Roland Berger Trend Compendium 2030

Megatrend 5
Dynamic technology & innovation

October 2017

About the Roland Berger Trend Compendium 2030

What is it?

> The Roland Berger Trend Compendium 2030 is a global trend study compiled by Roland Berger Institute (RBI), the think tank of Roland Berger

> It describes the most important megatrends that will shape the world between now and 2030

> The megatrends have a broad impact on the environment of companies, strongly influencing challenges and opportunities of their business

Our approach

> We first screened relevant trend, scenario and future studies worldwide

> Then we verified, analyzed and consolidated the results, using them to define the megatrends

> Next, we broke down the mega-trends into subtrends, looking at each from a global perspective and the viewpoints of industriali-zed and developing countries

> Finally, we identified corporate actions that companies worldwide should consider taking today

Use it!

> For your own presentations, for discussions with clients and business partners or as springboards for acquisition approaches

> Following the description of the subtrends and the recommended corporate actions, you will find the most important sources to help you keep track of the changes in the world, as well as dig deeper into the trends presented

The Roland Berger Trend Compendium 2030 focuses on stable long term developments

- The Roland Berger Trend Compendium covers megatrends – long-term developments with major impact (usually global) on companies, economies and the natural world
- The forecasts are based on estimates reflecting the "normal" case, i.e. a stable development of the global economy with no unexpected events ("black swans"). Major political or financial crises, large-scale natural disasters or similar far-reaching events are not integral to our assumptions
- To incorporate today's volatile, uncertain, complex and ambiguous (VUCA) environment into strategic planning we recommend to combine the megatrends of the Roland Berger Trend Compendium with the Roland Berger scenario planning approach

Methodology

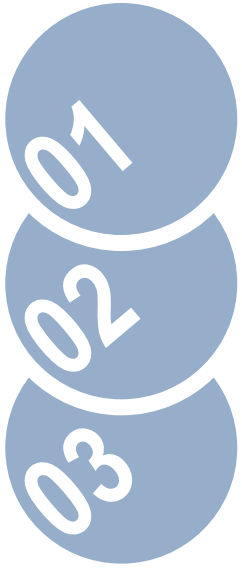
It covers seven megatrends that shape the future development of our world

1. Demographic dynamics
2. Globalization & future markets
3. Scarcity of resources
4. Climate change & ecosystem at risk
5. Dynamic technology & innovation
6. Global knowledge society
7. Sustainability & global responsibility

Megatrends

Dynamic technology & innovation are at the core of major forces in today's business environment – There are three key subtrends

Subtrends of megatrend "Dynamic technology & innovation"



Power of innovation – Driver of economic prosperity

Life Sciences – Addressing major challenges of humanity

Digital Transformation – The digital economy is here

The power of innovation is rooted in its ability to solve important problems for humanity

The Problem-Innovation-Solution-Chain

Problem	Innovation	Solution
> Demand for large scale transportation of people and goods	> Trains 	> Construction of railway networks
> Growing demand for food	> Synthetic fertilizer 	> Higher crop yields through intensive use of synthetic fertilizer
> Global warming through rising CO_2 emissions	> Lithium batteries 	> Reduction of CO_2 emissions through the usage of electro cars or storage of renewable energy such as solar

Today we still face major challenges, yet many promising fields of innovation are poised to overcome these challenges by 2030

Selected major challenges and fields of innovation towards 2030

Major challenges for humanity

- Provide enough water, food and healthcare
- Use resources more efficiently
- Cope with increasing energy and transportation demand
- Reduce waste and pollution
- Fight climate change
- …

Fields of innovation

- Life Sciences
- Digital Transformation
- Materials science
- New mobility
- Environmental science
- …

Over the next decades, disruptive as well as sustaining innovations will change our lives

> **Innovation** is the most important **lever to overcome current and future challenges,** such as aspects of demographic dynamics (see trend 1), scarcity of resources (see trend 3) or climate change (see trend 4). Innovation will impact **across many different fields.** To solve a broad range of pressing problems, innovations in **Life Sciences** and in **Digital Transformation** are of particular importance; we will therefore analyze these subtrends in chapters T 5.2 and T 5.3. Examples of further important fields of innovation are **materials science, new mobility** and **environmental science**

> **Innovations** can be classified in different ways. In this context, a useful **classification** is to differentiate between sustaining and disruptive innovations. A **sustaining innovation evolves existing markets** with better value (e.g. higher speed micro-chips improving the performance of PCs), while a **disruptive innovation** (such as cars, PCs, downloadable digital media) helps to **create a new market,** drastically altering an existing one

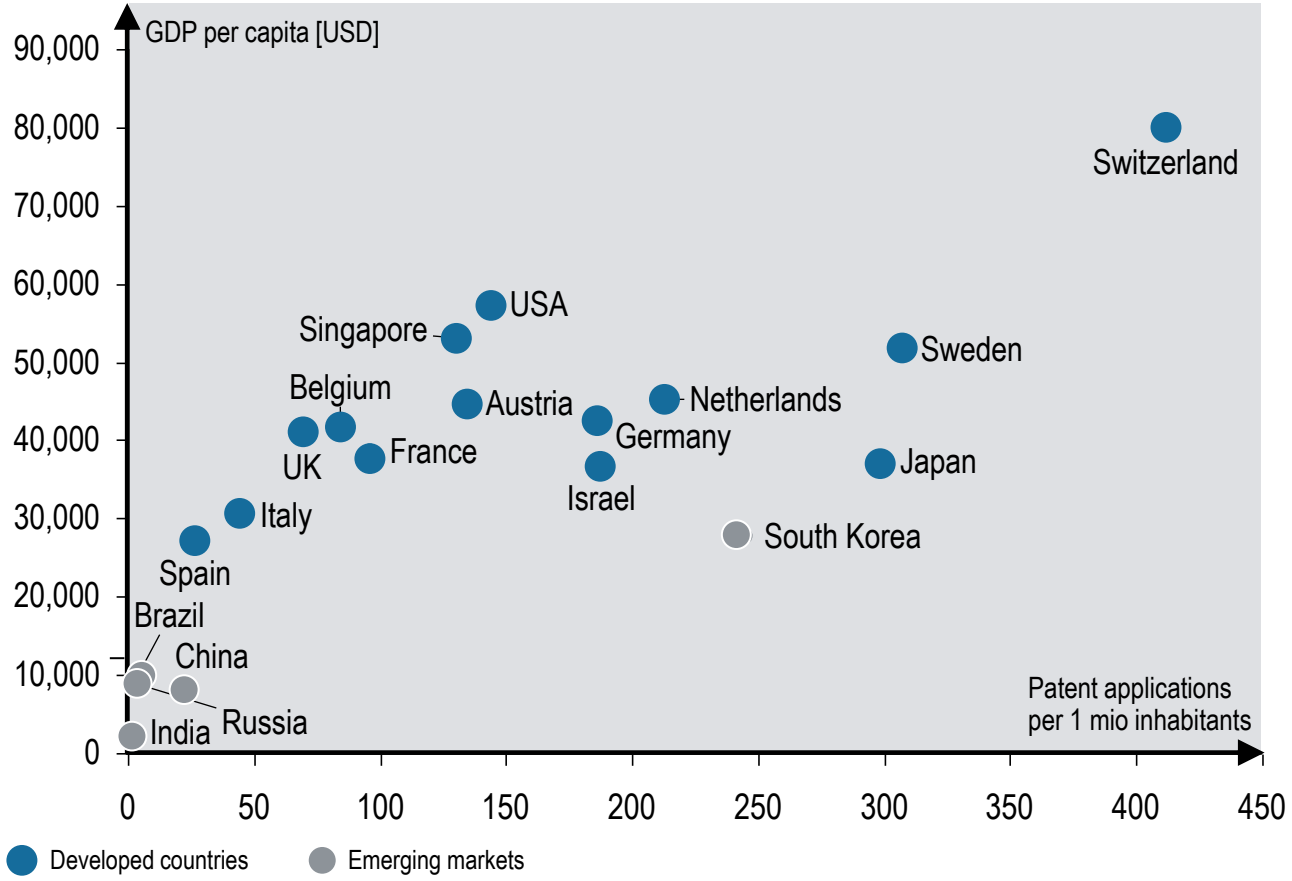
> **Most innovations are technology-based**. Product innovations generate added value for people and companies, but the **greatest added value** is generated when innovations result in **new work and manufacturing processes** or even new **business models**. In particular, new web-based business models from companies such as Apple, Google and Facebook have dramatically changed our lives and work habits in the past – and are expected to further change them in the future

> **Materials science** is expected to develop **new high-tech, high-performance materials** such as new superalloys and nanomaterials. These help to reduce weight, enhance the performance of devices, machinery and vehicles and allow for entirely new engineered materials with artificial properties not yet encountered (metamaterials). Innovation with regards to **new mobility,** e.g. in **battery technology** will push demand for electric cars. **Autonomous cars** are expected to come to market within the next few years and suggest significant growth potential. **Environmental science** is trialing innovative solutions to **eliminate garbage patches littering the world's oceans** and to reduce air pollution

Source: Clayton Christensen, BBC, Wonderfulengineering

Innovation drives wealth – BRIC countries have to catch up but Chinese corporations gain pace

GDP per capita and PCT[1)] applications relative to population in 2016



Largest corporate PCT applicants 2015

1. **Huawei** (3,898; CN)
2. **Qualcomm**(2,442; US)
3. **ZTE** (2,155; CN)
4. **Samsung** (1,683; KR)
5. **Mitsubishi** (1,593; JP)
6. **Ericsson** (1,481; SE)
7. **LG** (1,457; KR)
8. **Sony** (1,381; JP)
9. **Philips** (1,378; NL)
10. **HP** (1,310; US)

1) Patent Cooperation Treaty: Intellectual property rights enforced in 148 countries worldwide

Source: IMF, Wipo, WEF

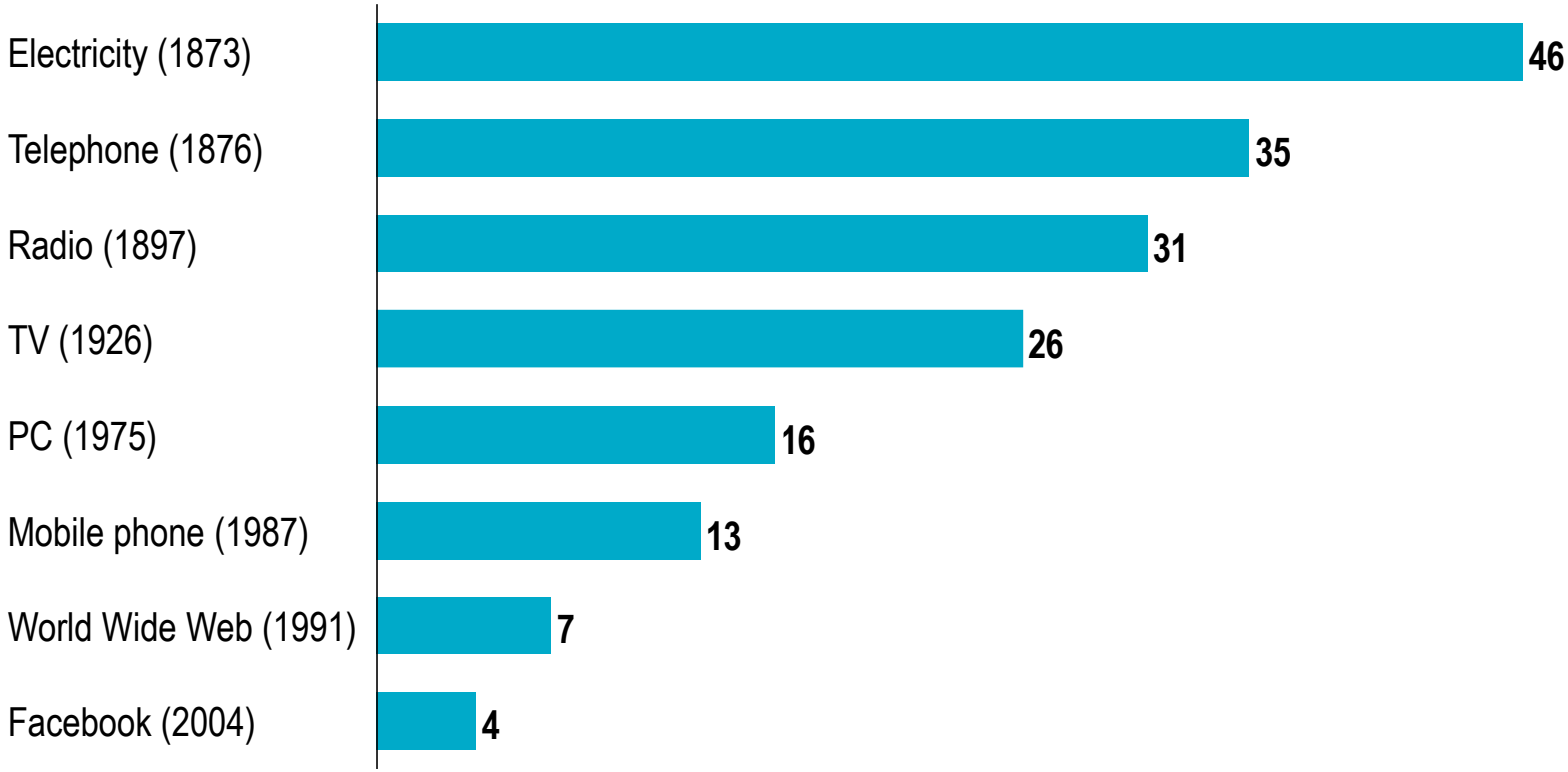
Creating wealth and increasing prosperity through innovation is more sustainable and stable than through resource exploitation

- There is a **strong link** between the number of **patent applications per capita** and the **level of a country's prosperity:** countries with **few** (exploitable) **natural resources,** such as Switzerland, Sweden and Japan, have the **highest rate of patent applications per 1 mio inhabitants,** suggesting that innovation is more than a viable substitute for natural resources in terms of wealth creation. However, patents cannot be seen as stand alone drivers of economic prosperity since possible benefits depend on their degree of utility and efficient, intelligent marketability. **Emerging markets** like the BRIC countries are still **lagging behind advanced economies** regarding patent applications, with the **exception** of a number of **Chinese corporations** e.g. Huawai (rank 1) and ZTE (rank 3) who belong to the leading global patent applicants. While **resources are finite** and resource prices remain highly volatile, countries such as Russia need to shift their focus **from resources to innovation** to make their economic model **more sustainable**
- **Low income countries accounted for only 0.3% of worldwide total patent applications** in 2015 and lower-middle income for 2.7%. The upper middle-income countries increased their share from 26.2% in 2010 to 43.5% in 2015, with China accounting for the majority of this, sustaining progress especially in telecommunications and consumer electronics. **Africa equates to 0.5%, Latin America and the Caribbean to 2.3%** of worldwide patent filings in 2015. This illustrates the huge gap of innovational power, resulting in disadvantages on world markets. Governments of both developed and developing countries need to exploit their knowledge effectively and invest in scientific infrastructure
- The **basis of competitive innovation strength** lies in an **adequate amount of R&D.** Thus, **R&D expenditure expressed as a share of GDP**, both public and private, is an **indicator of future competitiveness**. Of the countries displayed previously, highest shares of R&D expenditure (% of GDP) in 2015 fall to South Korea (4.3%), Israel (4.1%), Japan (3.6%), Sweden (3.2%), Austria (3.0%) and Germany (2.9%) respectively. In addition, **venture capital fosters innovation** in the private sector. Here the US leads with more than USD 70 bn of venture capital invested compared to only about USD 18 bn in Europe, and nearly USD 40 bn in Asia in 2016

Source: Wipo, IMF, World Bank, EVCA, KPMG

Increasingly, innovations are reaching significant diffusion milestones faster

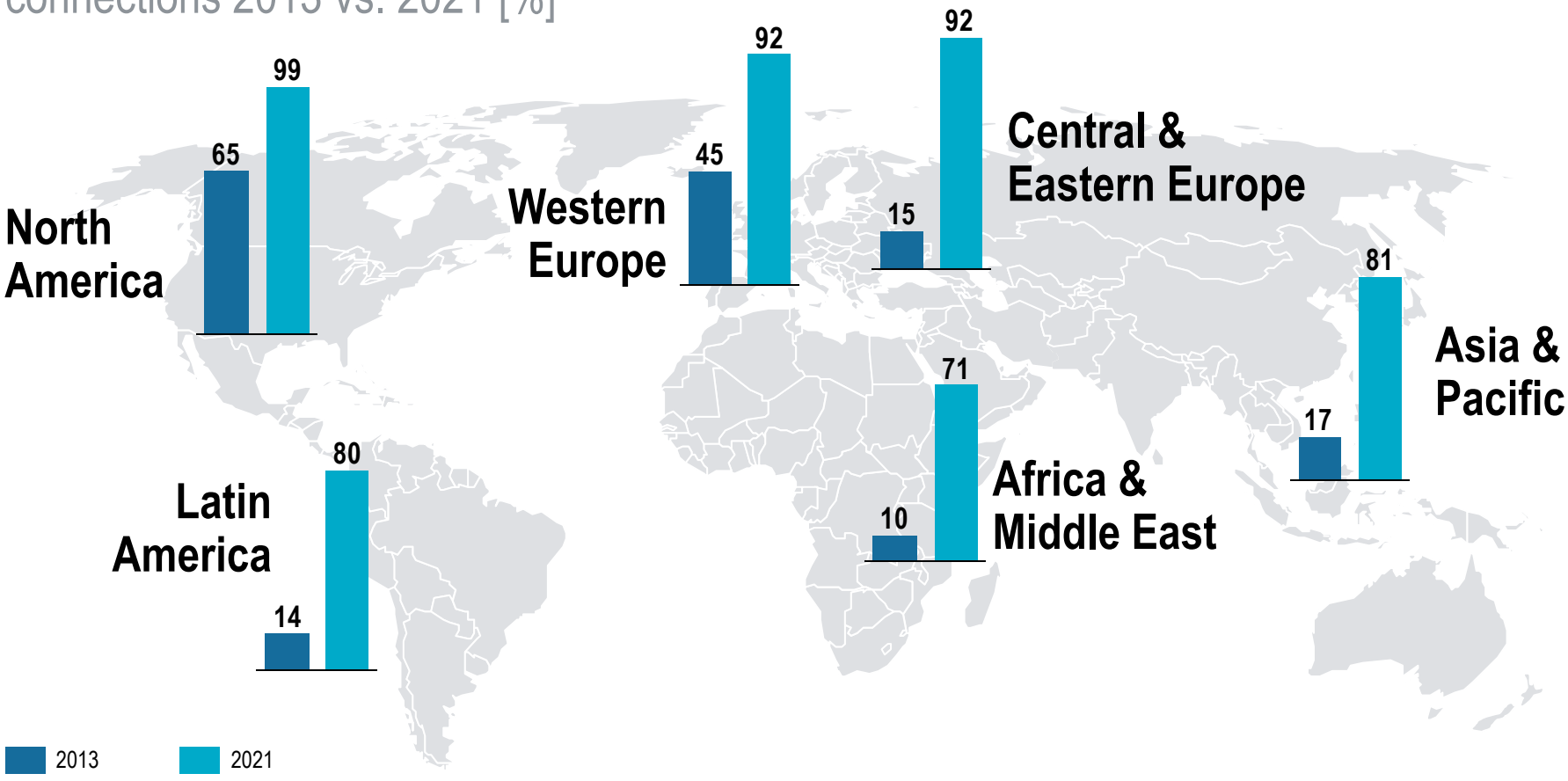
Time from introducing a product to an adoption rate of 25% across US citizens [years]



Source: FAZ

Fast diffusion of technology is a global reality and not restricted to advanced economies

Mobile smart devices and connections[1] as share of total number of devices and connections 2013 vs. 2021 [%]



1) Defining mobile smart devices and connections as those having advanced computing and multimedia capabilities with a minimum of 3G connectivity

Source: Cisco

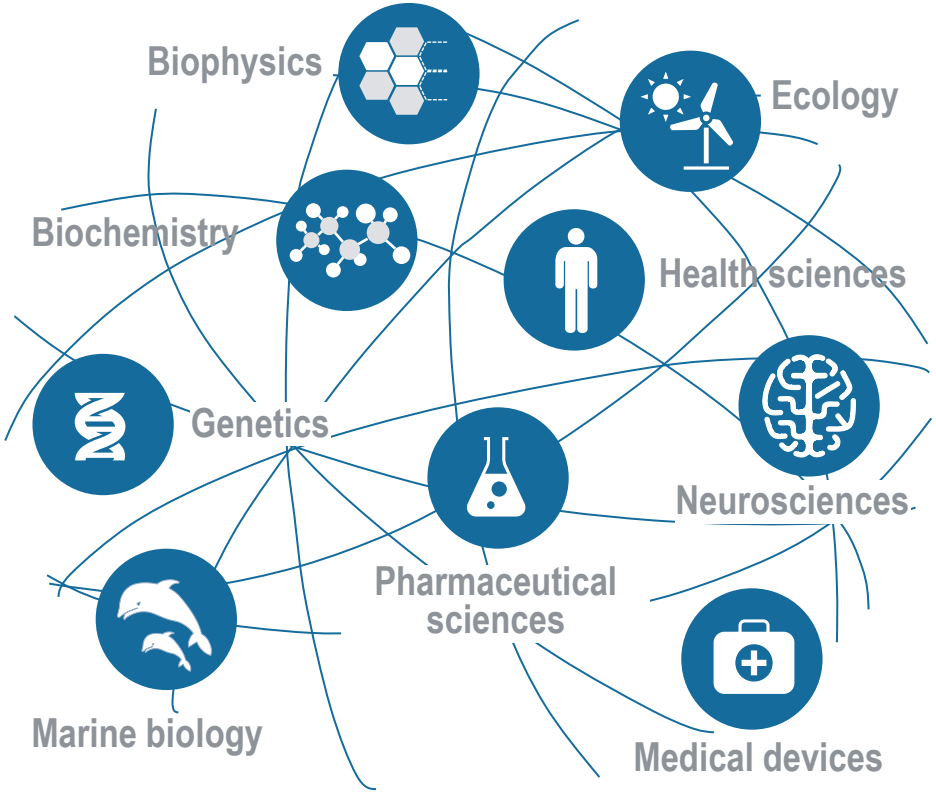
Technology diffusion accelerates globally and drives economic growth, especially in developing markets

- The overall **importance of technology will increase** within the next twenty years as **new technologies are being adopted more widely, reaching significant diffusion milestones earlier** and **innovation cycles become shorter.** This development follows a long-term trend. In the US, for example, time to an adoption rate of 25% in fundamental technologies decreased significantly since the second half of the 19th century. This trend is set to continue to 2030 as **product life cycles become ever shorter** with numerous new smart products penetrating multiple markets
- **Fast technology diffusion** is not restricted to advanced economies. Other clusters face **strong growth rates** e.g. **in mobile smart devices and connections** as a share of the customer's device mix. By 2021, Central & Eastern Europe (92%; + 77%-points since 2013) will draw level with Western Europe (92%; +47%-points). In the same time frame, North America reaches nearly 100% while Africa & Middle East (71%), Latin America (80%) and Asia & Pacific (81%) will have even higher shares of mobile smart devices and connections than Western Europe today (69% in 2016)
- Technology diffusion enables **new business models** and the **ease of doing business**, ultimately **fostering economic growth** especially in developing countries. For example, in Africa mobile phones are used to facilitate remote pricing between farmers and intermediary sellers in crop markets, improving price transparency and delivering real time demand. Also, transactions via cash-backed payment systems connected to mobile phones can be processed in real time, fostering financial inclusion. The **influence of spatial distance** between innovators and adopters, which in the past played a significant role in adoption speed, **diminishes** as accelerating digitalization reduces obstacles e.g. in communication, and fosters an even stronger exchange of information worldwide

Source: FAZ, Cisco

The powerful network of biology, pharmaceutical and chemistry in Life Sciences provides answers to future challenges of humanity

Selected fields of Life Sciences

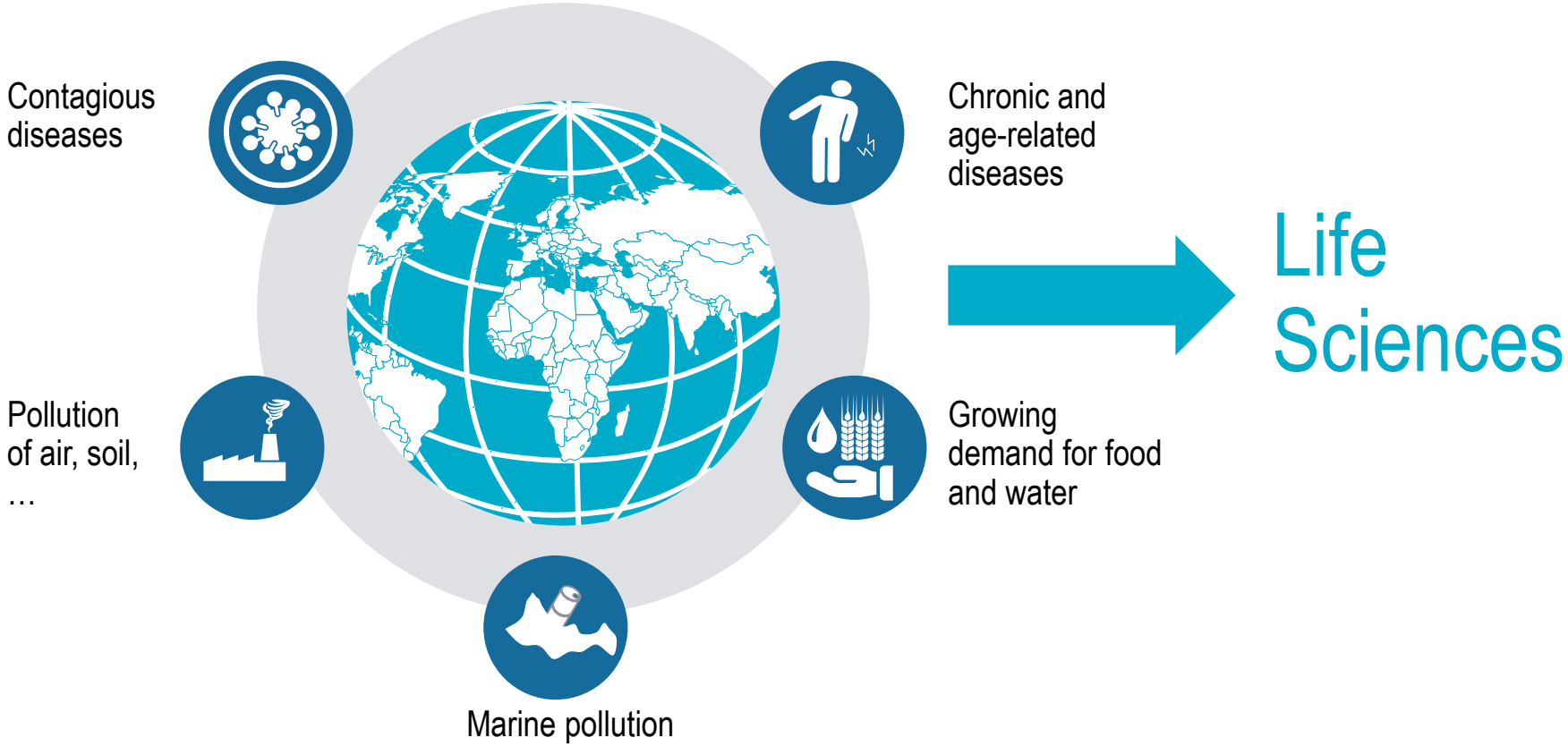


- **Life Sciences** are concerned with the study of **living organisms** and their **direct and indirect impacts on the environment,** such as humans, animals and nature
- It encompasses research fields of **biology, pharmaceuticals** and **chemistry,** making Life Sciences a **broad and powerful intersection for addressing challenges** stemming from areas such as a rising/aging population, a threatened natural environment, and the increasing spread of diseases
- The **interdisciplinary** approach of Life Sciences creates **synergies,** e.g. early detection of symptoms through neuroscience and treatment with pharmaceuticals

Source: PwC, Deloitte

Huge challenges across the globe are calling for solutions from Life Sciences …

Selected important challenges associated with Life Sciences



… to deliver approaches to overcome these global challenges (1/2)

Challenges of diseases & selected solutions

- **Poor access to health care** currently affects about 1 billion people. With fast growing populations and economic challenges, **developing countries should follow different pathways in healthcare** compared to the developed world. An extensive hospital/doctor network is hardly feasible: Nigeria, for example, would require about 12 times as many doctors by 2030 as currently available just to reach OECD standards. Instead, **this gap needs to be narrowed with** innovative **medical technologies** allowing for **remote medical analysis, diagnosis** and, ultimately, **treatment advice** and **medicine/drug delivery**
- **In developing countries** relatively fast improvements are achieved in terms of longevity goals to 2030. **Cheaper generics** and **new biotechnological methods address diseases** such as malaria or dengue fever. For example, genetically modified mosquitos are breed specifically in order to "crash" malaria-carrying species. **Life Sciences** also help to address the **three P's**, combating **pathogens** and **pollution** as well as decreasing the use of **pesticides.** Genetically modified crops and nutrient-fortified plants will help diminish natural deficiencies or climatic challenges
- **Chronic diseases** are expected to **increase by 2030** due to an **aging population** and **changing living habits**. **Currently 60% of all deaths worldwide** are caused by **chronic** diseases (e.g. heart disease, stroke, cancer, chronic respiratory diseases, diabetes) and with a **similar level of risk for both developing and developed countries. Innovative companies** should **align their R&D portfolio to this fact.** Innovations such as **artificial organs** or tailor-made, **3D printed implants** are available to individuals living in countries with a higher level health system. Similarly, **induced pluripotent stem cells (IPS)** are promising great progress: IPS are able to heal harmed cells and cure tumors. **Neuro-scientific progress** supports brain structure analysis as well as more sophisticated biomarkers, in turn leading to early diagnosis (and treatment) of diseases such as dementia

Source: Imperial College London, Deloitte, WEF, NIC, ARTE Tech Mag, WHO, Nature, World Future Society

… to deliver approaches to overcome these global challenges (2/2)

Environmental challenges & selected solutions

> Climate change, soil degradation (see trends 3 & 4) and a growing world population (see trend 1) are addressed through the means of a **"bioeconomy"**[1], i.e. the **application of biotechnology to primary production**[2]**, health and industry**. Solutions are found in so-called **white, green and red biotech,** whereby white biotech relates to industrial use, green biotech is concerned with plants and red represents medical solutions

> **White biotech** can **help traditional industrial companies** to reduce their dependency on natural resources such as oil, coal and gas. The Fraunhofer Institute estimates that two thirds of polymer products could be substituted with so-called Bio-Polyethylene, a chemically identical compound. Its degradability can be modified for individual products and purposes. Moreover, microorganisms can then help to greatly reduce plastic garbage in the future

> **Green biotech** holds huge **potential for food supply** with more resilient crop plants. One example is making rice, a staple for more than 3.5 billion people, fit for more saline soils. In food production, added amino acids or Omega-3 fatty acids help provide more protein to humans and animals while also creating higher resistance to illness and help overcome signs of deficiency

> At the **interface** of **white and green biotech,** new biofuels are being developed with a higher energy density and fewer harmful emissions. To avoid degradation of forests or exploitation of farmland, new ways for the production of biofuels are explored, e.g. through re-assembling algae's DNA

> One example for **red biotech** is **microbiome composition analysis,** which aims to **tailor the use of pharmaceuticals** more specifically to the patient's needs

1) The term bioeconomy derives mainly from the OECD 2) Agriculture, forestry, fishing and mining

Source: Fraunhofer, OECD, World Future Soc., NIC, US Rice Producers, The higher education, Biotechnologie.de

Emerging countries in particular face major challenges which can be addressed with enhanced capabilities in Life Sciences

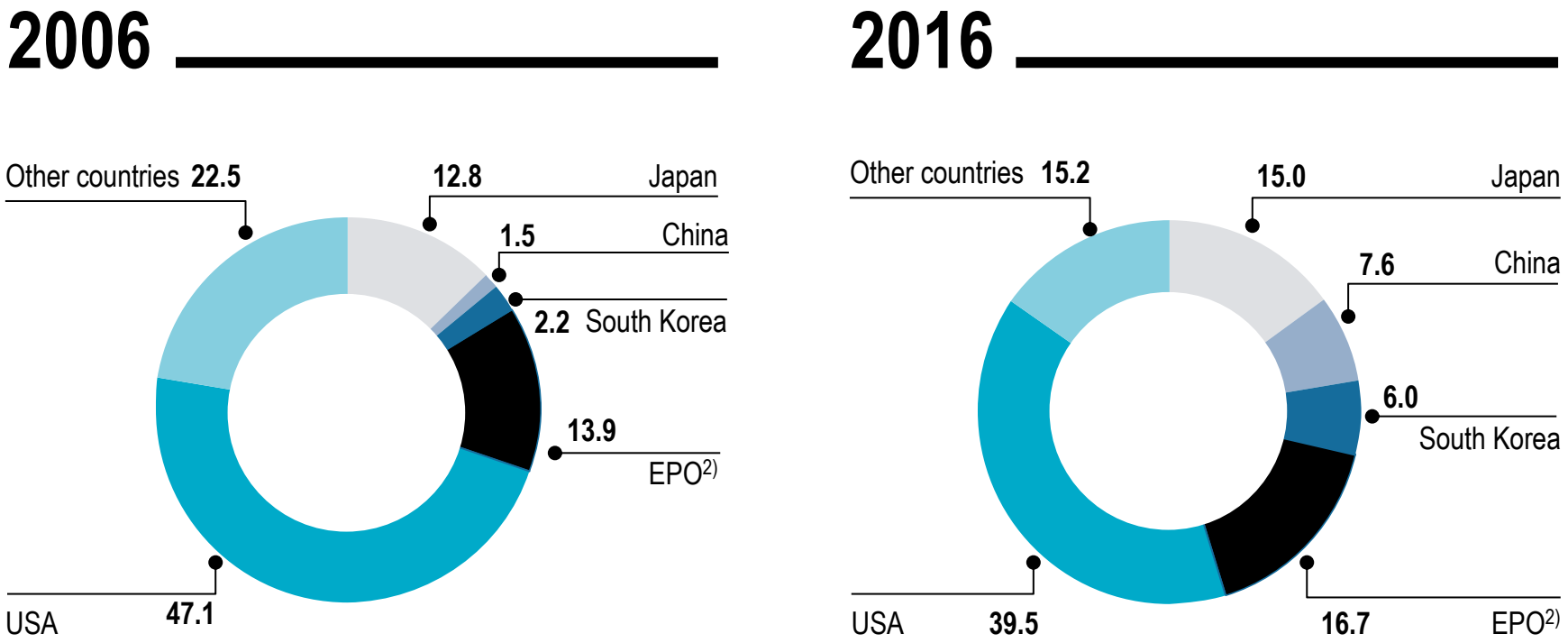
- The **majority** of today's Life Sciences markets is **centered around industrial countries,** especially **USA, Japan** and **Europe. For example, industrial countries account for 70% of the global pharmaceutical market.** In the future, **their share of the Life Sciences market is set to decrease** due to other markets scaling up new capacities
- **Chinese companies** will **become global players in Life Sciences** as domestic consolidation progresses. **China's pharma sales** value has surpass Japan's, becoming **the second biggest pharma market worldwide**. **By 2020, China will overtake the U.S.** as the largest pharmaceutical market, according to IMS Health. The need for new medical technology is increasing due to lack of ubiquitous healthcare provision and demographic changes in population
- Although a latecomer, **India** possesses **great potential,** provided that its government takes action on broader healthcare access. Currently India ranks fourth in the world among the highest generic pharmaceuticals producers. Low urbanization rates make health care provision through a traditional hospital system challenging. **New cost saving medical technology** will **provide basic health care** for a more widely dispersed, rural population
- **Brazil** is the **biggest Life Sciences market in Latin American** today with strong growth rates, especially regarding pharmaceuticals (generics in particular). **Green biotech** innovation can help **increase crop yields** without requiring additional farmland, thereby protecting the **rainforest**, in itself a unique and valuable **source of indigenous drugs**
- **Indonesia**, as the world's 4th most populated country and a GDP below 4.000 USD PPP per capita, **strongly depends on progress in Life Sciences.** However**, to become a global player** in this field**,** it has a **long way to go**. Latest policies aim at reducing Indonesia's high raw materials import dependency of pharmaceutical ingredients (currently 90%). Additionally, intellectual property rights need to be strengthened. **Biodiversity** may provide solutions regarding **green biotech** and help to **mitigate national ecological problems**, reshaping its economy towards more sustainability

1) Patent Cooperation Treaty: Intellectual property rights enforced in 148 countries worldwide

Source: WEF, Global Data, PwC, Forbes, IBIS World, Evaluate Group, USDA, JLL, Deloitte, BCNet Staff, EY, World Bank, IMS Health

Life Sciences markets are shifting – In terms of patent publications, the US are losing share while Asian countries are gaining

Selected PCT Life Sciences[1] publications by filing office [% of global total]

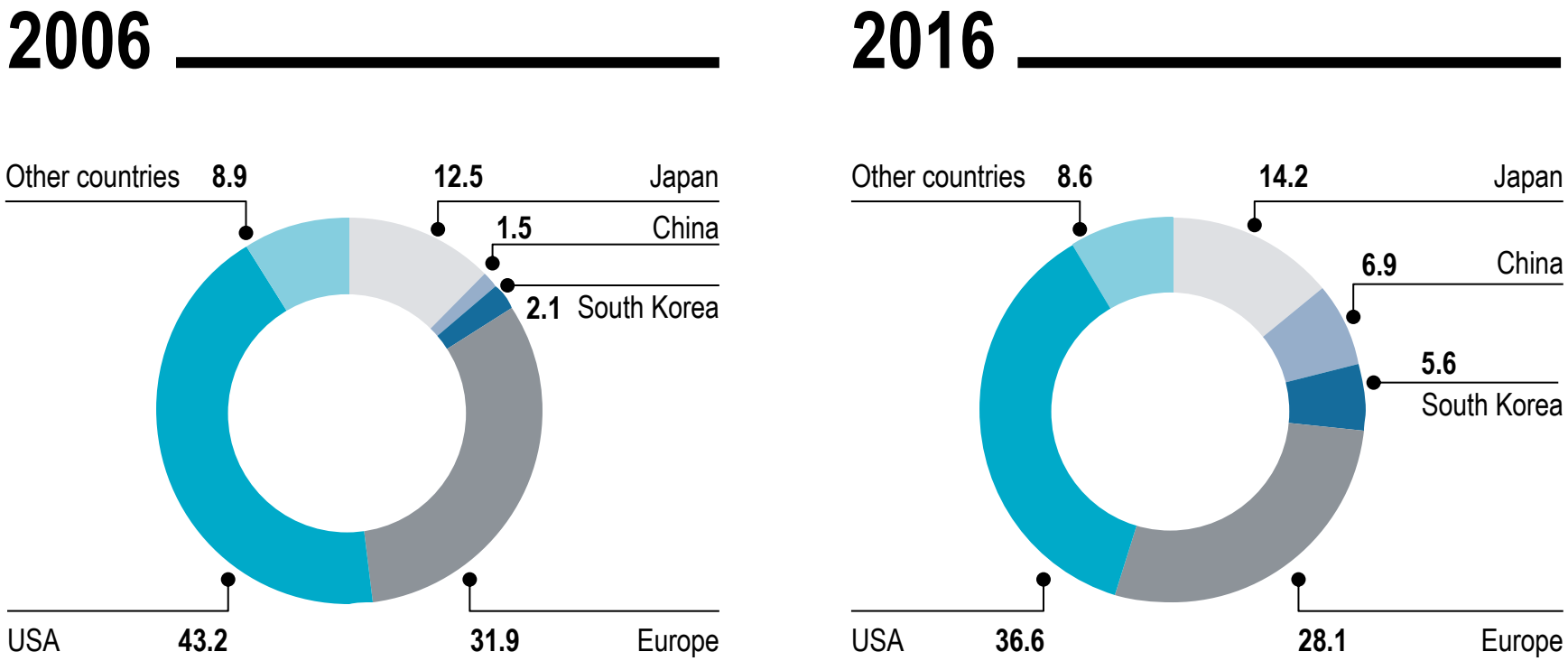


1) PCT (Patent Cooperation Treaty: Intellectual property rights enforced in 148 countries worldwide) applications here refer to analysis of biological materials, medical technology, biotechnology, pharmaceuticals, food chemistry, environmental technology 2) EPO = European Patent Office

Source: Wipo

Similarly, in terms of patent publications by origin of applicant – Asian countries are catching up, the US and Europe are loosing

Selected PCT Life Sciences[1)] publications by origin of applicant [% of global total]



1) PCT (Patent Cooperation Treaty: Intellectual property rights enforced in 148 countries worldwide) applications here refer to analysis of biological materials, medical technology, biotechnology, pharmaceuticals, food chemistry, environmental technology

Source: Wipo

New research competition in Life Sciences: National research clusters in Asia are showing signs of promise

- The strong growth of Asian markets in Life Sciences can be observed in PCT applications with parts of Asia, in particularly **China**, attracting the **biggest increase in patent protection as measured in patent publications filed.** Within the last 10 years, **publications by filing offices** in China increased more than fivefold while global publications grew by only 21%. This shows the fundamental importance of the Chinese economy for Life Sciences and its demand for Life Sciences solutions regarding pollution, an aging society and the need for a stable food and water supply. Also **by origin of applicant,** the global share shows that the **Asian market is catching up** (+11.8%-points from 2006-2016 to 31.5%) to the US market (-6.6%-points to 36.6% in 2016). **China** has five times more publications today than in 2006 and thus increased its share by +5.4%-points to 6.9% in 2016
- Boosting biotech, one of the strategic, emerging industries in **China's** Five-Year Plan, is paying off in terms of strong research: **Shanghai** and **Beijing** incorporate strong national **research clusters.** The awareness of Chinese government for the need of Life Sciences solutions with a view to health care and environmental challenges drives positive developments in Life Sciences fostered by strong institutional research
- The **Indian** government aims to **improve its Life Sciences positioning** by transforming itself from **imitator to innovator.** As stated in the official Indian "Pharma Vision 2020", the country is expected to become a global leader in end-to-end drug manufacturing. Overall, the country has a good starting point: **India supplies** domestic and certain foreign **markets with a need for cheaper drugs** and generics, such as Latin America and Africa. Expiring patents on pharmaceuticals will also ease the entry into markets abroad
- **Singapore**, with its **highly skilled labor force** and well functioning **intellectual property rights regime,** is an attractive research **alternative to China or India** from which to penetrate Asian markets by 2030. The shift from manufacturing to a **research-based Life Sciences market** has been realized with the establishment of high quality R&D facilities

Source: WEF, IBIS World, Evaluate Group, Financial Times, IMS, Adroit People, Deloitte

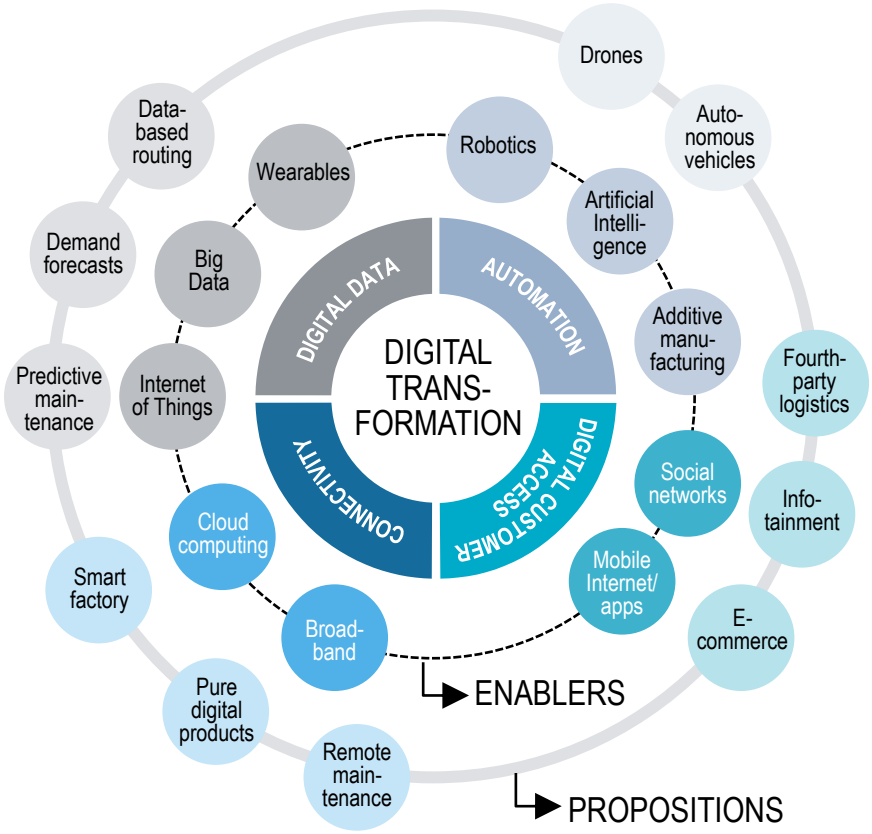
Life Sciences are not without criticism – Genetic engineering, use of nanoparticles and other methods give rise to controversy

- **Genetic engineering** offers huge potential for more stable, **less chemical intensive farming and food supplies,** particularly in developing countries facing climate and resource challenges. However, **genetically modified crops can sideline traditional crops** and further research is needed into long-term effects of the consumption of genetically modified foods. Equally, effects on ecology and bio-system dynamics, e.g. in the insect world, have yet to be understood
- **Use of embryonic stem cells for medical research** brings the promise of new treatments for certain diseases and disorders, e.g. spinal cord injuries. **Ethical concerns about using embryonic stem cells** are a matter of debate, ultimately **depending on legislation** varying from country to country. Also, fast reproduction of stem cells is complex and challenging, with mutations and other longer term problems requiring further research
- Use of **nanoparticles and endocrine disruptors** are making headlines. Nanoparticles e.g. from cosmetic products **find their way into drinking water supplies,** causing new challenges at purification plant level. **Endocrine disruptors,** i.e. chemical compounds found in many household and industrial products, **interfere with hormone systems of animals and humans** leading to infertility, tumors, birth defects, or developmental disorders
- **Legislators and consumers react very differently,** depending on their origin. In certain countries, mixed views regarding genetic engineering from politicians and consumers **can pose a direct obstacle to growth** and **R&D** itself**.** The corporate innovations **portfolio management** responsible has to **specifically target beneficial projects for certain regions** while culling dead-end projects elsewhere, or address/identify other markets. For example, BASF relocated its crop research capabilities to the USA. In the EU, policy makers as well as the general public face crucial decisions to find a consensus for a strategic pathway in biotechnology and Life Sciences

Source: FAZ, Wissensschau

After digitalization of the consumer sphere, Digital Transformation is permeating all areas of the economy – Taking effect via four levers

Levers of Digital Transformation



For consumers, digitalization – e.g. in the form of e-commerce, mobile internet and social media – has long since been part and parcel of everyday life. Now, **Digital Transformation**, i.e. the **seamless, end-to-end connectivity of all areas of the economy**, brings fundamental change to business. Digital Transformation takes effect via **four levers**:

> **Digital data.** Capturing, processing and analyzing huge amounts of data allows better predictions and decisions to be made

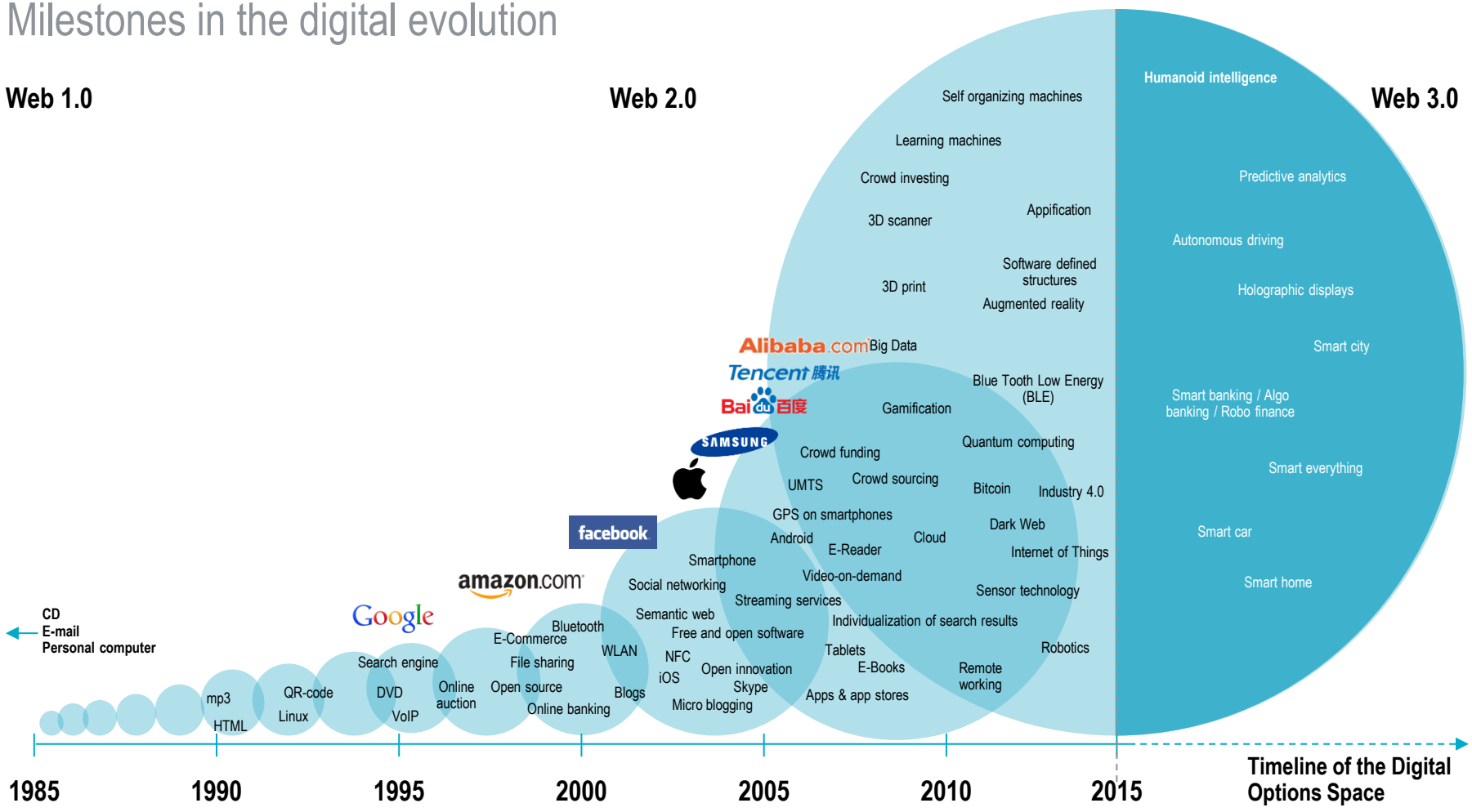
> **Automation.** Combining traditional technologies with Artificial Intelligence is increasingly giving rise to systems that work autonomously

> **Connectivity.** Interconnecting the entire value chain and products via networks to synchronize supply chains and shorten both production lead times and innovation cycles

> **Digital customer access.** The (mobile) internet gives new intermediaries direct access to customers offering choice, transparency and new services

Digital Transformation has changed everything and is set to continue, as digital options follow an exponential growth path

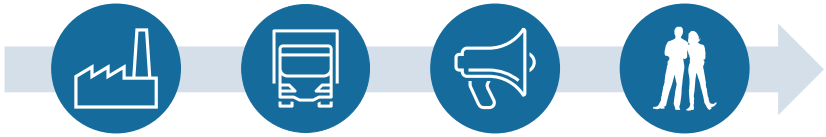
Milestones in the digital evolution



In the digital economy platform thinking is the foundation for new value creation – Leveraging network effects is key to success

Platform-driven business models

Traditional thinking



> Traditional one-way pipe business models
> Upstream production and downstream consumption of value
> Content is added incrementally

Platform thinking

> Creation of two-sided networks
> Co-creation of value by harvesting resources and capacity of an ecosystem you do not need to own
> Content is added exponentially

Premium cable and satellite television network providing (self-produced) TV-series, movies and other entertainment content

HBO vs. YouTube

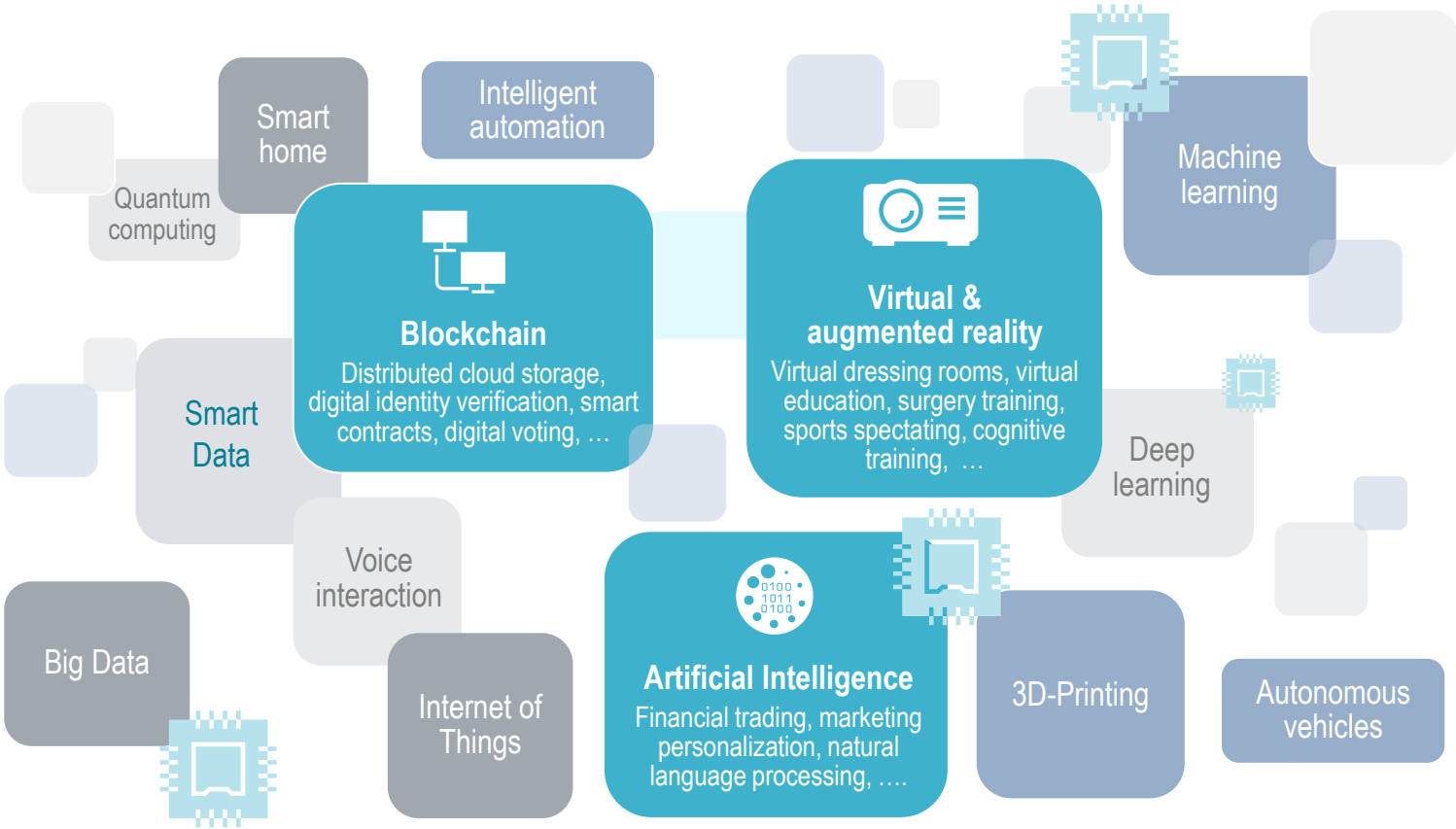
Video sharing platform leveraging content from a broad ecosystem of contributors and offered for free

4.7 bn	Revenues	8.2 bn
74 bn (Time Warner Inc.)	Market Cap.	80 bn
140 mn	Unique users	>1 bn

Source: Roland Berger, Yahoo Finance

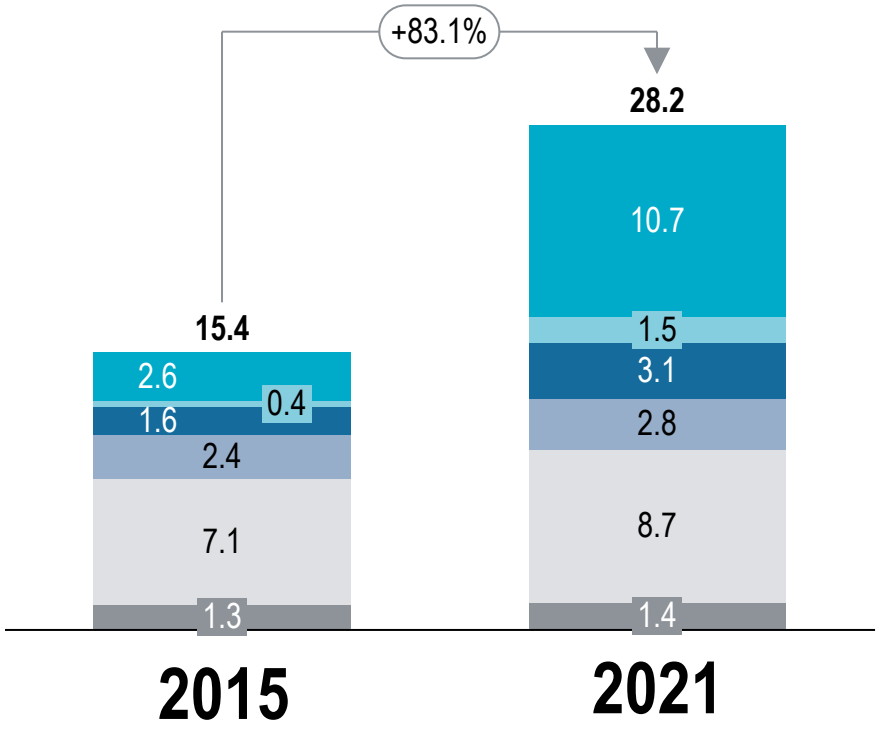
New technologies emerge that strongly impact our daily life and the way we do business

Overview of technology trends



The Internet of Things is an important enabler of Digital Transformation and its growth is accelerating

Forecast of connected devices[1] by Ericsson 2015 vs. 2021 [bn]



- The **Internet of Things (IoT)** is a **network of physical objects** (machines, cars, household devices etc.) that contains embedded technology (electronics, software, sensors and connectivity) enabled to **communicate** and sense or interact with their internal states or the **external environment** such as humans and (other) physical objects/devices
- **The speed of innovation is difficult to predict** – overall numbers are fluid but the direction and device category developments are clear
- In 2013, Cisco predicted 50 bn things to be connected to the internet in 2020, however now **halved this number to around 25 bn devices in 2020** in their latest report (06/2016). Gartner estimates 20.8 bn connected devices by 2020

M2M; non celullar | M2M and consumer electronics; celullar | Consumer electronics; non celular | PC, labtop, tablet | Mobile phones | Fixed phones

Notes: CE = Consumer Electronics 1) a connected device is a physical object that has an IP stack, enabling two-way communication over a network interface (traditional landline phones are included for legacy reasons)

Source: Ericsson, Cisco, Gartner

A world of sensors envelopes our business and private lives – Changing habits and products

- **By 2020/21, approximatively 20-30 bn devices[1] will be online/connected worldwide,** with a further increase by 2030. Virtual (VR) and augmented reality (AR) have the potential to become the next big computing platform (after the PC, the web and smartphones/tablets) and reshape existing ways of doing things. IDC predicts that worldwide revenues for the AR/VR market will grow from USD 5.2 billion in 2016 to more than USD 162 billion in 2020 (+136 % p.a.). Mobile AR is likely to become the primary driver of the VR/AR market. **New mobile devices** incorporating smart glasses set the trend, leading from networking devices to networked humans. **Smart cities** designed and built from scratch are a new reality (e.g. Songdo in South Korea), **where physical objects are connected to interact** or follow human supervision. Established through public-private partnerships, these cities will become more and more ubiquitous in countries facing pressure from high urbanization rates
- **Sensors in all major objects** create a **network of interfaces between real and digital life.** Improvements in **biometrics** with facial recognition play a key role in **connecting humans with their virtual realm** in real-time, with everyday objects recognizing authorized users on streets, public transport or in shops. **Personalized advertisement** will be the norm. **EEG[2]/brain wave/mind-controlled devices,** such as headsets, tablets or screens, will **allow new ways of interaction between humans and products,** in private and public places.
- **New hardware** and sensors incorporated into clothes, glasses, cars etc. **will be integral to this new cyber reality** by 2030. Virtual retinal and/or other hardware displays allow **content to be displayed floating in front of users**; spatial augmented reality solutions project virtual information onto physical objects. **New possibilities** arise also with commercialized **virtual holidays, e-therapy** in healthcare as well as **virtual counseling** by doctors, and **electronic health records,** decentralized but accessible to medical staff and patients, and (anonymously aggregated and analyzed) to help provide smart insurance products and predict epidemics or disease hotspots

1) Excluding smartphones, tablets, and computers 2) Electroencephalography: Detection/recording of electrical brain activity along the scalp

Source: BBC, ABI, WEF, WirtschaftsWoche, InnovationExcellence, SRI, Futuresearch, IDC, Goldman Sachs, Digi-Capital, Gartner

Roland Berger and others are forecasting vast market dynamics: Digital Transformation/IoT boost global economy over next decades

Economic value creation in Europe and globally with Digital Transformation/IoT

Europe

1.25

Roland Berger estimates an increase in value added through Digital Transformation of 20-30% or **EUR 1.25 trillion** for European industry by **2025**

> 1.0

The European Commission predicts that the EU market value of the IoT is expected to exceed **EUR 1 trillion in 2020**

Global

8.0

Cisco predicts that IoT will generate **USD 8 trillion** worldwide in Value at Stake[1)] over the next decade **(2015-2024)**

3.0

Machina Research estimates the total IoT revenue opportunity at **USD 3 trillion** in **2025** (up from USD 750 billion in 2015)

1) The potential bottom-line value (higher revenue and lower costs) that can be created or that will migrate among the private and public sector

Source: Roland Berger, European Commission, Cisco, Machina Research

Processing myriad data points demands new hard- and software – But this pays off in higher value added and productivity

- **A world of sensors** and connected devices offers great **opportunities for individualizing services and products,** but **processing a nearly infinite data stream is a core challenge. Advances in high-tech computing** (e.g. cloud computing, GPUs[1)] and quantum computers in the future) **provide solutions for structuring and processing this amount of big data.** With progress in semantic and linguistic contextual analysis, vast volumes of qualitative, not just quantitative data bring further insights regarding markets, competitors, product data and customer behavior
- **The Digital Transformation** will affect the global economy to a far stronger extent than the internet revolution of 1995-2005. **Projections in value added** with regard to Digital Transformation opportunities in business and industry, as well as inter- and cross-disciplinary synergies, **reflect tremendous expectations.** Due to Digital Transformation, the **increase in data continues with high speed**: having increased tenfold from 2006 to 2012, data generated will be **8.3 times larger** (exabytes per month) **by 2020 compared to 2015**
- A study from the MIT Centre for Digital Business found that already today, **companies** that were one standard deviation **higher in being data-driven** had **4% higher productivity and 6% higher profits** than the average. **Retailers reduce inventory by 20%** with self-learning algorithms, due to refined sales predictions. **Overall productivity gains can rise by up to 20-30% to 2025,** depending on the rate of technology adoption within economies and companies. **Salesforce** (one of the largest customer relationship management (CRM) companies) will be using **IBM Watson** to optimize its AI CRM service (Einstein AI). **Einstein AI** is designed to analyze and understand information and data collected. Its customer value proposition encompasses sales, service, marketing, commerce and other corporate functions
- Regarding **digitalization processes in companies,** the role of **digital directors** is **gaining traction.** About half of today's 300 largest companies[2)] appointed a digital director in the last couple of years, indicative of an accelerating trend

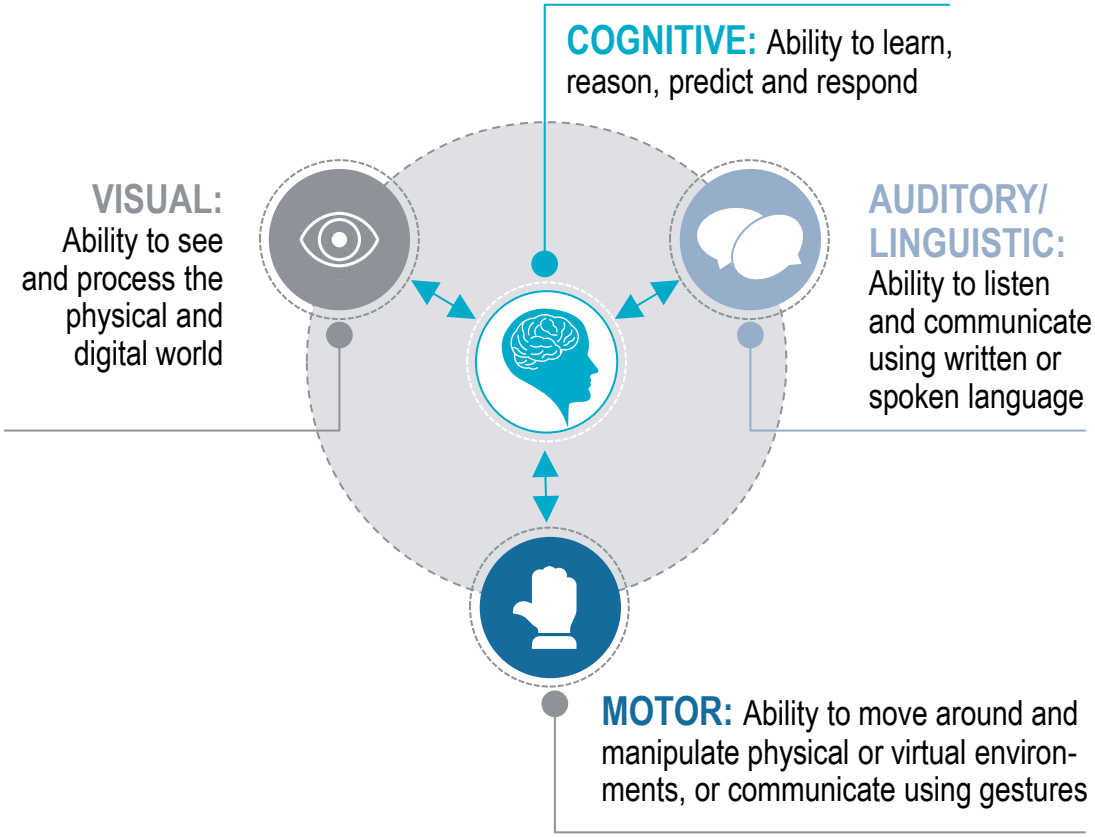
1) A Graphics Processing Unit (GPU) is is a specialized electronic circuit designed to rapidly manipulate and alter memory to accelerate the creation of images 1) Fortune 100 USA; Fortune 100 Europe; Fortune 100 Asia/Pacific

Source: GE, NIC, Gartner, Fraunhofer, MIT, BITKOM, HBR, WirstchaftsWoche, SZ, SRI, Russel Reynolds

Artificial Intelligence (AI) will change our future – AI comprises intelligent systems that can sense, think, interact and learn

Definition of Artificial Intelligence

> Today, AI refers to systems that employ **machine learning** and can
  - **Sense**: Collect and process signals via sensors or other methods
  - **Think**: Classify, reason, and predict possible outcomes
  - **Interact**: Interact with people or other machines
> The **cognitive ability** is the key distinction between machines and rule-based systems. Without it, machines simply respond to pre-defined inputs**; with it, they can self-program based on new data**



Source: Altimeter

AI affects a wide range of products, technologies and industries …

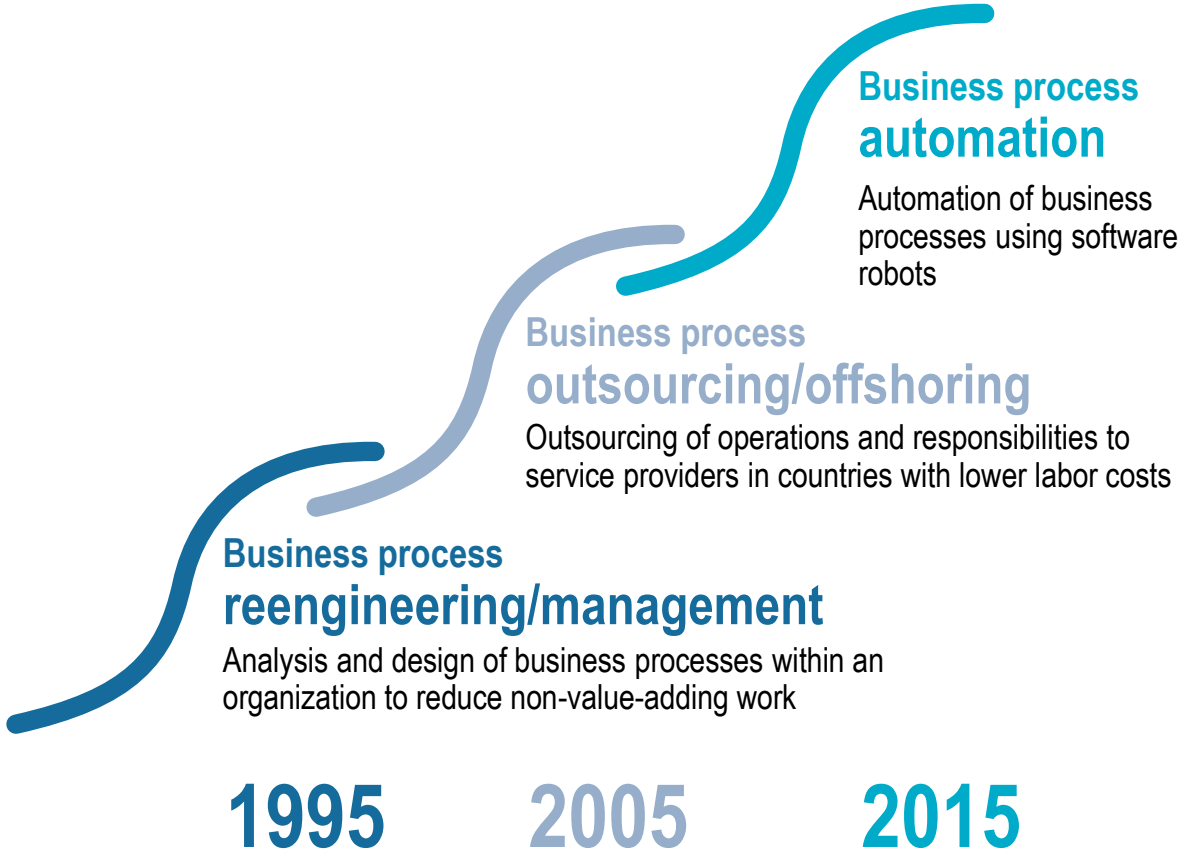
Examples of Artificial Intelligence in consumer and business applications

Products & Technologies	Driverless Cars & Drones	Augmented & Virtual Reality	Chatbots & Intelligent Agents	Machine Learning Algorithms	Imaging (Computer Vision)	Robots & Robotics
Potential Value	> Transportation > Delivery > Quality assurance > Security	> Cross-channel insights > Language translation > 3-D maps > Virtual shopping	> Customer service & experience > Personal productivity > Knowledge management	> Forecasting > Knowledge management > Price/purchase prediction > Virtual sales assistants	> Virtual diagnostics > Brand management > Quality assurance	> Automating manual processes
Relevant Industries	> Transportation & logistics > Oil and gas > Manufacturing > Security & defense	> Hospitality > Travel > Retail > Gaming > Media > Entertainment > Medicine > Manufacturing	> Consumer Electronics > Travel > Retail > Beauty > B2B sales > Legal services	> City planning > Financial serv. > Retail > Healthcare > Food safety > Security > Transportation	> Medicine > Manufacturing > Architecture > Retail > Food & beverage > Security	> Security > Smart homes > Precision medicine > Manufacturing > Transportation

Source: Altimeter

… and has the potential to raise efficiency to the next level across industries

Major efficiency levers over time



> *Today artificial intelligence is where the internet was in 1996*
>
> ***AI Research Lab Merantix***

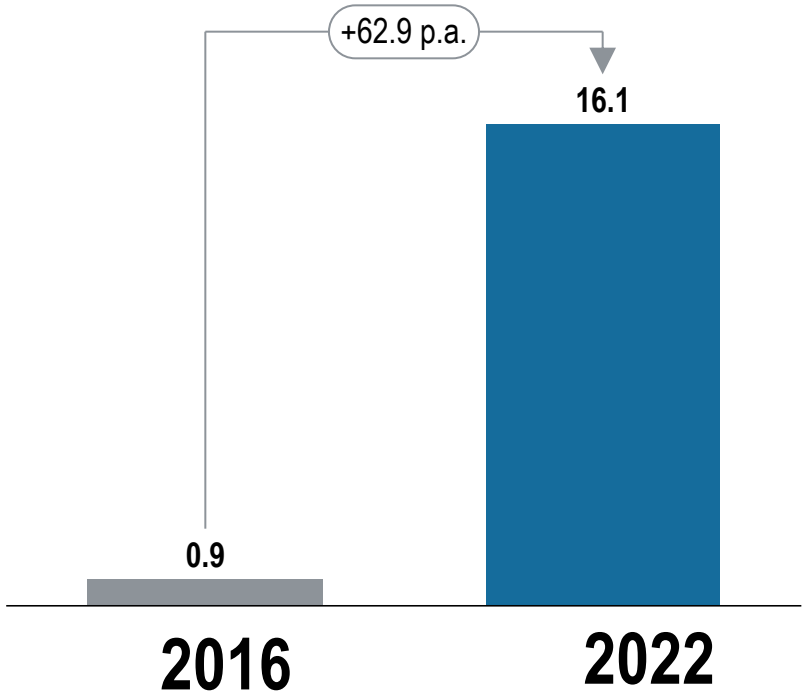
> *What can these things do? We don't really know the limits. It has incredible possibilities. I think it's impossible to forecast accurately*
>
> ***Sergey Brin – Google co-founder***

> *Every aspect of our lives will be transformed. In short, success in creating AI could be the biggest event in the history of our civilization*
>
> ***Stephen Hawking – theoretical physicist and cosmologist***

Source: Press research, WEF, Merantix

Predictions show a huge market growth potential for AI with corporate investment increasing threefold in the near term

AI hardware market[1] worldwide 2016 vs. 2022 [bn]



- The **AI hardware market** is expected to be worth USD 16.1 billion by 2022, growing at a **CAGR of 62.9%** from 2016 to 2022 according to MarketsandMarkets
- Forrester predicts that across all businesses **investment in AI** will be **three times greater in 2017** compared with 2016
- The **field of AI is shifting** toward building **intelligent systems that can collaborate effectively** with people, including creative ways to develop interactive and scalable ways for people to teach robots
- Gartner predicts that **by 2020**, **100 million consumers will shop in augmented reality** to enhance the shopping process, resulting in dramatically higher levels of customer engagement

1) Artificial intelligence is a consolidation of state-of-the-art technologies which are used to develop products which work similar to human intelligence. It considers revenues generated from the hardware devices which go into making of following AI technologies such as Deep Learning (DL), Robotics, Digital Personal Assistant, Querying Method, Natural Language Processing (NLP), Context Aware Processing. Third party software/platform and service providers in the AI ecosystem are not included

Source: MarketsandMarkets, Stanford University, Gartner

Industry is fundamentally influenced by Digital Transformation – Industry 4.0 and the Industrial Internet address different aspects

	Industry 4.0	Industrial Internet
Key authors	> German Government, acatech (National Academy of Science and Engineering)	> Large Multinationals such as GE, AT&T Intel, IBM, Cisco
Taxonomy of revolutions	> Four (mechanization, mass production, automation, robotization)	> Three (industrial revolution, internet revolution, industrial internet revolution)
Strategic focus	> Industrial policy: "the German strategic initiative to take up a pioneering role in industrial IT"	> Interoperability: "establishing interoperability in various industrial environments"
Sectoral focus	> Manufacturing	> Manufacturing, energy, transportation, healthcare, utilities, cities, agriculture
Technological focus	> Supply chain coordination, embedded systems, automation, robotics	> Device communication, controls and integration, data flows, predictive analytics, automation
Optimization focus	> Production	> Asset

Source: MAPI

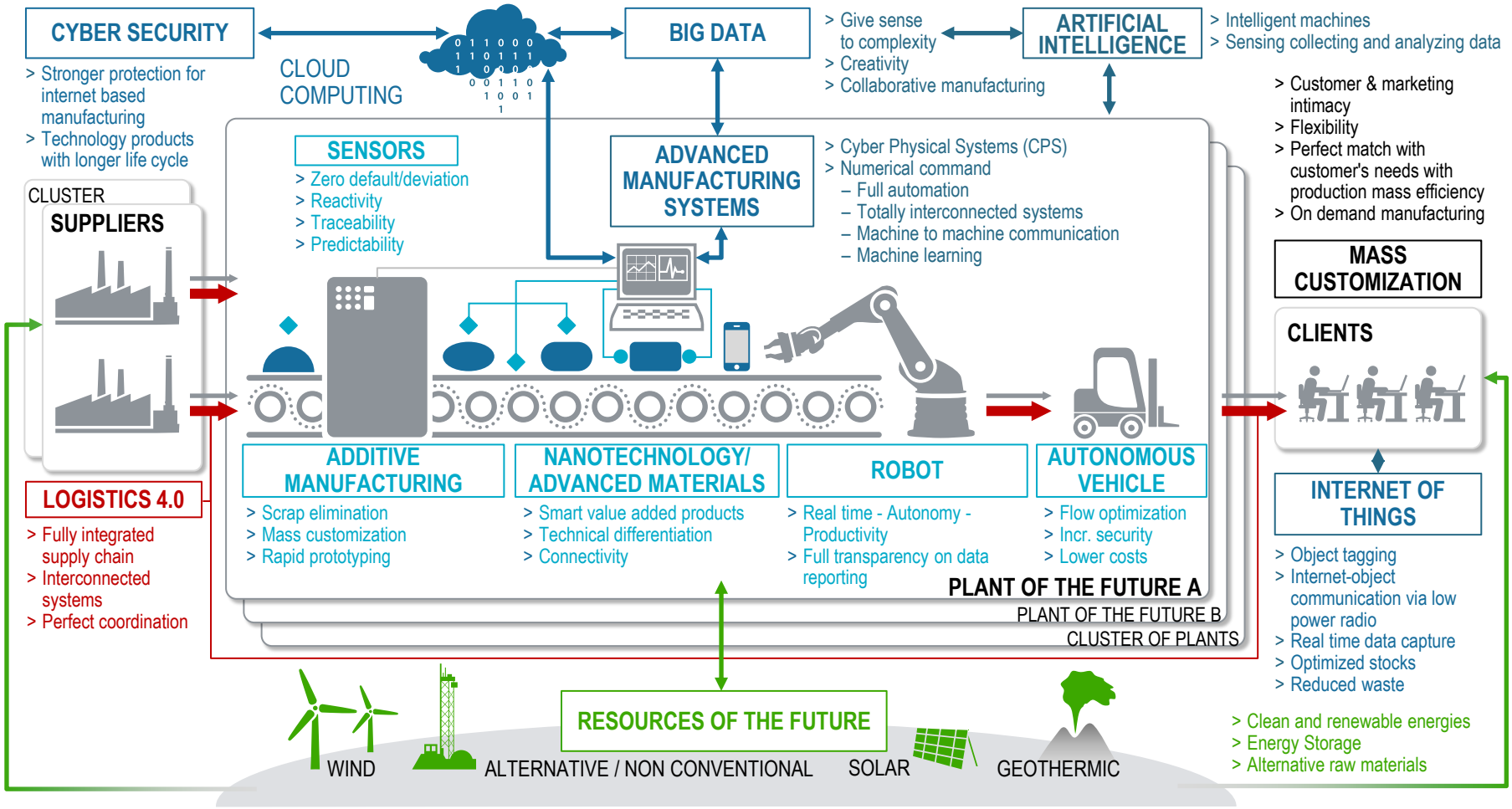
Industry 4.0 focuses on manufacturing while the Industrial Internet takes a broader view – Approaches cooperate, not compete

- **Industry 4.0, first coined in Germany in 2011,** focuses on the **manufacturing industry** and the **optimization of the production process** by bringing together intelligent machines, advanced analytics, and people at work. It embodies a network of numerous devices connected by communications technologies that results in systems that can monitor, collect, exchange, analyze, and deliver valuable new insights. These insights help to drive smarter, faster business decisions for industrial companies. Industry 4.0 **dominates in the EU** due to a strong German manufacturing base, corporate and academic thought leadership and government programs
- The **Industrial Internet** also known as the **Industrial Internet of Things** (IIoT), is an **American approach** that describes **similar phenomena** to those summarized under **Industry 4.0**. The main difference between the two systems is that the Industrial Internet **goes beyond manufacturing** to cover the wider adoption of the web into other forms of economic activity. It **applies to several sectors**, such as manufacturing, energy, transportation, healthcare, utilities, agriculture and cities. The focus of the Industrial Internet is the **optimization of assets** and not limited to the production process, as seen in Industry 4.0
- The term "**Industrial Internet**" was coined by **General Electric**, and joined by AT&T, Cisco, Intel, and IBM to set up the **Industrial Internet Consortium** (IIC) **in 2014**. The IIC is a non-profit, open membership organization with over 250 members that was formed to accelerate the development, adoption and widespread use of interconnected machines and devices, and intelligent analytics. The IIC **catalyzes and coordinates the priorities and enabling technologies of industry, academia and the government around the Industrial Internet**
- Industry 4.0 and the Industrial Internet do not compete with one another – they are **complementary**. Representatives of the **platform Industry 4.0 and the IIC have agreed to cooperate** to ensure future interoperability of the systems, standardization and the use common test environments. A common roadmap has been developed for this purpose

Source: MAPI, Siemens, Industrial Internet Consortium

Industry 4.0 exemplifies this complex industrial ecosystem – New technologies will interconnect and disrupt business

Industry 4.0 ecosystem



Industry 4.0/Industrial Internet offer great variety and potential in new technologies and business model improvements

> Enabling an **Industry 4.0/Industrial Internet infrastructure** within a business is challenging. The **vast range of new technologies** makes it necessary to scrutinize a company's capabilities and its readiness to implement technologies. Not only technological innovations, but also **business model innovations** are being created. A stronger demand-side focus instead of supply-side is required, with **individual product services** and **faster response rates to customer needs;** this requires looking beyond horizontal integration and **strengthening the vertical integration** of production

> **Smart Robotics** continue to change business processes. New **machine to machine** (M2M) interfaces enable robots to **communicate, coordinate** and **repair themselves.** The total M2M revenue opportunity will grow by 12% annually from USD 500 billion in 2014 to USD 1.6 trillion in 2024. China and the US will be competing neck and neck for dominance of the global M2M market by 2024. China which will account for 21% of global M2M connections, ahead of the US on 20%. However, the US wins in terms of cellular connections (20% vs 15%) and M2M revenue (23% vs 19%). Third largest market is Japan with 8% of all connections, 6% of cellular and 7% of global revenue. With current growth rates for industrial and private sector robots, **robots could outnumber humans as early as 2040**

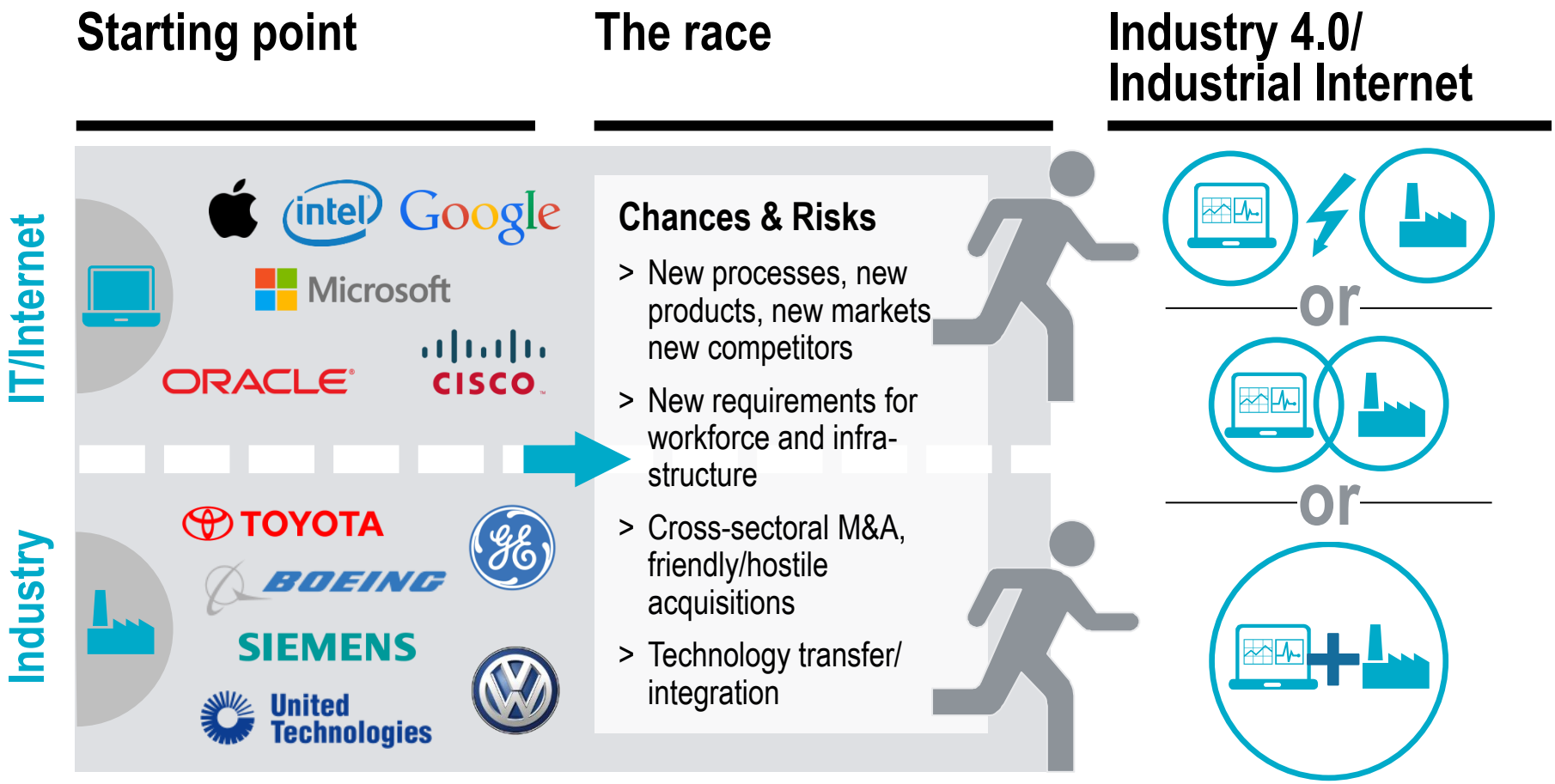
> Improvements of microcontrollers and **sensors embedded in systems** enable **streamlining of processes,** such as **monitoring** machine performance, **tracking** production completion, **inventory management** and rising **resource efficiency.** All in all, a **holistic approach to Industry 4.0/Industrial Internet** implementation makes it possible to **act proactively,** anticipating problems in production, logistics and customer services, instead of acting on historical data

> To capture the value **potential of Industry 4.0/Industrial Internet**, physical **product sales need to be understood with an IoT mindset** based on corresponding control points in products regarding the connection of products and their performance analysis. **Pure manufacturing** of physical assets **will gradually vanish** in favor of additional value added services, subscriptions or product apps. Today, about one quarter of industrial companies' production is digitized in terms of processes. The industrial sectors are planning to commit approx. 5% of revenues per annum to Industry 4.0

Source: IFR, Gartner, Fraunhofer, Harvard Business Review, SAP, Statista, Cisco, Machina Research, PWC

Global run for leading positions in Industry 4.0/Industrial Internet – Competition, co-opetition or collaboration?

The race to Industry 4.0/Industrial Internet



Winning with Industry 4.0/Industrial Internet – Guidance on technology and governance is needed

> At company level, **technology firms compete with traditional industrial companies** for the rewards of **Industry 4.0/Industrial Internet**. Increasingly, the two are **repositioning themselves** in terms of **competition, co-opetition** or **collaboration.** With the rising share of digitalization in manufacturing and the production of IT-intensive goods, **industry's dependency on IT/Internet companies increases** collaboration and co-opetition. Also, **IT/Internet companies are likely to alter traditional business** portfolios through disruptive and sustaining innovations, competing with existing products/services of industry. In turn, these developments cause higher levels of joint ventures and M&A activity between the two sectors

> With the ability of gaining and processing Big Data, **technology companies** can become **crucial partners of industry companies.** Engaging with **Industry 4.0/Industrial Internet means** investing near-term to widen technological perspective, **opening new production and service related pathways** while avoiding to fall behind in the "technology arms race". However, **data integrity and security** on a corporate level **is crucial** in order **to maintain clients' trust** in **Industry 4.0/Industrial Internet**. The importance of machinery data, its sensitive nature in terms of competition and therefore data safety, will increase with **Industry 4.0/Industrial Internet** implementation due to new M2M connections and sensors in products and equipment

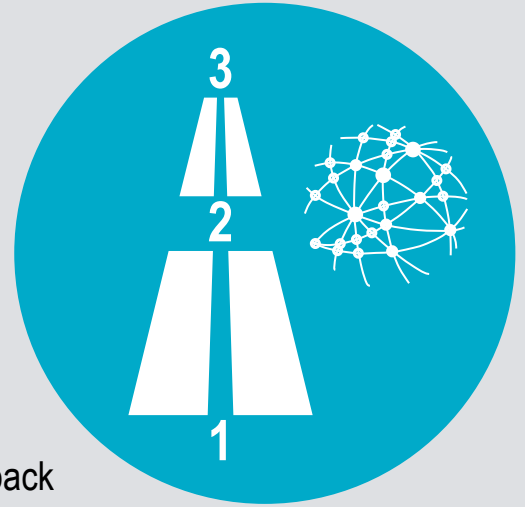
> With **Industry 4.0/Industrial Internet** being a field of vast growth opportunity, **governments and companies strongly advocate their interests. Standardization** (and its management) is seen as a **key issue** of supremacy. Germany, UK, France and the USA favor public-private governance concerning standardization: The **biggest interest groups** are found within the American **"Industrial Internet Consortium"** (IIC) and the **"Industrie 4.0 Plattform"** in Germany

> Overall outcome of the **race for Industry 4.0/Industrial Internet** dominance is as yet **undecided**; the **US** leads in **software and digital solutions** and follows a **pragmatic, trial and error approach in handling innovations,** while **Europe** thrives on its **industrial competence**

Source: VDE, DIN, China Times, Computerworld, Computerwoche

To capture the potential of innovation, companies need to use innovation roadmaps, research networks and think creatively

- After identifying new, marketable technologies within its business, **companies should set up an innovation roadmap** in order **to implement new business models and technologies** in a progressive manner, leading to achieving a clearly defined, future target. Not only does this innovation roadmap include new technologies but also the **strategic management of the wider innovation portfolio**
- A way to **extend R&D activities** without considerable investment is to establish or seek out and join cooperative **research partnerships** and networks. Financial benefits aside, advantages often lie in **synergies between and across different fields.** Partnerships can be formed with business partners, universities or research institutes. On a political level, **networking with e.g. foreign chambers of commerce** or NGOs will **facilitate market entrance** especially in developing countries
- The **creation of innovation demands the mastery of two opposing skills – convergent** (deriving at the single best answer) and **divergent** (exploring many possible solutions) **thinking** in equal measure. Before bringing together different ideas and aggregating them into a new best one, it is essential to first think creatively considering multiple new perspectives and possibilities
- **Foster beneficial exchanges outside and across the corporation,** between cultural and technological sectors; sensitize and/or reward relevant employees for honing an innovation mindset; keep awareness of new trends high on the agenda. The question needs to be answered whether digital innovation should be positioned within the company (either as "stand-alone" solution or integrated in certain departments) or outside as an "external vehicle" or unit, and how this could be linked back to the core business



To exploit the high potential of Life Sciences companies need to adjust their product and innovation portfolio

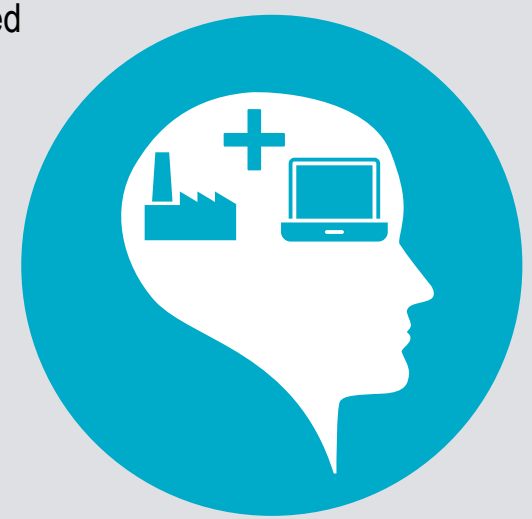
- Corporations active in **Life Sciences** face **great opportunities,** due to global **societal and environmental changes.** Societies and economies are adapting their inputs of **biotechnological solutions; food supply** challenges can be resolved with new **resilient crops** and animal food containing more protein. Demand for **biotech-based** instead of chemical-based **pharmaceuticals** is rising, and the importance of innovative **medical technology** becomes paramount in **aging societies**
- **Every market and every product needs a tailored strategy** to become successful. Managing the vast differences between certain markets and their products is challenging and demands a **sophisticated product management** from the earliest stages of product development onward. **Sensible innovation portfolio management** is able to exploit opportunities of many different markets. With generics substituting blockbuster products, product portfolios adapt from quantity to value-based offerings, **reflecting changing market demands**
- **Different markets offer different policy frameworks** regarding sales and research for new products. A **decentralized organization** dependent on fulfilling policy obligations is best positioned closer to sales markets while avoiding dead-end research
- The **long term research** for new products **is challenging** for research itself but also in financial terms. **Product pipelines require monitoring,** internal targets need to be set and achieved
- **Product financing has to be re-evaluated,** finding new ways to fund or support cost-intensive research. Here, e.g. **licensing of products can help** finance new research projects and **optimize cash management**

Unlocking new growth pathways with Digital Transformation requires rethinking along a user-centric approach, an agile culture ...

- Companies must **change from a product-centric to a user-centric approach to design customer-centric products and services**. They should focus on **identifying and fulfilling key customer needs** and aspirations to create the best solution for customer requirements rather than developing new offerings 'for novelty's sake'
- Companies should **rethink their traditional corporate cultures** to detect and realize customer needs and innovation potential in time. They must **create an agile culture that emphasizes transparency, flexibility, trust and collaboration** to enable the transformation to a digitally mature and dynamic organization. Therefore they must **change from a traditional mindset to a digital one** that is data driven, self organized, purpose oriented, customer centric, transparent and incorporates a risk culture that allows to fail fast
- Digital Transformation should be built into the **core strategy, processes and systems of an organization** – with the right people being in the lead. Digitalization should be addressed at CEO or board level with the clear designation of a digital director. The **biggest challenge** for companies isn't technology itself – **it is the mindset, the people and the organization's digital IQ**
- **Cooperation, networking** and forming **alliances is central** to capturing the potential of **Digital Transformation and Industry 4.0/Industrial Internet** with its **enhanced technological abilities.** Serving as a model of an **open ecosystem for technology collaboration,** the global "Open Automotive Alliance" exemplifies one pathway in which car manufacturer and technology companies create and optimize new products together

… embedded in a holistic digital platform strategy which analyzes potential disruptions and addresses technological shifts early

- Many companies have introduced a variety of digitalization initiatives that focus on isolated parts of the value chain. Instead they should implement and follow a **holistic digital platform strategy** that synchronizes their requirements. Through the creation of **two-sided networks** companies can achieve a **co-creation of value** while harvesting resources and capacity of an ecosystem they do not need to own and where content is added exponentially. The **ownership of customer data** and the direct ownership of the **customer relation** will decide on future success
- As digitalization **potentially disrupts** competitive positions and leads to radical shifts of profit pools, there is a need for **strategic analysis of disruptive market** scenarios. Companies must be **ready to change and enable their organizational** processes and provide the necessary framework conditions, e.g. in IT or security
- **Companies have to address technological shifts early,** since catching up on missed market trends is capital-intensive and hard to manage. Forrester predicts that firms that use AI, Big Data and IoT technologies to uncover new business insights will take over USD 1.2 trillion in revenue per annum from their less informed peers by 2020. A **network** to widen exchanges **between industry and IT players** brings the possibility of **identifying and incorporating crucial technology trends**, allowing new efficiency gains within vertical process integration
- Building up **a tailored, sophisticated data infrastructure is crucial,** since it transforms reactive management into **proactive decision making** regarding market trends, production performance and customer needs. Questions which need to be addressed concern data generating points and opportunities, data transparency and validity/validation of data in terms of decision processes



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Please contact us if you have any questions or comments – Six more megatrend insights await on our website

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Trend Compendium

https://www.rolandberger.com/en/Dossiers/Trend-Compendium.html

The bigger picture for a better strategy


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