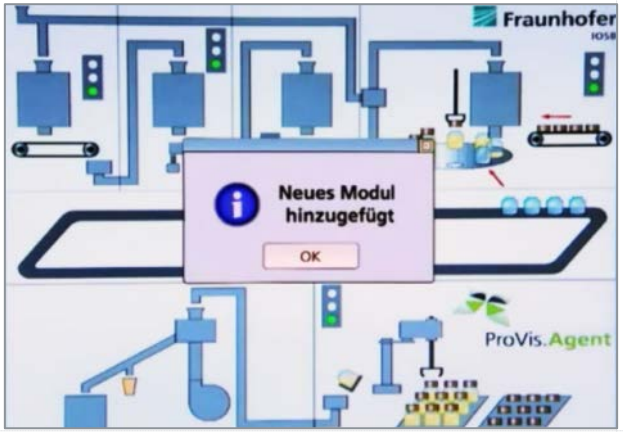
> The Fraunhofer IOSB, however, has already developed patent-registered solutions that will enable industrial companies to link any existing production component to a flexible production system using standardized interfaces

> This so called plug & produce ability of the production system allows an automatized cognition of the added component (e.g. roboter) in the control software

> All associated production processes will than be adjusted automatically afterwards

> The operational capability of this approach is already proven in the ProVis IT systems of the Fraunhofer Society that are for example used in the production facility of the Daimler AG in Bremen





Source: Fraunhofer Institute of Optronics, System Technologies and Image Exploitation; Roland Berger

Helping employees to do their job – The research plant Smart Factory integrated augmented reality into maintenance tasks

Smart Factory[KL]

social machines

Augmented operators

Smart products

Virtual production

Augmented service operators

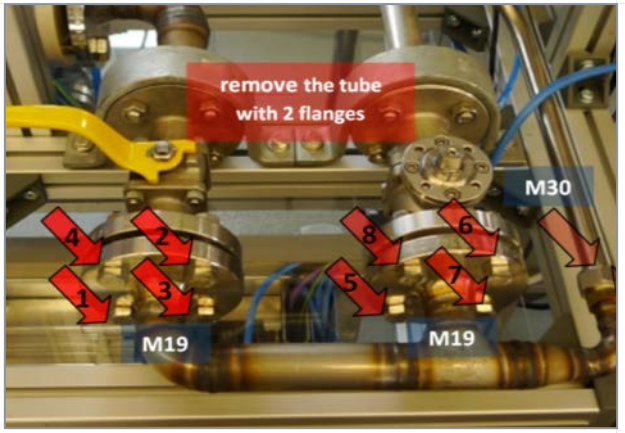
> Augmented operators have an virtually extended view on the production processes by using smart devices as for example iPhones, iPads or the Google Glass

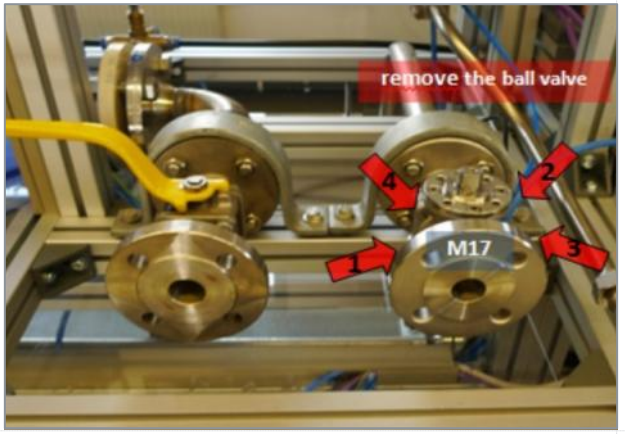
> In the manufacturer-independent research and demonstration plant Smart Factory in Kaiserslautern these devices are already partly in use for maintenance and service tasks

> A service provider for example automatically receives a message on his smart phone when a problem in one of the production systems occurs

> His tablet computer than guides him his way to the affected production system where his head mounted display shows him what he has to do in detail

> These so called augmented reality manuals can significantly simplify and accelerate maintenance, reparation or installation work on complex systems





Source: Smart Factory[KL]; Roland Berger

Bringing Industry 4.0 further – Bosch equipped Diesel injector parts with memories to make their production process smarter

Robert Bosch GmbH

social machines

Augmented operators

Smart products

Virtual production

Diesel injectors

> Production of diesel injectors only starts after an OEM anywhere in the world initiated an order

> A digital readable order card that travels with the part contains all information about technical requirements and the manufacturing sequence – the part itself now controls the production process

> Intelligent sensor systems permanently record the location of the part along the way – the part finds it's destination autonomously

> The client is always informed where his part is located and when the production will presumably be finished

> At the end of the production process an employee checks whether the product matches with the technological and quality requirements

Source: Robert Bosch GmbH; Roland Berger

Introducing machine tools to the cloud – With Baumüller the remote control of industrial facilities with smart devices comes true

Baumüller GmbH & Co. KG

social machines

Augmented operators

Smart products

Virtual production

Automation in the Cloud

> Baumüller introduced in 2013 an innovative automation solution called "Automation in the Cloud"

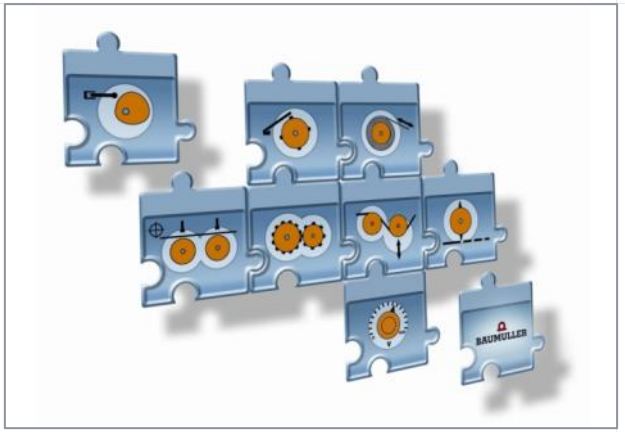
> This solution allows entire productions systems to be operated remotely using mobile devices such as smartphones or tablets

> So far the developers of the system focused on remote diagnosis and maintenance functions

> In this context the automation cloud is able to provide the possibility to diagnose and maintain the production systems from a distance

> Occurring problems will be recognized early and machine breakdowns can therefore be prohibited – this saves a lot of service and further downtime cost

> The modularization – not only in mechanical and electrical components, but also in software – allows Baumüller systems to offer machine builders substantially simplified ways of managing variants



Source: Baumüller GmbH & Co. KG; Roland Berger

Roland Berger