Industria 4.0 – Perché la nuova rivoluzione industriale è un'opportunità per le nostre aziende

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Milano, November 18th 2015

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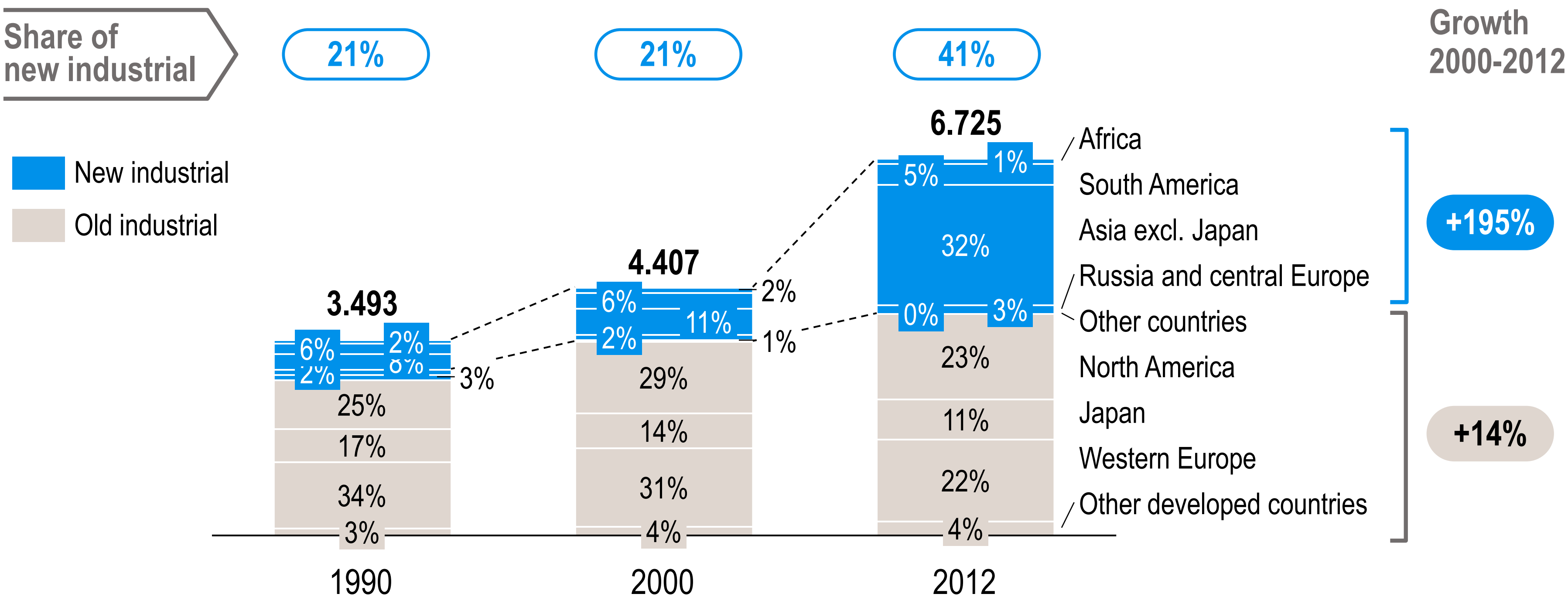
A. **The industrial downfall**: What has happened and how we can impact it

New industrial countries capture ≈40% of global industrial added-value

Global Manufacturing added value[1] [EUR bn]

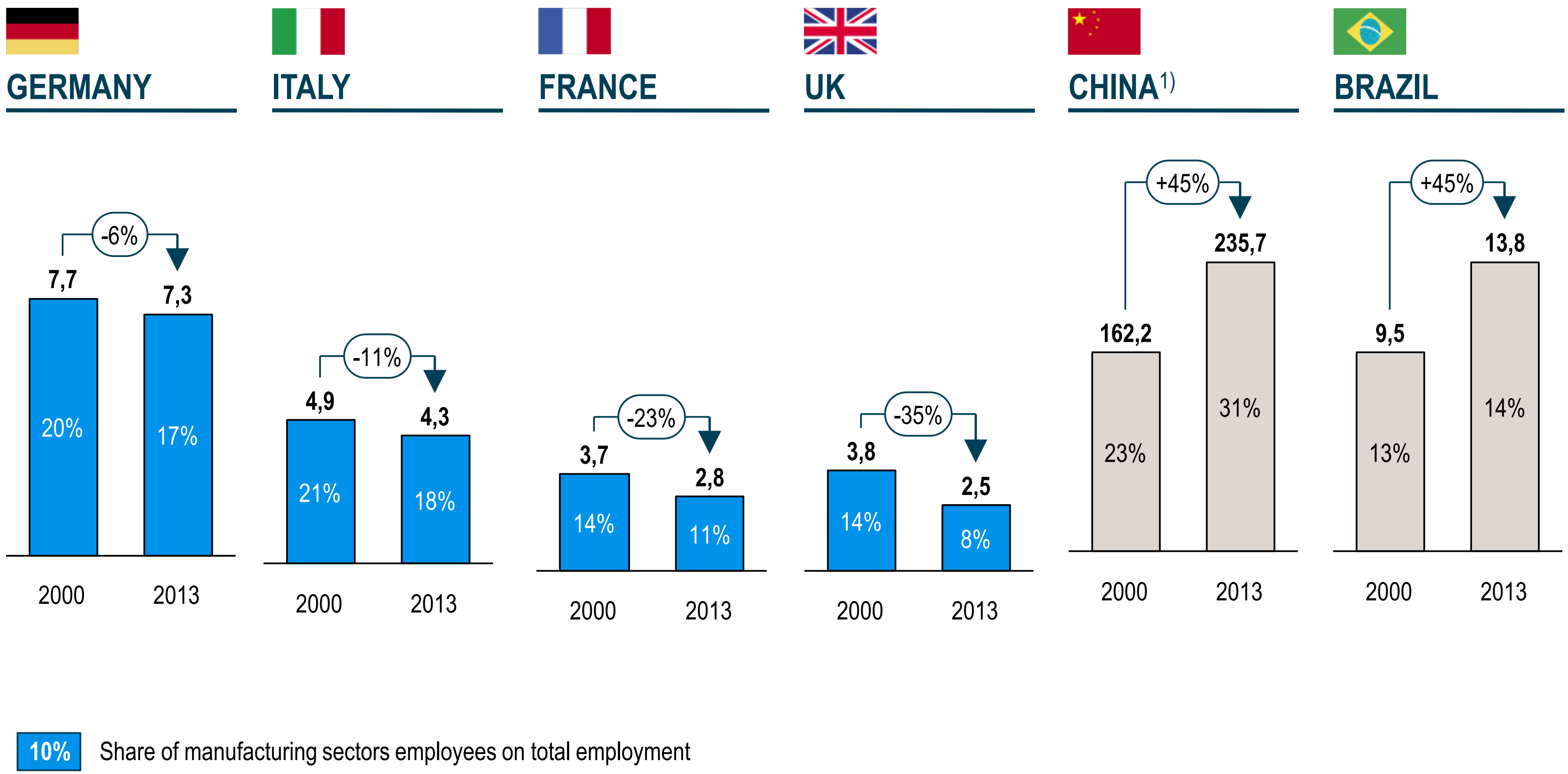


1) UNCTAD data in constant USD (2005 rate), converted in EUR (2005 exchange rate)

Source : UNCTAD, Oanda

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

Evolution of manufacturing employment rate [2000-2013 ; Mln of employees, %]

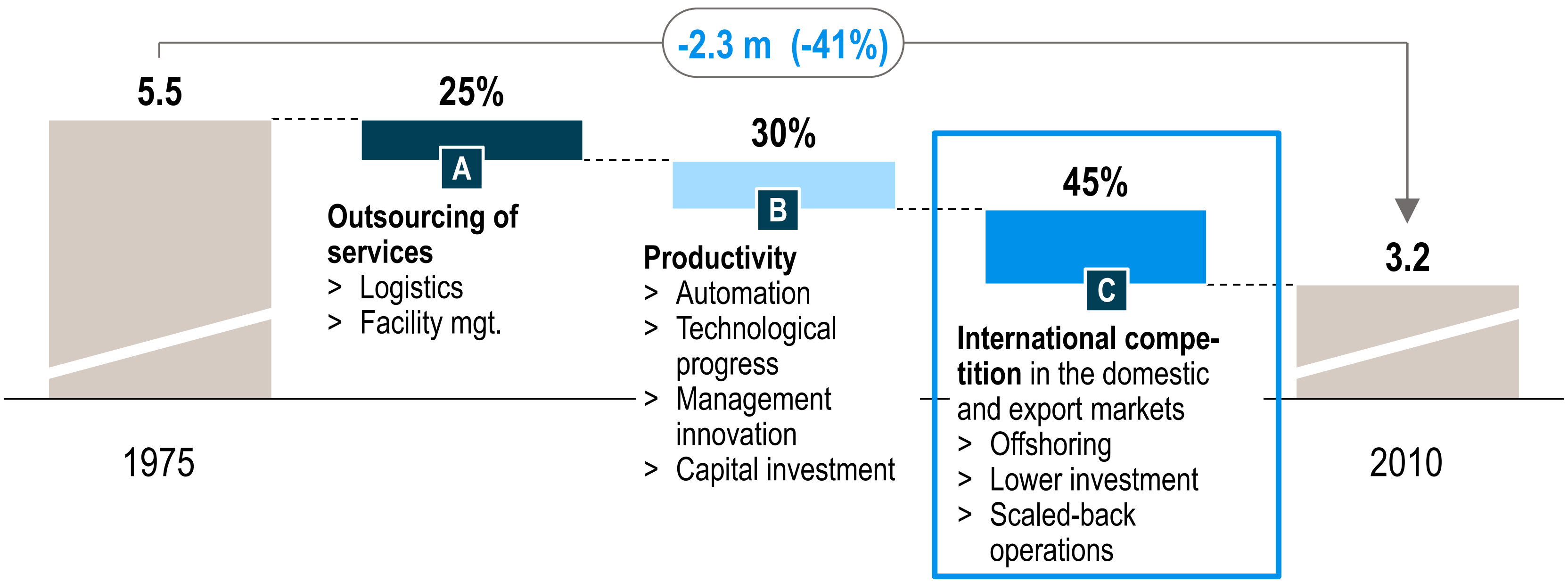


1) Including the construction sector

Source: Eurostat, Oxford Economic, National Bureau of Statistics China, Roland Berger Strategy Consultants analysis

Three main reasons for deindustrialization: service outsourcing, productivity gains and loss of competitiveness

Loss of industrial jobs[1]: Example France [1975-2010; million jobs]



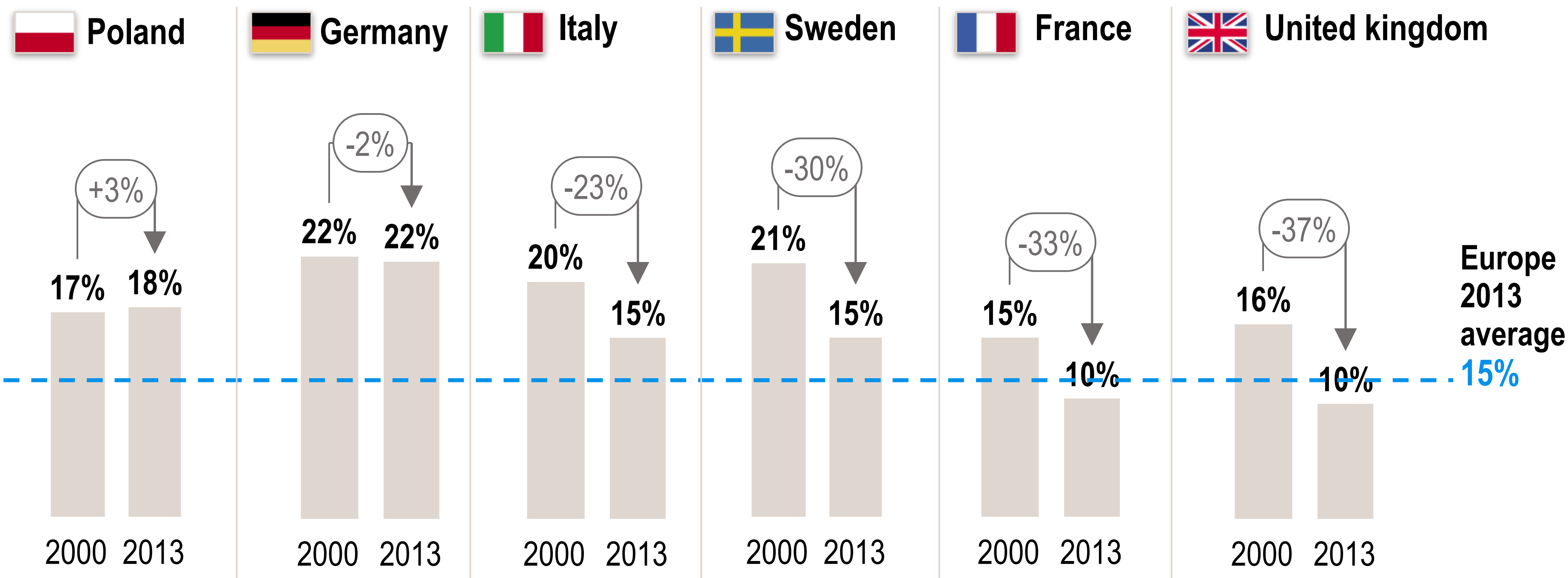
> **Outsourcing – not offshoring – services and increased productivity lead to growth, employment and wealth**
>
> **Therefore loss of competitiveness can/must be addressed at national and EU level**

1) Salaried and non-salaried jobs

Source: French Treasury report on deindustrialization in France; INSEE; Roland Berger analysis

Nevertheless, European countries maintain a high level of industrial added value – France and UK strongly decrease

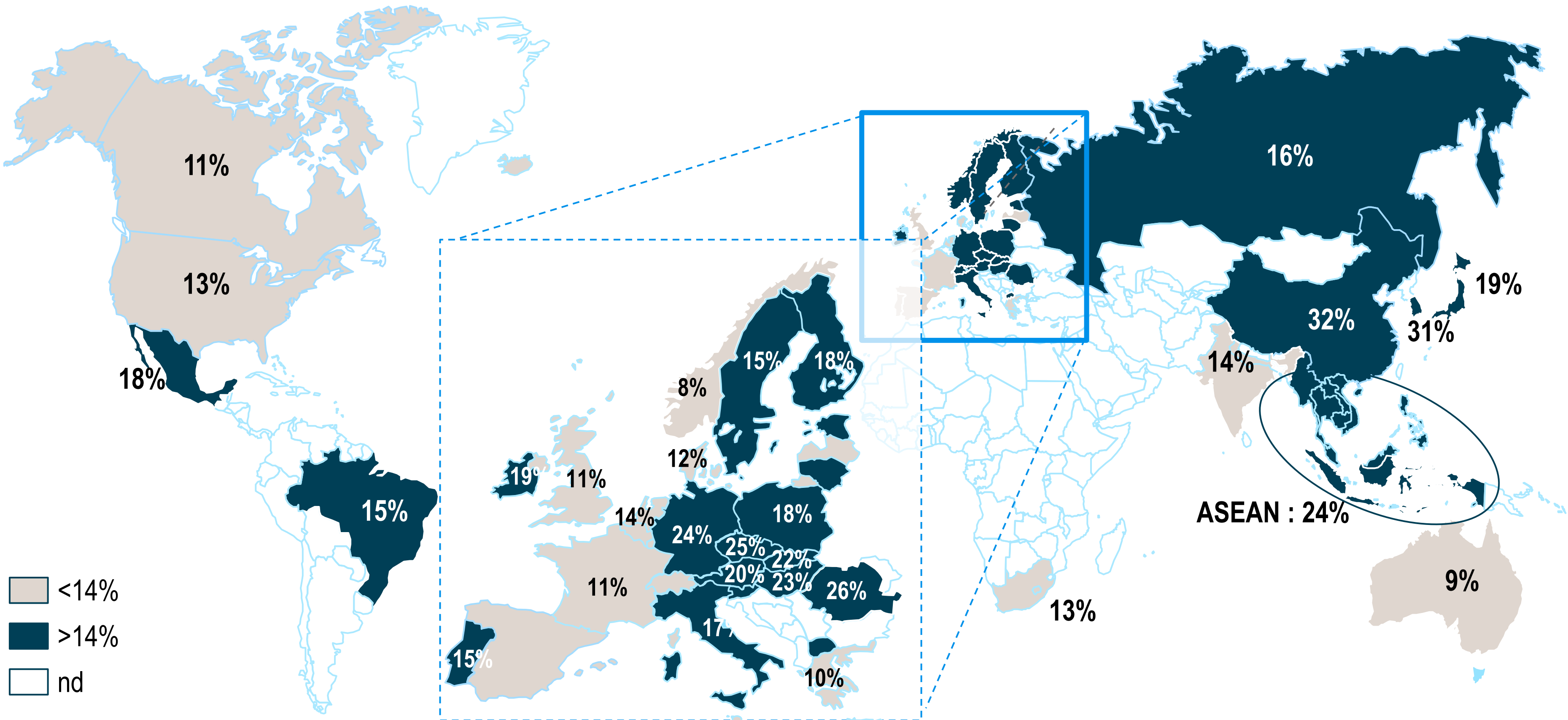
Industrial share in added value in selected countries [2001-2011]



Source: Eurostat

Europe becomes split in strong and weak industrial countries

Industrial[1)] share in added value [2011; Industrial added value/ Total added value]



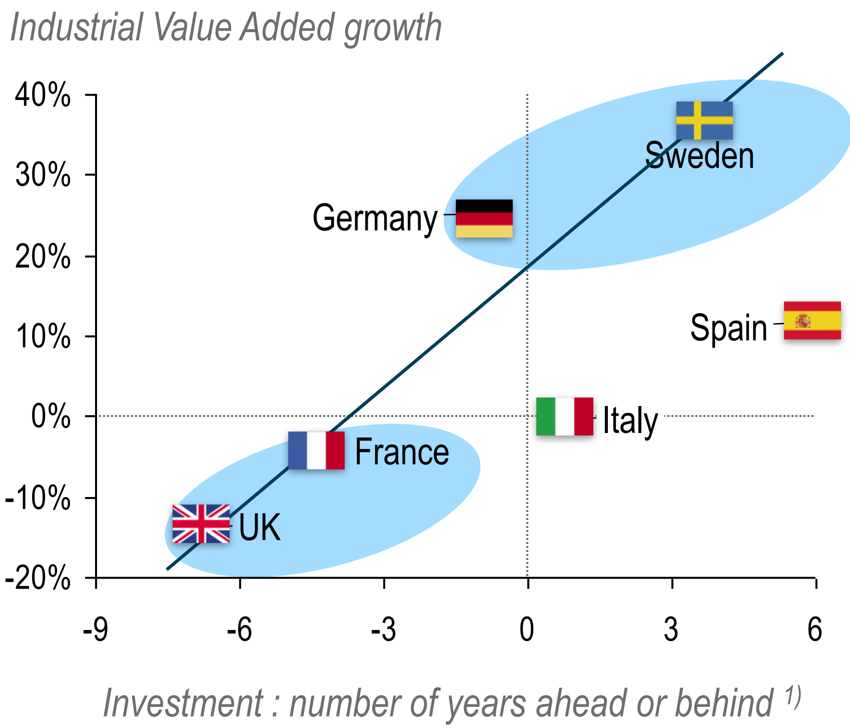
1) Excluding electricity, mining and quarrying

Source: Eurostat, UNCTAD

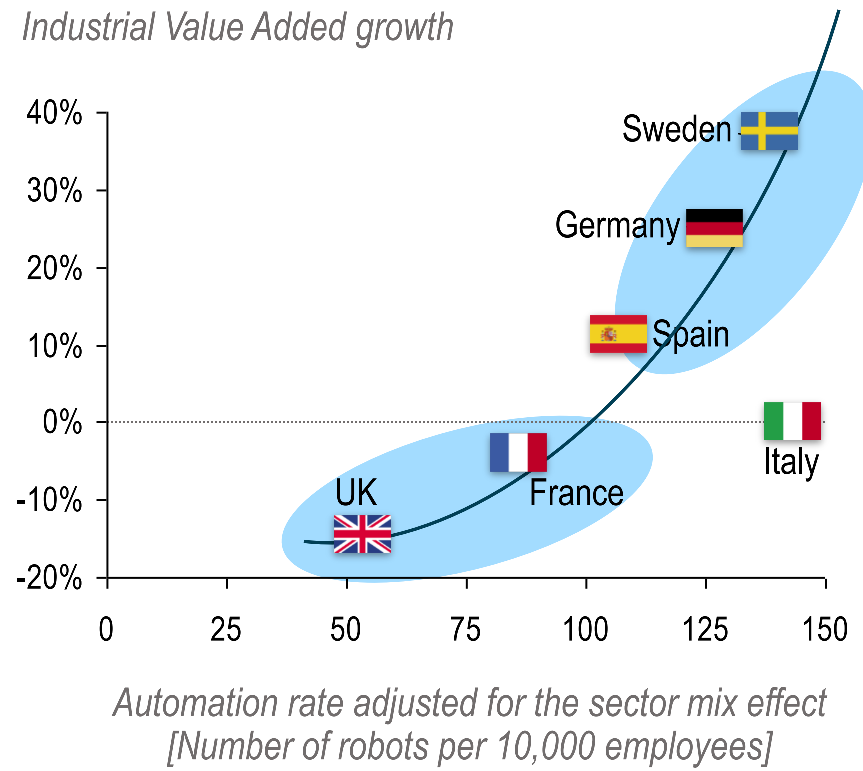
Industrial value-added growth is directly correlated to the machine park quality

Correlation analysis between the industry weight and industrial equipment modernity

Industrial Value Added growth and investments
[2002-2012]



Industrial Value Added growth and automation rate
[2002-2012]



NB : Perimeter : Mining industry, Manufacturing industry and Utilities
1) ∑ (CapEx – Depreciation)/Years of average CapEx

Source : IHS Global Insight, Eurostat, IFR, Roland Berger analysis

Initiatives have raised in main manufacturing countries across the world – however, project status and budget varies across countries

Initiatives for Industry 4.0 in the world

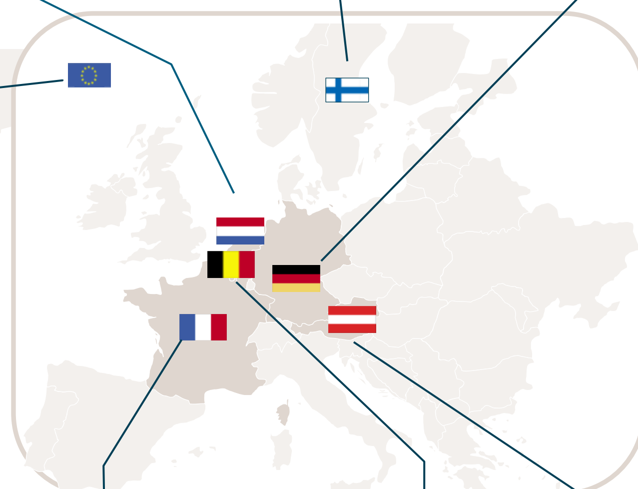
smart industry
> **Status**: Implementation kick-off
> **Budget**: tbd

Tekes
> **Status**: Implemented
> **Budget**: EUR 150 m to manufacturing

Plattform INDUSTRIE 4.0
> **Status**: Implementation
> **Budget**: EUR 600 m [2)]

EFFRA – European Factories of the Future Research Association
> **Status**: Strategy determination
> **Budget**: EUR 600 m[1)]

Industry 4.0 partnership with Germany



industrial internet CONSORTIUM
> **Status**: Implementation
> **Budget**: Part of **national network for manufacturing innovation** (NNMI), EUR 700 m

les usines du futur
> **Status**: Strategy determination
> **Budget**: tbd (kick-off 2015)

MADE DIFFERENT – FACTORIES OF THE FUTURE
> **Status**: Awareness creation
> **Budget**: EUR 15 m [3)]

aws ProTrans Industrie 4.0
> **Status**: Implementation
> **Budget**: Part of EUR 250 m Industry 4.0 development plan

1) To be matched by the private sector; 2) EUR 200 m to cyber security , EUR 200 m to Industry 4.0 and EUR 200 m to smart services; 3) Annual public subsidies, expected to increase to EUR 25

Source: Roland Berger

These pilot projects are largely funded by governmental support and financing programs

Support and financing programs for advanced industry in Europe

Support and financing programs

#	Name	Supporting institution	Support volume	Content/ Goal	Project partners
1	Zukunftsprojekt Industry 4.0	BMBF[1)]	Up to EUR 200 m	Support Germany industry to be prepare and ready for future challenges	165 partners from the industry and economy
2	Autonomik für Industry 4.0	BMWi[2)]	Up to EUR 40-50 m	With the technology program Autonomic modern technologies are to be connected with industrial production using innovation potentials	91 providers from the industry, research and universities
3	Industry 4.0 – Forschung auf den betriebl. Hallenböden	BMBF[1)]	n.a.	Intelligent interconnection in the production by making use of modern cyber – physical production systems (CPPS)	Currently in phase of application
4	SPARC Robotics	EU Commission	EUR 700 m	Support from EU to the robotics industry and value chain, from research through to production	>180 members from industry & research
5	ICT Innovation for Manufacturing SMEs	EU Commission	EUR 145 m	Support from EU in adoption of next generation ICT advances in the manufacturing domain	Phase of application
6	Future Internet Technologies	EU Commission	EUR 300 m	Support from EU for topics related to future internet usage and different experimental projects	125 members - new in each phase
7	Horizon 2020	EU Commission	EUR 13,500[4)]	Support from EU for various projects, i.e. Intelligent Manufacturing, action plans steel industry or clean production	Currently in phase of application

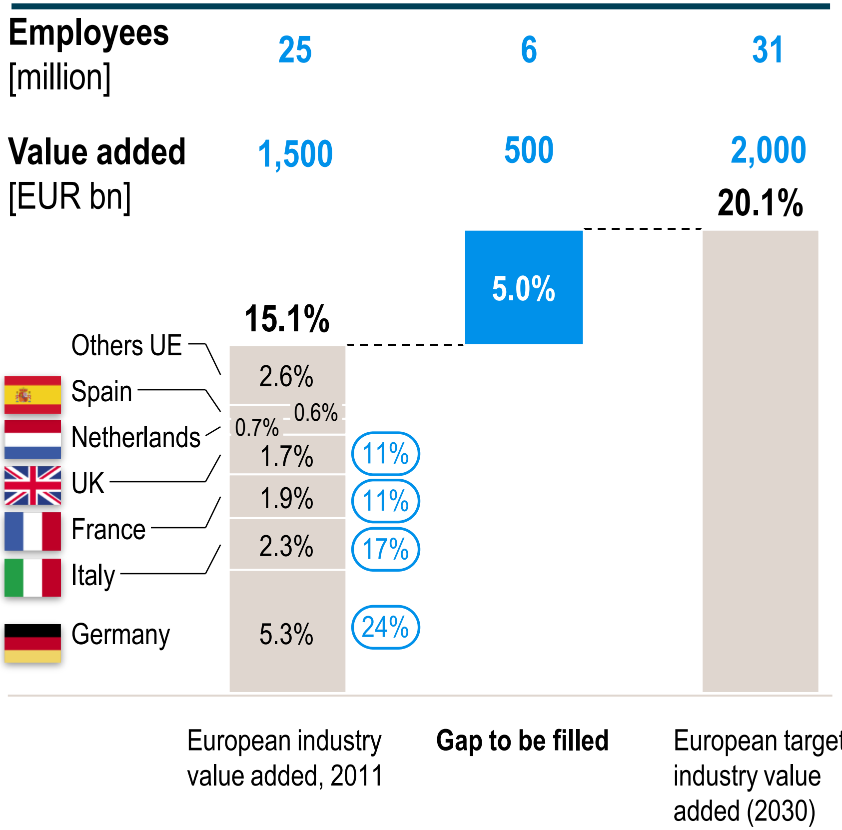
1) Bundesministerium für Bildung und Forschung 2) Bundesministeriums für Wirtschaft und Energie 3) Information- and Communication-Technology 4) Industry part only

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

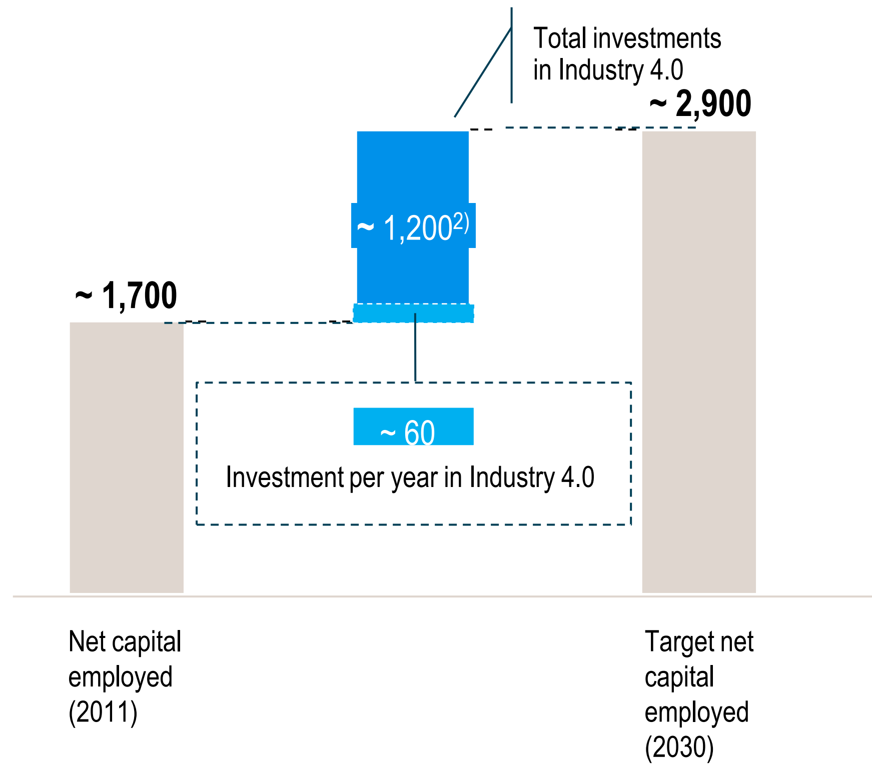
Industry weight in Europe[1)]

[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 2) Return On Capital Employed, Long-term hypothesis

Source: analyse Roland Berger

B. **Industry 4.0:** The emergence has started and we are at the beginning

Mechanization, electrification and computerization influenced our working world radically –Industry 4.0 is the next step

Development stages of industrial manufacturing

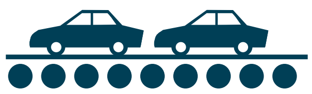
First industrial revolution

1784

Mechanical weaving loom

Introduction of mechanical production assets based on water and steam power

Second industrial revolution

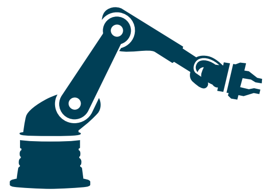


1923

Introduction of a "moving" assembly line at Ford Motors

Introduction of mass production based on division of labor and electrical energy

Third industrial revolution

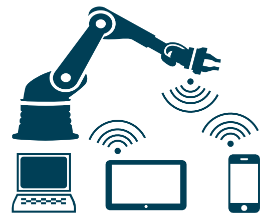


1969

First program-mable logic controller (PLC)

Introduction of electronics and IT for higher auto-matization of production

Fourth industrial revolution?



2014

Real time, self optimizing connected systems

So far < 10% advanced

Time

Impact of each Revolution

> Introduction of **new products** and **means of producing existing ones**

> **Disruption of the competitive status quo** (both within and between countries and enterprises)

> **New requirements** to **workforce** and **infrastructure**

Source: Bitkom/Fraunhofer, DFKI, Roland Berger

Despite different definitions for "Industrie 4.0" there are various aspects which have developed into common understanding

Key aspects around Industry 4.0

What?

> **Real and virtual world** growing together (humans, machines, technologies, Internet)

Who?

> **Providers of infrastructure:** provide supporting structures and services, e.g. cloud computing or storage for Big Data (e.g. TelCos, Cisco, Amazon)
> **Industrial users**: Globally operating manufacturers such as VW or BASF.
> **Providers of technologies:** provide key technologies for production such as collaborating robots or remote maintenance systems

How?

> Via intelligent, horizontal and vertical **linking-up**

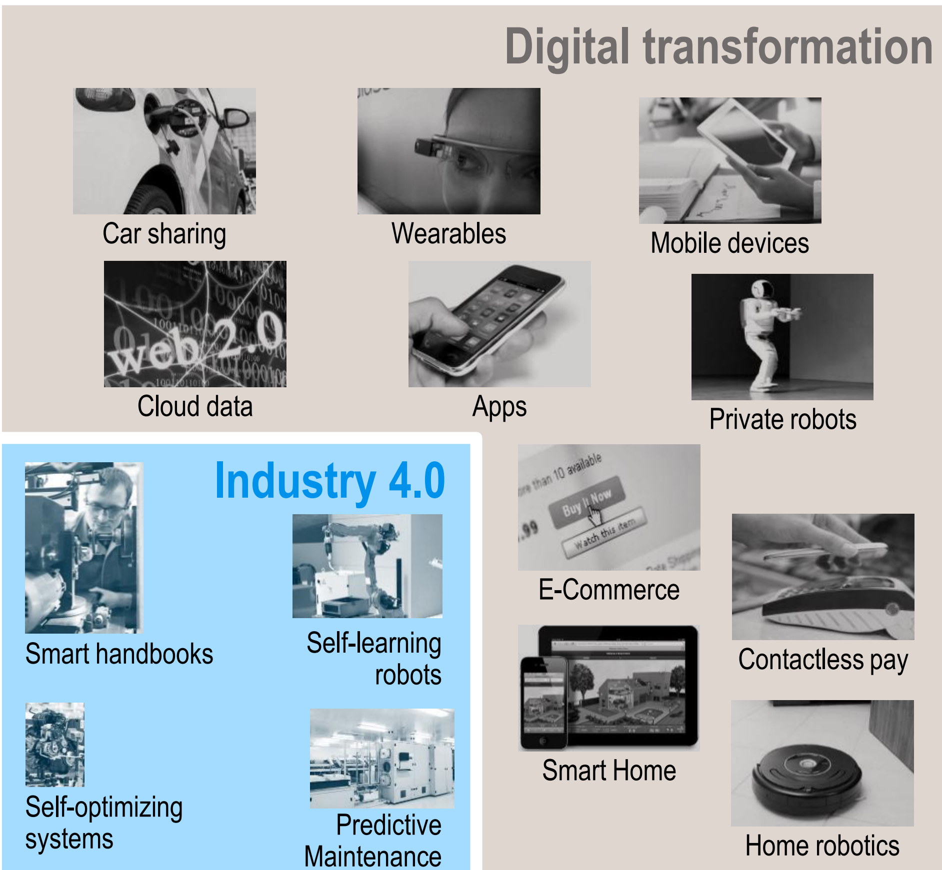
Why?

> Individualized or **mass customized products**
> Highly **flexible production**
> **Integration** of customers and value adding partner **into value creation**
> Coupling of **production and high-value services**
> **Cost** and **efficiency** benefits and **quality** improvements

Source: Bitkom, Fraunhofer

Industry 4.0 can be understood as the full integration and digitalization of the industrial value creation

Definition of Industry 4.0 (not exhaustive)



> **Digital transformation** refers to the changes associated with the application of digital technologies in all aspects of human society

> Industry 4.0 is the **industrial application** of the concepts applied in the **digital transformation, key elements are:**
- Complete connectivity with real-time ability
- Decentralized, intelligent and self optimizing / organizing
- Modular and reconfigurable

> Assessment of **Industry 4.0 impact** needs to take **analogies** from **digital transformation** and specifics of the manufacturing industry into account

> The digital transformation in the **consumer goods sector is much more advanced** than the industrial application

Source: Plattform Industry 4.0, MIT Sloan Management Review, Roland Berger

Digital transformation: four Critical Insights…

- **1st Insight:** The only constant is change & the rate of change is increasing
- **2nd Insight:** You either disrupt your own company/products, or someone else will. Standing still = death
- **3rd Insight:** Your competition is no-longer the multinational overseas. It is the explosion of exponentially empowered entrepreneurs
- **4th Insight:** Technology is transforming "Scarcity – Abundance"

Source: Peter Diamandis – Singularity University

Technology is transforming "Scarcity – Abundance": $5 a carat - flawless diamonds made in a lab

"Technology can take that which was scarce, and makes it Abundant.."

… So what else do we consider scarce?

… What is scarce in your business?

Source: Peter Diamandis – Singularity University

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

Industry 4.0 roadmap

USE CASES FOCUS

Pilot solutions

Today

Solutions barely existing as products in the market – Mainly **showcases** or laboratory solutions in development

Pilot full plant / Precursor

~2020

Mid-term Industry 4.0 use cases are driven **mainly by technology;** Pilot solutions in the scale of full plant will be developed

Broad adoption of standard solutions

2025

The penetration of the market with isolated solutions will lead to an **interconnection of many solutions** via existing connectivity channels – A gradual replacement of most machinery will begin

Transition to "True Industry 4.0"

2030+

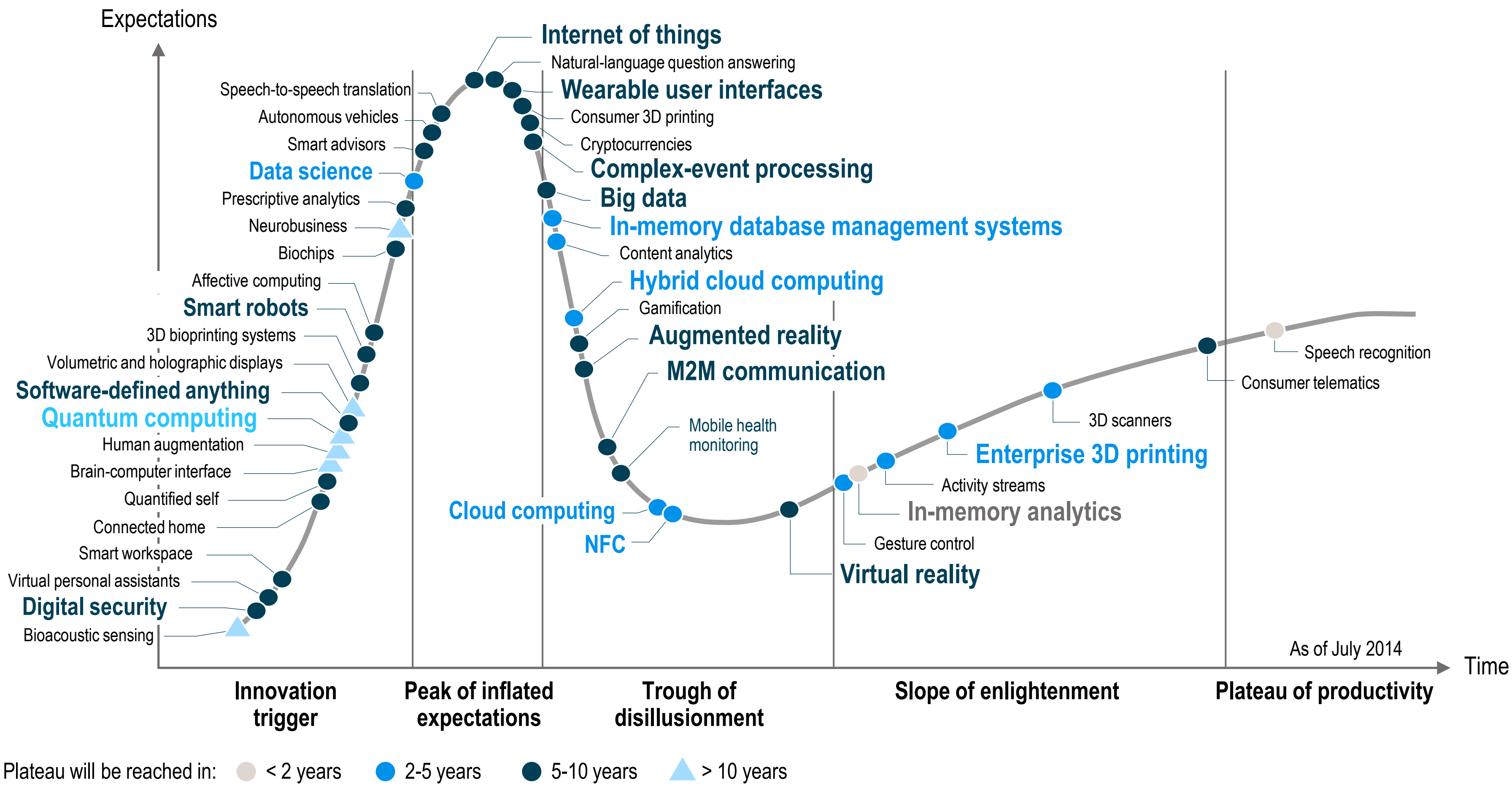
Along the lifecycle of most production machinery the transition to true Industry 4.0 will start to be more comprehensive once most **machinery and employees are Industry 4.0 ready** and the connectivity infrastructure has been adapted to the new needs and standards

Source: Roland Berger

The various technologies which make up Industry 4.0 are expected to reach the plateau of productivity at different points in time

Gartner Hype Cycle for Emerging Technologies 2014

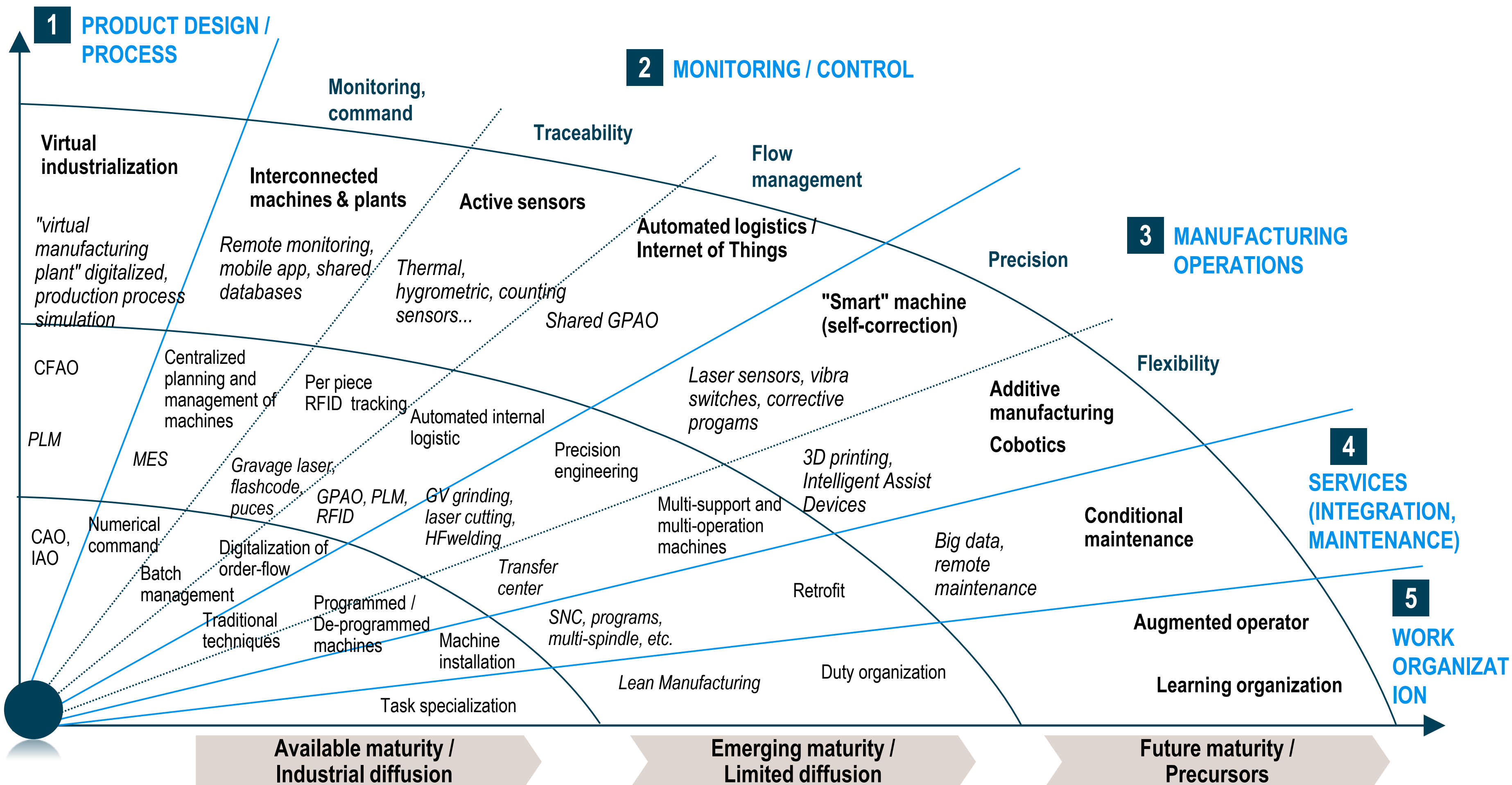
ILLUSTRATION



Source: Gartner (July 2014)

Industry 4.0 combines a wide set of technologies with different maturity

Example of technology mapping – Extract



Source : Roland Berger

C. **Industry 4.0**: What is at stake and what will that change for all parties

Industry 4.0 will have fundamental impacts on traditional ways of doing

Impacts of Industry 4.0

1	**Flexibility / Mass customization**	> Ability to reduce changeover time – seamless production change > Dynamic product schedules allowing to adapt real-time to customer needs
2	**Direct client relationship**	> Closer relationship between producer and customers > Disintermediation and change of business rules
3	**De-laborization**	> Reduced share of labor cost – Reduced dependency to LCC
4	**Asset rotation**	> Increase machine open time & utilization, reduce breakdown time thanks to conditional maintenance > Reduce stocks along the value chain
5	**Decentralization / Regionalization**	> Reduce impact of size / scale effect – Ability to decentralize processes > Possibility to relocate production process close to customer needs
6	**Fast-product launch**	> New product industrialization is performed seamlessly and without disruption > People are guided through virtual tools to adopt new products
7	**Shift of skillset**	> Less working forces in daily operations thanks to automated robotics > Maintain of needs for medium-qualified workers due to simplified Human-Machine Interface

Source: Roland Berger

Industry 4.0 is potentially changing the paradigm

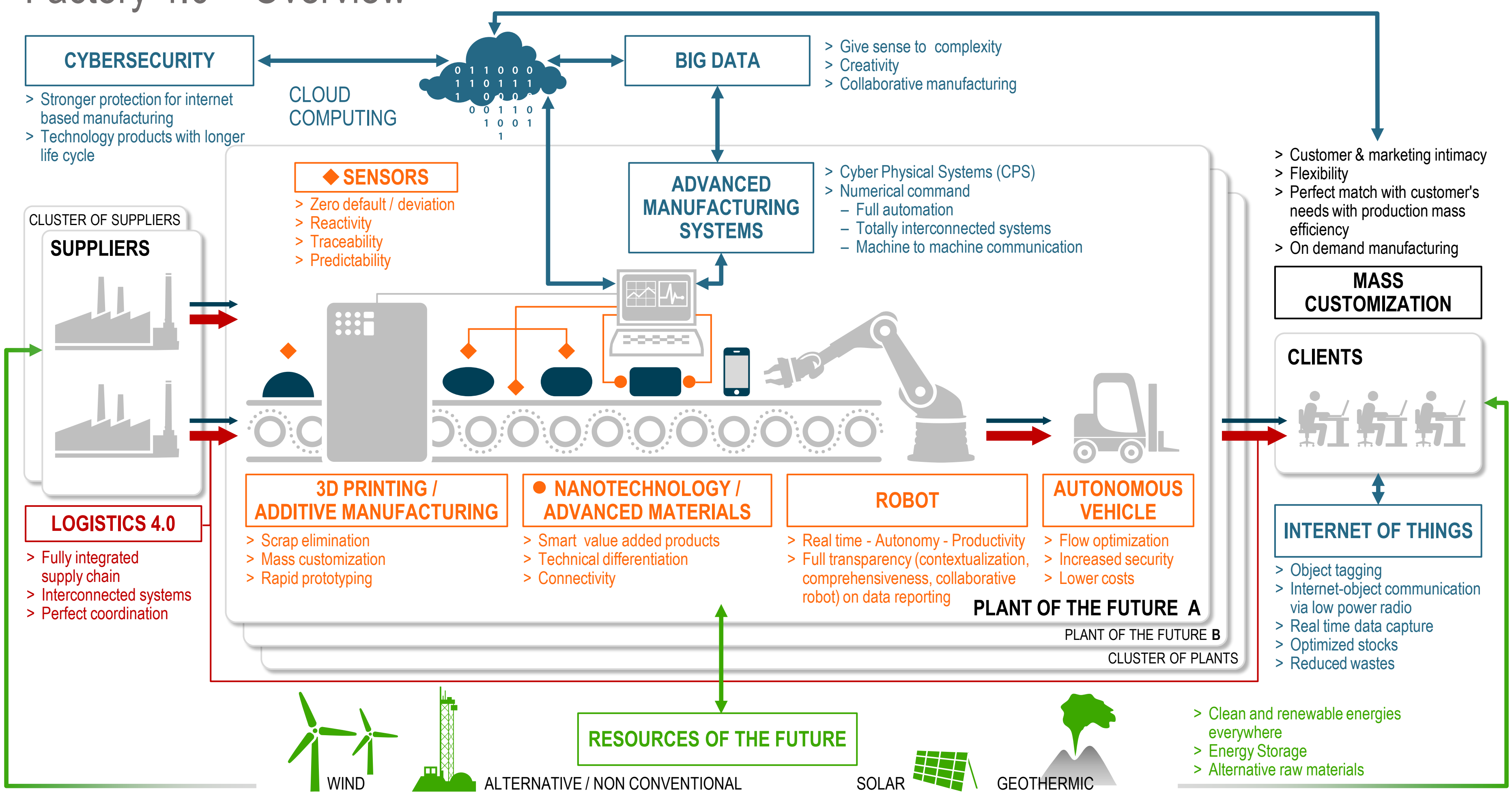
Characteristics of new Industry 4.0

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

The future "Factory 4.0"

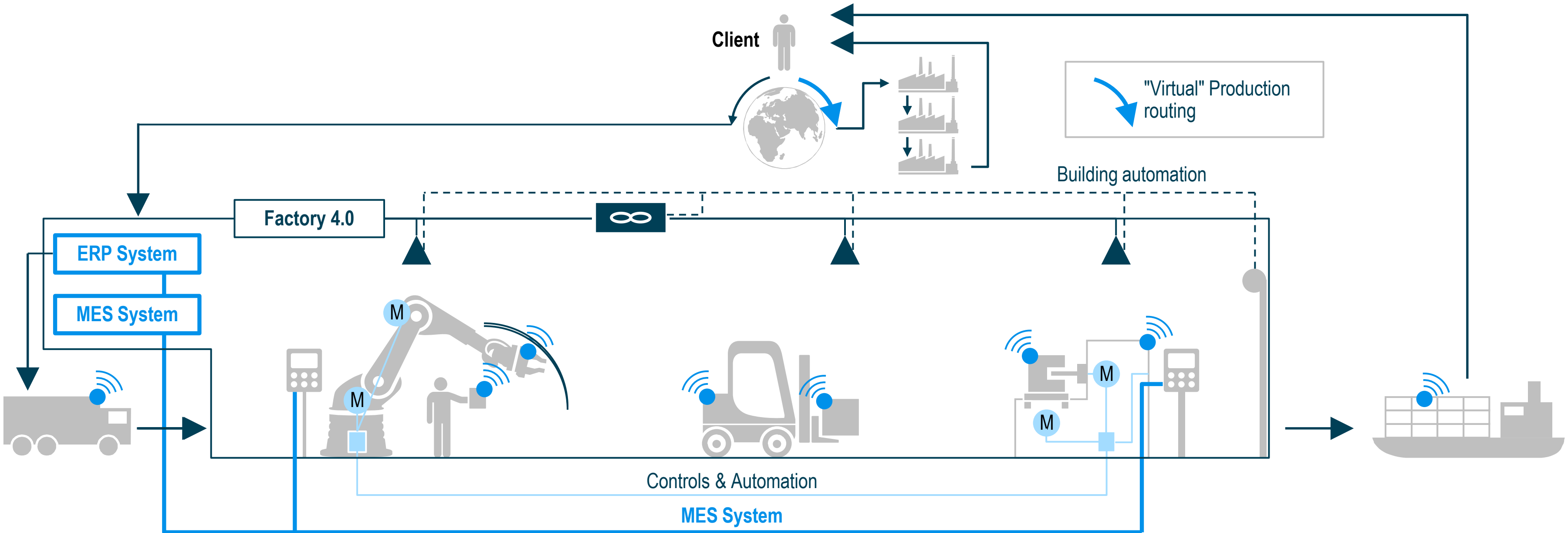
Factory 4.0 – Overview



Source : Roland Berger

Data and communication will be the backbone of Industrie 4.0 – Some players with already wide offering and new players entering

Positioning of different players for Industry 4.0 – Factory view



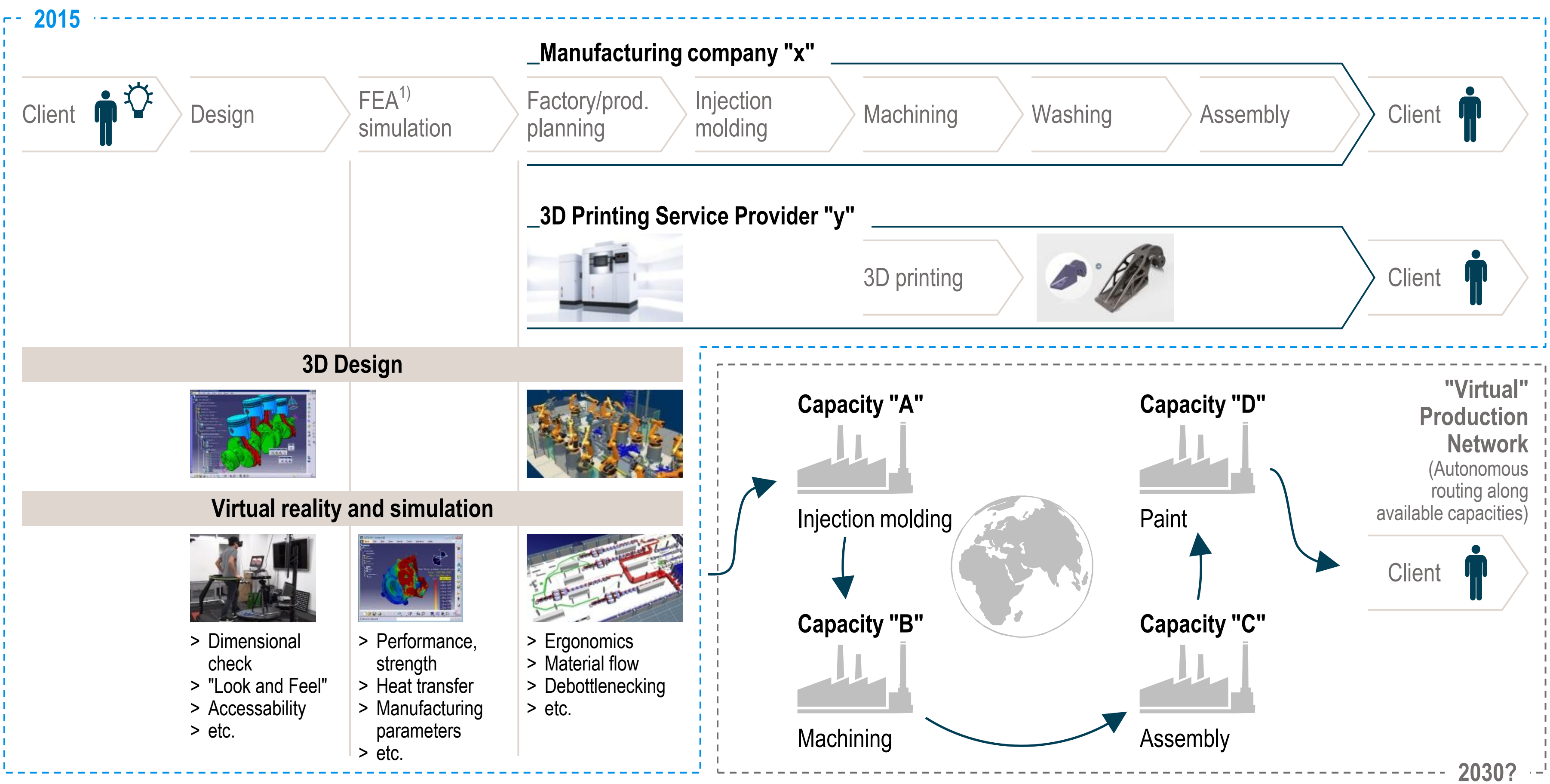
	ERP System	MES System	Sensors/Automation	Building Automation	3D Data	New players: Big Data Services
Data/ Funct.[1]	> All transaction data > Asset data > Price/cost data	> Shopfloor transaction data > Machine data > Maintenance data > Logistic data	> Sensor status like pressure, position etc., communication with other sensors > Machine control data	> Status of all building data, e.g. temp., light, access control, ventilation	> Product 3D data > Factory 3D data > PLM data	> Storage capacity > Algorithms and analytics > Connectivity
Players[1]	ORACLE, SAP	SIEMENS, APRiSO, mpdv	SIEMENS, Rockwell Automation, BOSCH, FANUC	SIEMENS, BOSCH, Honeywell	SIEMENS, Dassault Systèmes, PTC	IBM, Google, T

1) Not exhaustive; examples only

Source: Roland Berger

Virtual design verification, test/simulation, factory planning and "virtual" prod. networks will create new business models and SC

Virtual reality(ies) as support for design and production



1) Finite Element Analysis

Source: Dassault, Siemens, EOS, Roland Berger, NASA/Oculus Rift

Industry 4.0 can create significant added-value for the European industry

Estimated potential [Germany, selected industries, EUR bn, Δ value add 2025 vs. 2013]

	Levers [examples]	**Value-added potential** [Eur Bn]
Mechanical Engineering	> More innovation through network-like usage of operating-, status- & environment-data of installed base	23.0 +30% of segment value add
Automotive	> Versatile products due to flexible automation > Higher efficiency through integration of real-time data at R&D – Production interface	14.8 +20% of segment value add
ICT[1]	> Enhanced product offering to offer solutions for easy-to-use & flexible real-time production-planning and -monitoring	14.1 +15% of segment value add
Electrical Engineering	> Increased configurability of world wide production processes through real-time data transfers	12.1 +30% of segment value add
Chemicals	> Improved productivity through real-team usage of operating-, status- & environment-data in process monitoring	12.0 +30% of segment value add
Agriculture	> More flexible and real-time production planning due to ad-hoc connectivity of agricultural machinery	2.8 +15% of segment value add
		= 78.8

Comments

> Automotive industry is face to next challenges:
  - **High CAPEX** investment
  - More and more **mass customization** & more complex **supply chain**
  - More **global network**

> By leveraging on advanced technologies, Industry 4.0 can:
  - **Improve** machine utilization and **ROCE**
  - Digitalize supply chain and make it **more flexible**
  - Introduce dynamic production planning and **improve manufacturing efficiency**

1) Information and Communication Technology 2) Return of capital employed

Source: BITKOM, Roland Berger

Disruptive trends are converging significantly reshaping the Automotive lanscape

Key drivers

Major disruptions

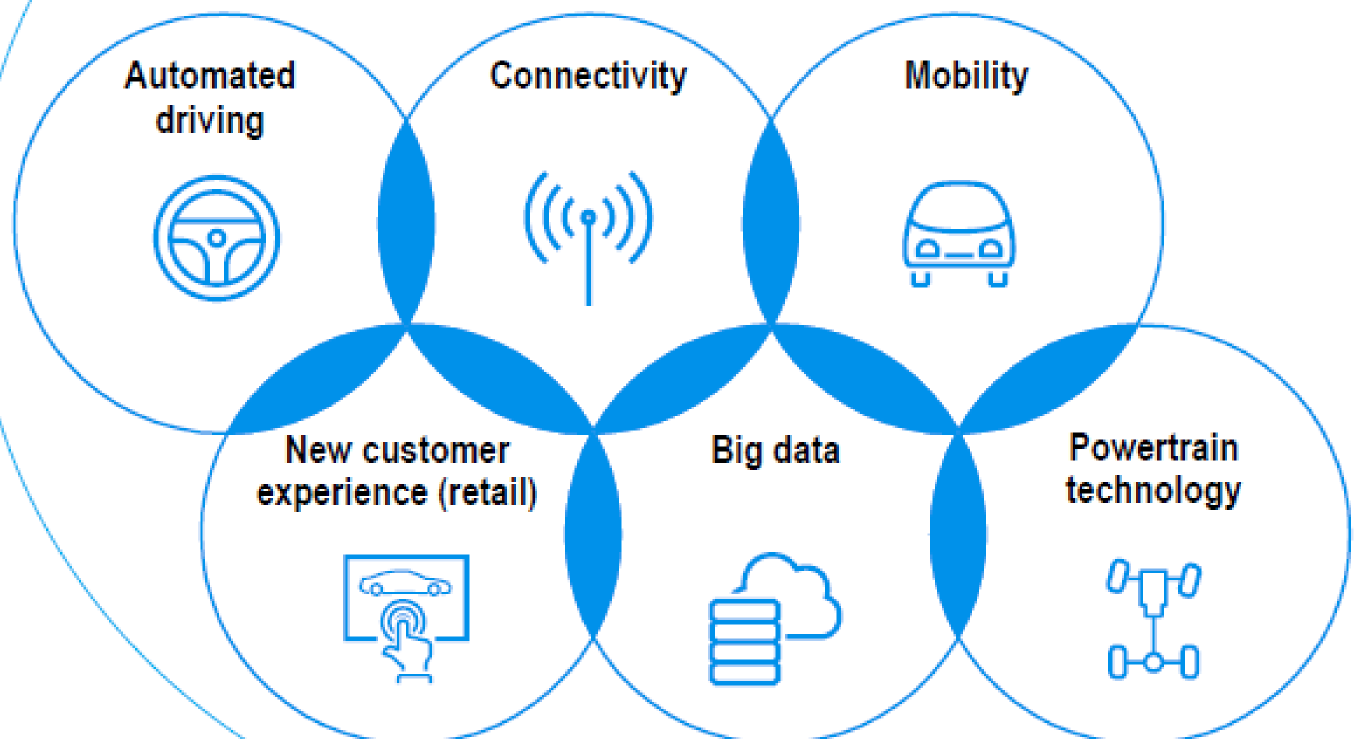
> Re-prioritizing of **customer expectations** & buying criteria

> New and open **eco-system**

> Innovation in **business models**

> Change in **value centers**

> Fast **development cycles**



OEMs and suppliers with different need for action for future value generation

Share of own value-add at OEMs (as % of total manufacturing costs) – Selection

OEM	Share of own value-add
BMW	25-30%
Mercedes-Benz	25-30%
Jaguar / Land Rover	17%
Porsche	15%

Key trends

> **Decreasing value creation** for OEMs driven by:
- – increasing system competences of Tier-1
- – cost pressure from material cost increase
- – higher possible return for OEM shareholders by focusing on design/assembly

Need for action for

Value generation from…	OEMs	Suppliers: Product Innovators[1]	Suppliers: Proceess specialists[2]
Increase of customer value	↑	↑	→
Business model enhancement	↗	↗	↗
Productivity increase	→	↗	↑

1) Business model based on innovative products with differentiation potential 2) Business model based on process expertise (while product differentiation potential is limited)

Source: Company information; Roland Berger

Automotive companies put huge hopes to Industry 4.0

Why do automotive companies plan use Industry 4.0?

Shorten development cycles	> Connectivity leading to improved interfaces with suppliers > The resulting time gain is a true competitive advantage	BMW
Attractive products and efficient processes	> Via networked systems located inside and outside company premises, enabled by horizontal and vertical integration	DAIMLER
Mass customization	> Respond flexibly to meet individual customization needs and shortening production time through interconnection between devices, corporate IT systems, and people.	HARLEY-DAVIDSON
Unique selling position through classic & digitization	> Trying to combine classic themes such as design with new aspects such as digitization	OPEL
Optimized value chains	> Dual approach: Sell Industry 4.0 solutions and use them in practical by itself to reduce complexity in the overall value chain	BOSCH
Productivity gains	> Goal: 10% improved efficiency for 2018 by using a digital factory concept, up-to-date 'tools', motivation and teamwork	VW

Source: Roland Berger COO Insights, Company Websites, Deutsche Bank,, Germany Trade & Invest , ABC Advisory group

Automotive sector will be at the forefront of Industry 4.0 – all players are launching initiatives or even pilot projects

Overview of selected current automotive Industry 4.0 projects

Focus on production [initiatives]

Company	Partners	Industry 4.0 Projects
BMW	Universal Robots; MIT Massachusetts Institute of Technology	"Collaborative Robotics"; A new generation of safer, more user-friendly robots works more closely alongside humans as a team in assembly line as a team
	TUM Technische Universität München	"3D Printed Thumb"; 3D printing customized thumb that can bring reinforcement for factory workers and to help them to work safely and efficiently with minimum strain on their hands.
	Fraunhofer IML	"Gesture-based quality assurance"; Gesture-based quality assurance"; to improve quality assurance process for painted bumpers by gesture interaction
Opel	DMG Mori; Hohenstein Werkstückspannung; KIT; Fraunhofer IML; SOFI	"IWEPRO"; Modular/job-shop production with de-central intelligence
Continental	Contact Software; TU; Siemens; Universität Kaiserslautern; Schaeffler	"mecPro2"; Model-based new development process for cyber physical systems
Bosch	Fraunhofer IML; GEMAC; FORCAM	"smARPro"; Smart assistance for humans in production systems
BorgWarner	Fraunhofer IML; SAP; Flughafen Stuttgart; Universität Stuttgart	"KapaflexCy"; Self-organizing capacity flexibility in human-cyber-physical system
o/e	Universität Potsdam; mpdv; OHST Medizintechnik AG	"LUPO"; Performance assessment of autonomous production objects

Focus on production planning / logistics / engineering [pilot stage]

Company	Partners	Industry 4.0 Projects
Volkswagen (Production planning)	TUM Technische Universität München; ART Advanced Realtime Tracking; KIT; Daimler	"Applied reference architecture for virtual services and programs"
	Festo; Ruhr-Universität Bochum RUB; GROB; Vorwerk	"Synchronous production through partly autonomous planning and human-centric decision support"
	Universal Robots	"Collaborative Robotics"; A new generation of safer, more user-friendly robots works more closely alongside humans as a team in assembly line as a team
	Siemens	"Condition monitoring"; Optimized up-time of Schuler presses in the key plant in Wolfsburg
Daimler (Logistics and production)	Siemens; Opel; KIT; BMW; BLG Logistics	"RFID-based parts tracking"; Optimizing logistics processes based on RFID technologies for the automotive industry
	IBM	"Optimization of cylinder head manufacturing"; With the help of data mining technologies and real-time analytics capabilities
Hella (Customer value through eng.)	Fraunhofer IPT	"Intelligent headlamp technology"; Actuator-based systems for self-aligning intelligent headlamp to improve road safety, incl. new production concepts
Benteler	Universität Paderborn	"Intelligent heat transfer for efficient electric vehicles"; to develop a self-regulating thermal management system for electric vehicles

Source: Company websites, Roland Berger

D. **Implications**: How to approach Industry 4.0 challenge?

Five key questions need to be addressed to unleash the full potential of Industry 4.0 opportunities

Key questions to address to capture 4.0 benefits

What value for the customer ?	> What **key performance** can bring value to the customer ? > In which aspect Industry 4.0 can help to **create a rupture** ? > What **value proposition** could be a differentiator for the customers ?
What are the opportunities ?	> What are the **key improvement levers** to increase performance ? > What **Industry 4.0 opportunity brings** to enable those levers ? > What would be the **expected economical benefits** ?
Which technical short & mid-term solutions ?	> What technical solution can match the needs ? What short term actions could be undertaken ? What is the maturity ? With which partners ? > Which **time horizon** for implementing each of them?
What is the impact on organization, processes and competencies ?	> What practice / processes have to change / be modified ? > What is the impact on current skills base ? What impact on the workforce ? > How quick this transformation can happen ?
Which roadmap and governance	> Which projects to launch to complete the gaps? How to **reposition** some **current initiatives** ? (e.g. IT-oriented projects, Capex projects, etc..) > **Which governance to steer this initiative ?** At which **level of organization**?

Source : Roland Berger

We have structured a 4-step approach to frame Industry 4.0 vision and priorities and deliver a tailor-made roadmap

1. What objective(s) for your company ?

1 Priority Objectives

2. Which opportunities for your company?

2 Customer needs / differentiation

3 Internal performance diagnosis

4 Disruptive new technological solutions

Opportunity identification

3. Which potential for your company ?

5 Prioritization of levers

Quantification of full potential (financial, skills …) & impacts

6 Mapping of building blocks (regulations, technology, cyber security, standards, …)

4. Which way to excellence ?

7 Implementation roadmap and program governance

Key deliverables

1.
> Validated list of priority objectives to cover through the program

2.
> Internal diagnosis of company current 4.0 performance
> Review of current initiatives
> Defined target for the company
> Gap analyses to target

3.
> List of operational prioritized improvement levers
> Financial target impact on CAPEX, WCR, Gross margin
> Detail of impacts on job and skills (resource shift, new skills to capture)

4.
> Operational roadmap including main milestones
> Adjusted budget including program financial impacts
> Program governance set up

In order to prioritize Industry 4.0 levers, we used a proven RB framework which consist basically in a selection of levers based on several logical filters

Conceptual framework for Industry 4.0 lever selection and prioritization

Enablers

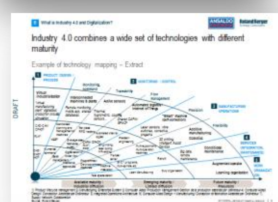
Connectivity

Cloud Computing / Digital data

Digital devices

Potential opportunities from Industry 4.0

> Overall **industry 4.0 solutions listing and clustering**



Selection of initiatives applicable

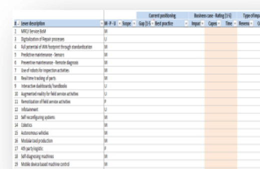
> **Selection of Industry 4.0 initiatives** based **on applicability** on **the business model**

Illustrate best practices and positioning

> **Evaluation of current position vs the market**
- initial positioning from the management perception
- Validation of the positioning on the market

Initiatives prioritization

> **Prioritization** of initiatives based on:
- Impact on **business/ capex**/ **time**
- Relevance on **costs/ revenues**



Detailed business case of the selected initiatives

Source: Roland Berger

Industry 4.0 solutions are conventional production methods backed up with state-of-the-art IT systems and pioneer software algorithms

Potential Industry 4.0 solutions

Cyber world

- Intelligent rush/new order management
- Demand driven provision of material and tools
- Smart handbooks and process documentation
- Virtual process optimization
- Predictive quality / Enhanced Throughput
- Demand-response energy management systems
- User-friendly operations dashboards
- Digital Prototyping
- Mobile device based machine control
- Centralized machinery planning
- Self-learning robots
- Self-optimizing system
- Customer triggered lot-size 1 production

Physical world

- Self-reconfiguring machines
- Cobotics
- Autonomous vehicles
- Modularized production
- Additive manufacturing
- Smart storage bin
- Logistics automation 4.0
- Self-diagnosing machines
- Smart products
- Unitary, RFID-based parts tracking
- Smart environment recognition
- Interactive robotics
- Predictive Maintenance
- Virtual work preparation
- Augmented Reality

Computing Hardware

> Data storage hardware
> Embedded systems
> High-performance computing
> In-Memory computing
> LCD / touch interfaces
> Micro computing

Production Hardware

> Robotics
> New joining technologies
> Traditional Machinery
> Automation equipment

Connec-tivity

> High speed mobile broadband (e.g. 3G / 4G)
> Industrial Ethernet
> Internet protocols (IPv6)
> Local broadband (e.g. WIFI)
> Short range/low power transmissions (e.g. Bluetooth, NFC)

Software

> Real- time data processing
> Business process software
> Database management systems
> Cloud computing
> Real-time image processing (e.g. OCR)
> Advanced algorithms
> Machine learning

Interfaces

> Visual sensors
> RFID
> Biometrics
> Magnetic stripes
> Camera & imaging systems
> Semiconductor based sensors
> Traditional sensors

Base Technologies | Potential solutions

Source: Roland Berger

Harley Davidson achieved fast, low cost mass customization based on a networked manufacturing system and ERP infrastructure

Automotive OEM Use Cases – **Automated & networked manufacturing system**

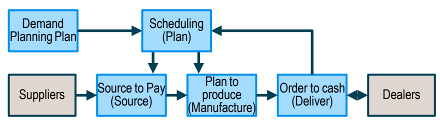
EXAMPLE

Starting point

- > Harley offers over 1,200 of customizing options
- > Key issues:
  - – the process of customization in the old factory was complex and it took over 20 days
  - – since each bike is unique, workers needed to continuously adjust without knowing what's coming next in the assembly line – This creates huge inefficiencies

Industry 4.0 solution by

Full integrated ERP infrastructure



Networked manufacturing system

Fully vertically integrated factory

- > **Highly networked** and **data-driven** manufacturing process (by SAP ERP & HANA) with **automated guided vehicles** allows the factory **respond flexibly** to higher priority orders and order machines to **re-tool immediately**
- > The new smart factory can produce an individual customized bike only **6 hours** compared to **21 days** before
- > In an Automotive context, OEMs can go for both offering **a variety of customizing options** to meet customer's individual needs and **shortening production time**
- > The new factory allowed Harley Davidson for the first time to **fully customize bikes already in the factory** – The existing molding/tuning shops were heavily hit by that move a lost a significant part of their business

Impact

- > **Lead time: -99%**
  - – An individual customized bike is produced in the new factory within only 6 hours compared to 21 days before
- > **Output: +13%**
  - – Take time of one new motorcycle reduced from 89 seconds to 79 seconds
  - – Output raised from 40 motor-cycles/hr to 46 motorcycles
- > **Asset productivity: +57%**
  - – Streamlined plant assets from 1.5 million sqft in 41 buildings to 650,000 sqft in 2 buildings (one for manufacturing with expansion, one for storage)
- > **Headcount savings: 100 m$ per year**
  - – 1,968 hourly employees reduced to 700-800 hourly employees
  - – 285 salaried employees reduced to 150 salaried employees

Source: SAP, Harley Davidson, Roland Berger

BMW obtains greater efficiency and flexibility by interactive robots working with human workers in factories

Automotive OEM Use Cases – **BMW's Interactive Robotics**

Starting point

- **Robots** have been a part of automotive manufacturing **for decades**
- Key issues:
  - Manufacturing **robots** are powerful and precise, but it's **never** been **safe** for **humans** to **work alongside** them
  - A significant number **of final assembly tasks**, in auto plants and elsewhere, were performed **almost entirely by hand**

Industry 4.0 solution by

Robot Assembly

Human Assembly

Direct human-machine coop. in serial production

- A new generation of **safer, more user-friendly robots** works **more closely alongside humans** as a team
- Robots can help people in production at hand and **remove** them **hard physical labor,** thus **increase production efficiency**
- In an Automotive context, collaborative robotics can utilize its **power** and **mechanical accuracy** and to support **human workforce healthy** for a long time

Impact EXAMPLE

- With assembly cost further reducing, Tier-1 suppliers will even more increasingly **need to focus on full solutions** rather than components
- Suppliers could potentially **differentiate** by designing products in an assembly friendly way

Source: BMW, MIT, Roland Berger

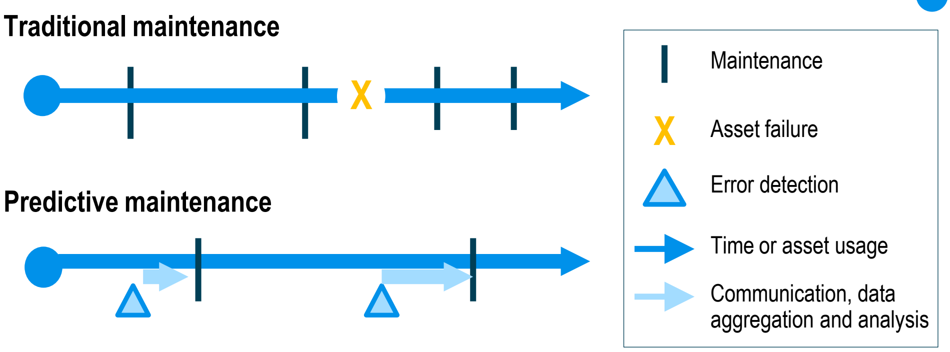
Predictive maintenance is a key to reduce unplanned interruptions to production for Automotive suppliers

Use Case – Predictive Maintenance by **connectivity and big data analytics**

Starting point

- **Down-time** is very **costly** due to disruptions to other business process and Automotive OEMs' production schedule
- Traditional maintenance methods:
  - **Incident based**; Fix when machine is broken
  - **Condition monitoring**; Fix when parameters move out of defined range
  - **Preventive maintenance**; Fix in certain fixed time-intervals

Industry 4.0 solution by BOSCH



- Overall goal is to **forecast machine failures** long **before** they **happen** , so that the issue **can be solved** with **planned maintenance**
- Predictive maintenance system could be bought from a **machinery company** (e.g. Bosch) or an **independent company** (e.g. IBM)
- System systematically analyzes the data collected from **machinery** by condition monitoring sensors (e.g. vibration, temperature etc.) and **general data** (e.g. machine type, number of days in operation, failure history etc.) to **detect patterns of errors & malfunctions** by **relying on algorithms and big-data**
- Subsequently, the current status of every asset can be evaluated and a maintenance schedule can be created where inspections and/or maintenance are performed **dynamically to prevent failures**
- Thereby **unplanned down-time** is **reduced, service & maintenance cost** could be **lowered**

Impact

EXAMPLE

- **Maintenance cost: up to -30%**
  - Decrease in inventory costs for repair parts and labor
  - 10% cost savings over preventive maintenance program
  - Potentially energy savings driven by fewer and less sudden restart processes
- **Unplanned breakdowns: up to -75%**
  - Increase machine operational life/availability
  - Allow for preemptive corrective actions
  - Limited sudden interruptions to the supply chain
- **Downtime: up to -45%**
  - Schedule maintenance activities to minimize overtime
  - Decrease in equipment or process downtime
- **Throughput: up to +25%**
  - Improve worker and environmental safety
  - Improve worker morale.
  - Better product quality

Source: Bosch, IBM, U.S. Department of energy, Roland Berger

The research plant Smart Factory integrated augmented reality into maintenance tasks

Smart Factory^{KL} - Augmented reality

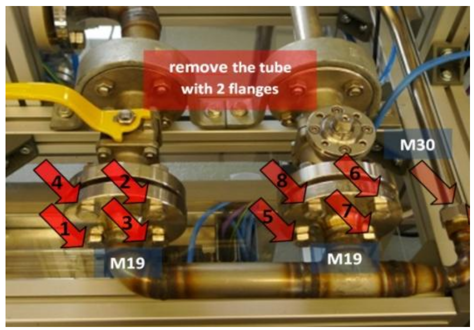
Starting point

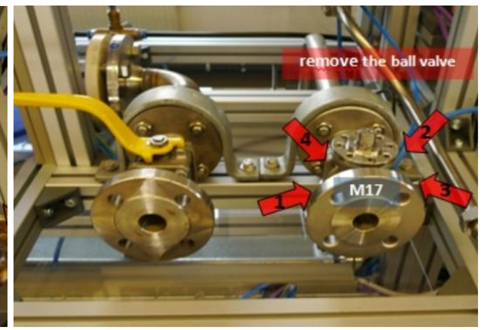
> Manufacturing systems become more and more complex for OEM / OES with more and more customization, diversity…

> Operators need to have constantly assistance to be informed "which part to produced" and "which production process to be used"

> Innovative devices for maintenance and service tasks already emerging in the manufacturer-independent research and demonstration plant Smart Factory in Kaiserslautern

Industry 4.0 solution by smartFactory^{KL}





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

> 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

Impact

EXAMPLE

> Augmented reality enabling:
  - **extended view** on production process and **assistance** for human operators to fulfill their tasks
  - **significant simplification** and **acceleration** of maintenance, reparation or installation work on complex systems
  - **increase** of manufacturing plant **efficiency** and potentially reduced risk of accidents

> Future development will further **intensify the socio-technical interactions**

Source: Smart Factory^{KL}; Roland Berger

Bosch equipped Diesel injector parts with memories to make their production process smarter

Use case - **Internet of Thing**

Starting point

- Tracking of automotive parts is currently realized by an unique part number and complex product management system
- It allows a tracking of several basic information in condition that it's correctly entered into information system
- Moreover, it doesn't allow a part location real-time tracking during delivery
- Finally, with the sophistication of supply chain, there could be potential of misdelivery

Industry 4.0 solution by BOSCH

- 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
- **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

Impact

EXAMPLE

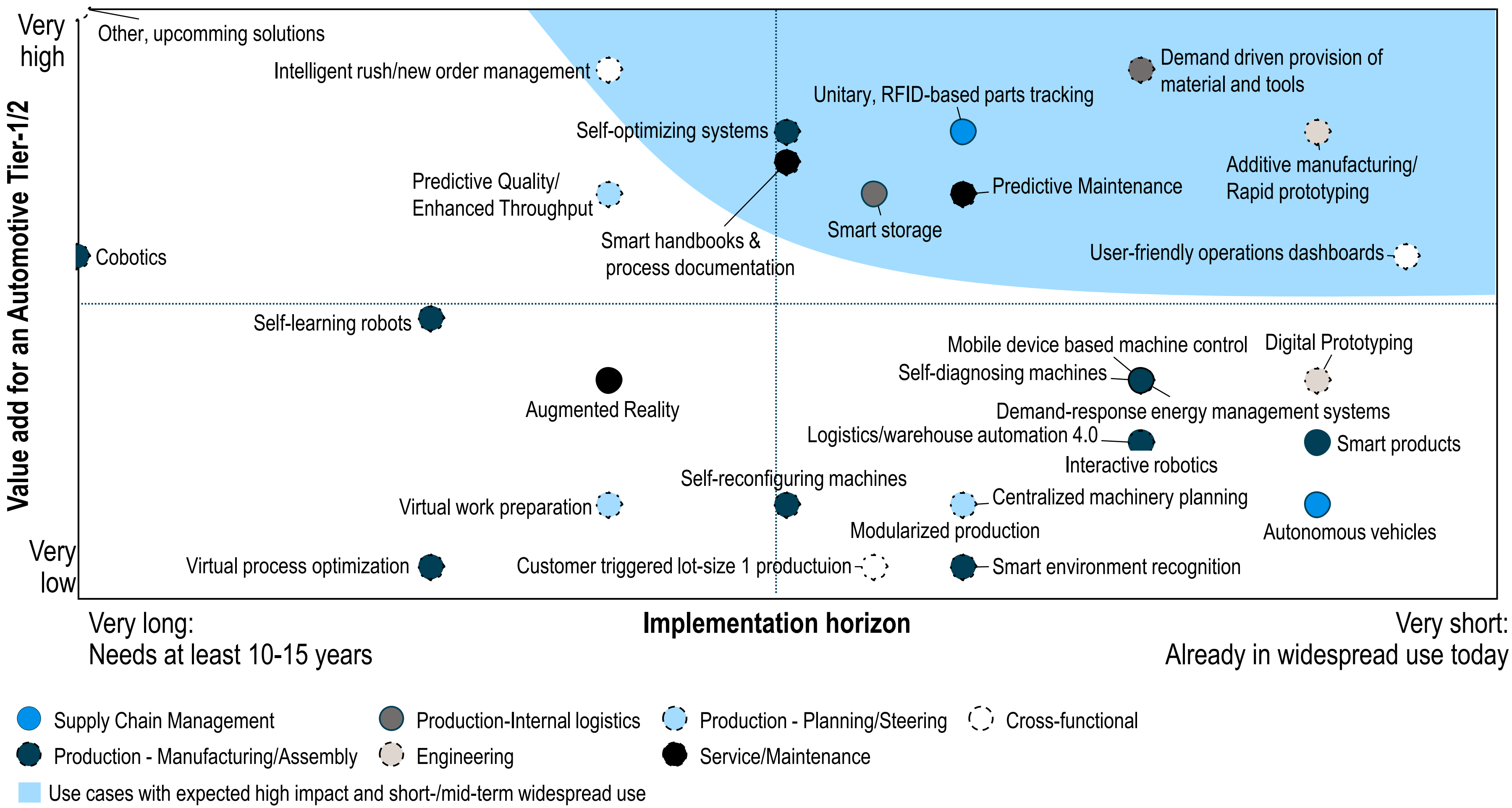
- **Simplification & smarter** of production process & interfaces:
  - Basic information **directly tracked by the part itself**
  - More accurate input without risk of errors
  - Centralized information in a cloud-based IT system
- **Optimized supply chain** & **customer interface**:
  - Real-time location tracking enabling OEM customer to adjust production planning
  - Easier verification process for requirements fulfillment

Source: Robert Bosch GmbH; Roland Berger

Going forward, the focus need to be on the use cases with the highest impact that will be realized in the mid-term

Derivation of use cases for an Automotive Tier-1/2

ILLUSTRATION



Source: Roland Berger

Roland Berger