



OLD SCHOOL • YOUNG MIND

Disruptive technologies in business

Session 2 – Disruptive innovation and Industry 4.0

Prof. Josip Marić, PhD



AACSB
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GRANDES
ÉCOLES



OBsis
IMPACT



ENPGE

Rules

- RESPECT the security measures – keep social distance, wear masks and wash hands regularly.
- RESPECT others – do not disturb the class!
- NO entertainment content / social media & communication on your computers.
- Pause (10-15min) each full hour.
- ONLINE PRESENCE - turn camera on (without exception).
- Be on time.



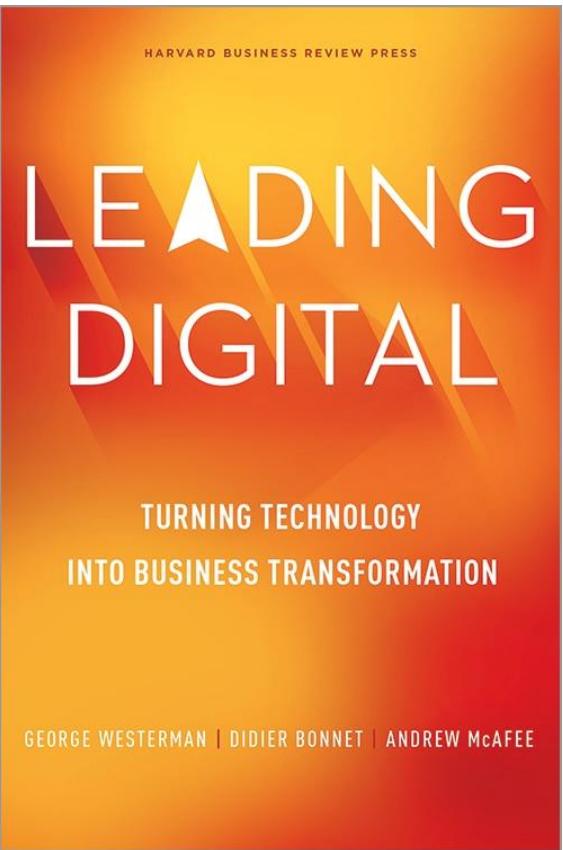
Course sessions and content

Session number	Day	Topic	Time slot (French Time)	Lecturer Format course	Student work
1	Monday 5 June 2023	Introduction to the course	10h-13h	Room 404	
2	Monday 5 June 2023	Disruptive innovation and Industry 4.0	14.30h-16.30h	Room 404	
3	Monday 5 June 2023	Emerging technologies of Industry 4.0 (I)	16.30h-18.30h	Room 404	Group presentations – team work
4	Wednesday 7 June 2023	Emerging technologies of Industry 4.0 (II)	10h-13h	Room 404	Group presentations – emerging technology
5	Wednesday 7 June 2023	Disruptive technologies – case of 3D printing	14.30h-16.30h	Room 404	Student work and simulation
6	Wednesday 7 June 2023	Disruptive technologies – case of AR/VR	16.30h-18.30h	Room 404	Student work and simulation

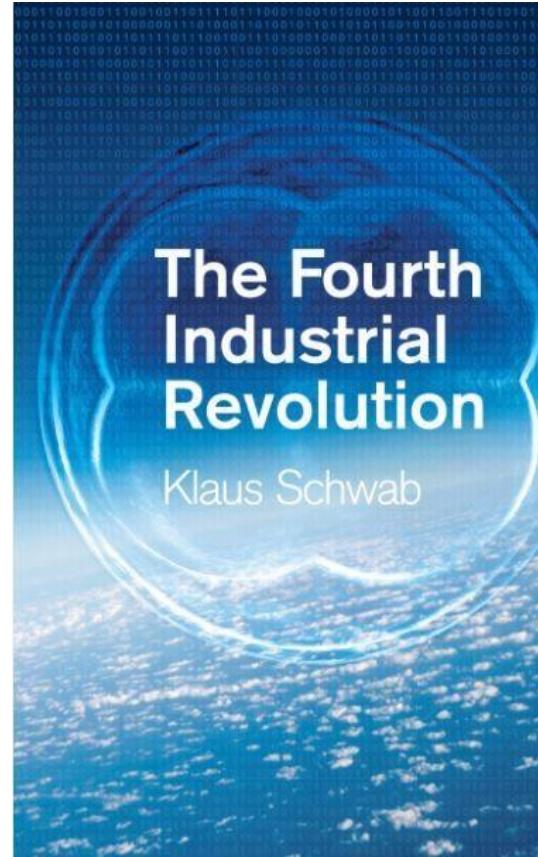
Course evaluation

Continuous Assessment (40%)	• Test (MCQ/Open end questions)	20%
	• Course Participation Mark	20%
Final Project (60%)	• Final Presentation (Session 4 “Emerging technologies of I4.0”)	60%
Total		100%

Recommended textbooks



George Westerman, Didier Bonnet, & Andrew McAfee (2014). *Leading digital: turning technology into business transformation*. Harvard Business Review Press



Klaus Schwab (2017). *The Fourth Industrial Revolution*. WEF, ISBN-10: 9781524758868.

Session 2 (S2)

Disruptive innovation and Industry 4.0



Session 2 (S2)

- ▶ Innovation
 - ▶ Disruptive innovation and Diffusions of Innovation (DoI)
- ▶ Industry 4.0
 - ▶ Historical perspective on I4.0
 - ▶ Technological perspective on I4.0
 - ▶ Measuring performance in I4.0

Innovation



Digital reality and business strategy

Companies must move fast to thrive



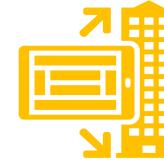
Industry 4.0

Hyper connectivity is improving quality, efficiencies, and opening up new opportunities



Pace of innovation

More than ever it is challenging to keep up with rapid innovations in products, services, capabilities, and processes



New business models

New digital capabilities are enabling creative service and business models for increasing revenue and customer satisfaction



Globalization

Companies must adapt to increasing and diverse compliance, accounting, sustainability, and competitive pressures

New technologies are serving as both disruptors and catalysts for significant industry change

Pace of innovation

**THE ONLY THING
CONSTANT IS
CHANGE**

HERACLITUS

"The enterprise that does not innovate inevitably ages and declines. And in a period of rapid change such as the present, an entrepreneurial period, the decline will be fast"

- Peter Drucker



From creativity to innovation

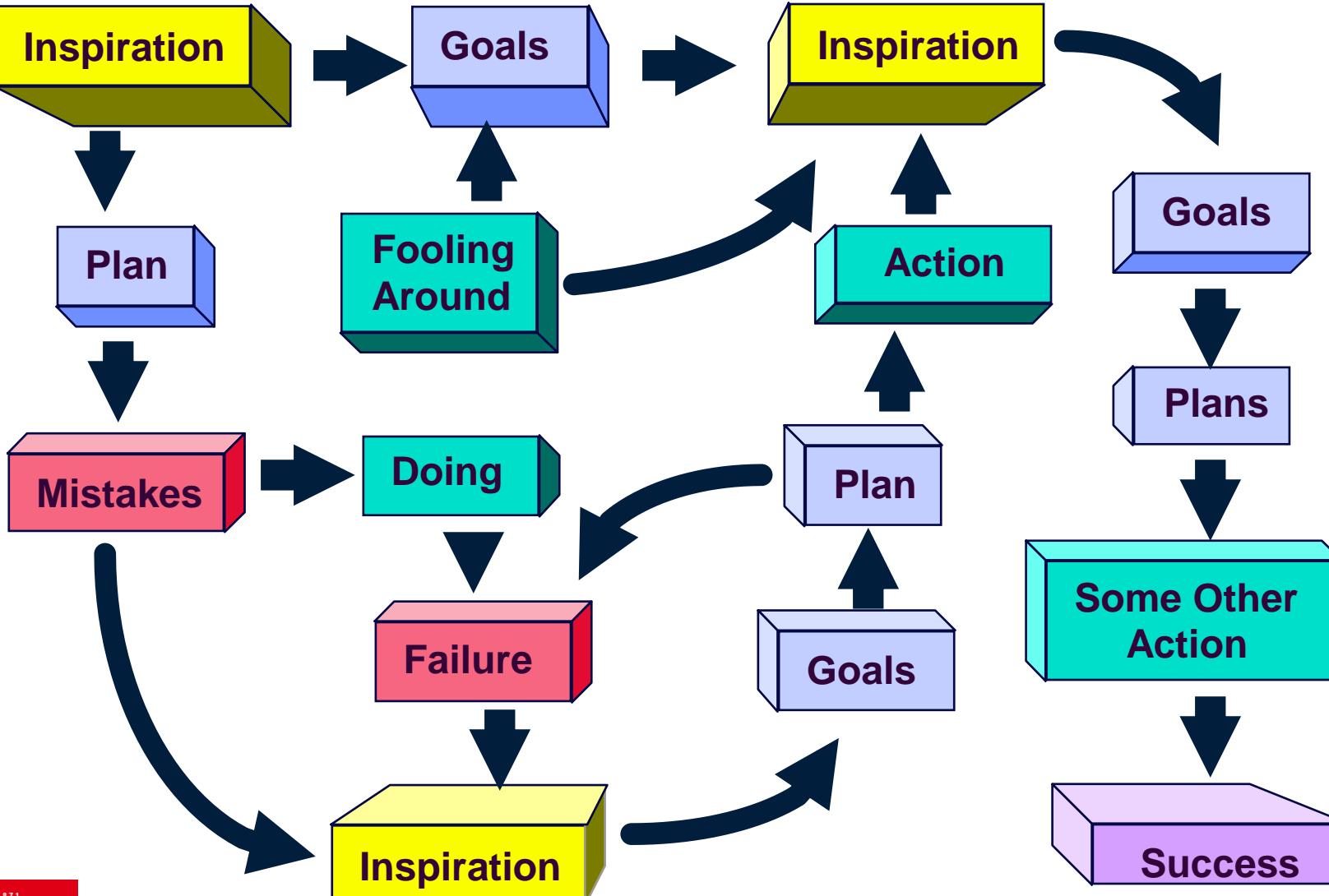


Creativity is thinking new things, and innovation is doing new things

- Creativity is the ability to develop new ideas and to discover new ways of looking at problems and opportunities.
- Innovation is the ability to apply creative solutions to those problems and opportunities in order to enhance people's lives or to enrich society

Entrepreneurship = creativity + innovation

Starting a business from an idea

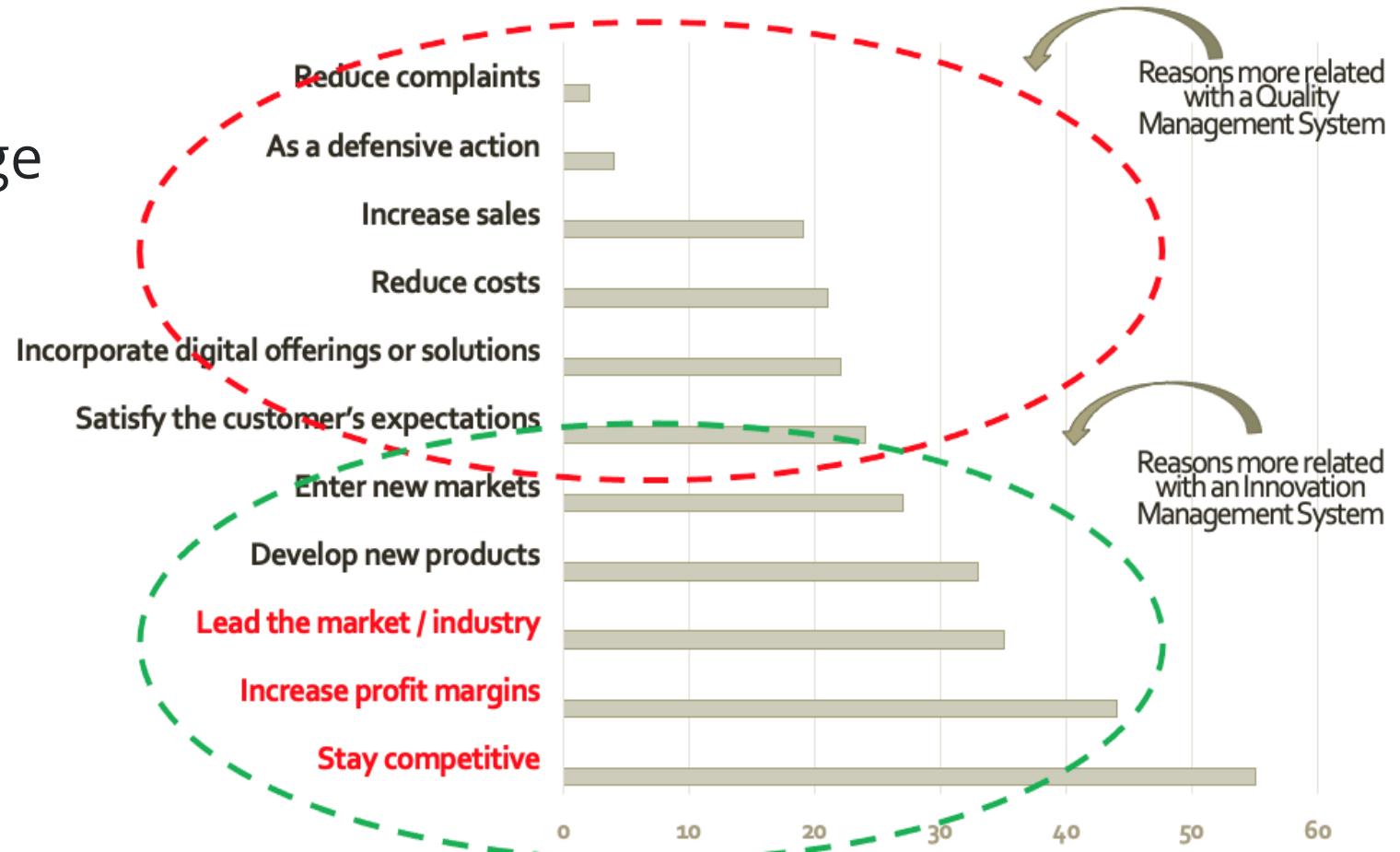


Source: Pinchot & Pellman,
Intrapreneurship in Action

Drivers of innovation

Why innovate?

- Competitive advantage
- Profit
- Market leadership



Source: PWC Strategy & Argentina - 300 cases - 2017

Disruptive technologies and innovation

Technological innovations – based on specific technology, invention, discovery

- Clayton Christensen has offered a framework to describe outcomes of innovative technologies, which highlights two main categories of these technologies
 - **Sustaining or incremental technologies**
 - **Disruptive or radical technologies**
- Sustaining or incremental technologies are well understood and typically exploited by market leaders, which produce continuous, incremental improvements over time

1 Clayton M. Christensen, Michael E. Raynor, & Rory McDonald (2015) What Is Disruptive Innovation? Harvard Business Review. URL: <https://hbr.org/2015/12/what-is-disruptive-innovation>

2 Joseph L. Bower & Clayton M. Christensen (1995). Disruptive innovation - catching the wave. Harvard Business Review. URL: <https://hbr.org/1995/01/disruptive-technologies-catching-the-wave>

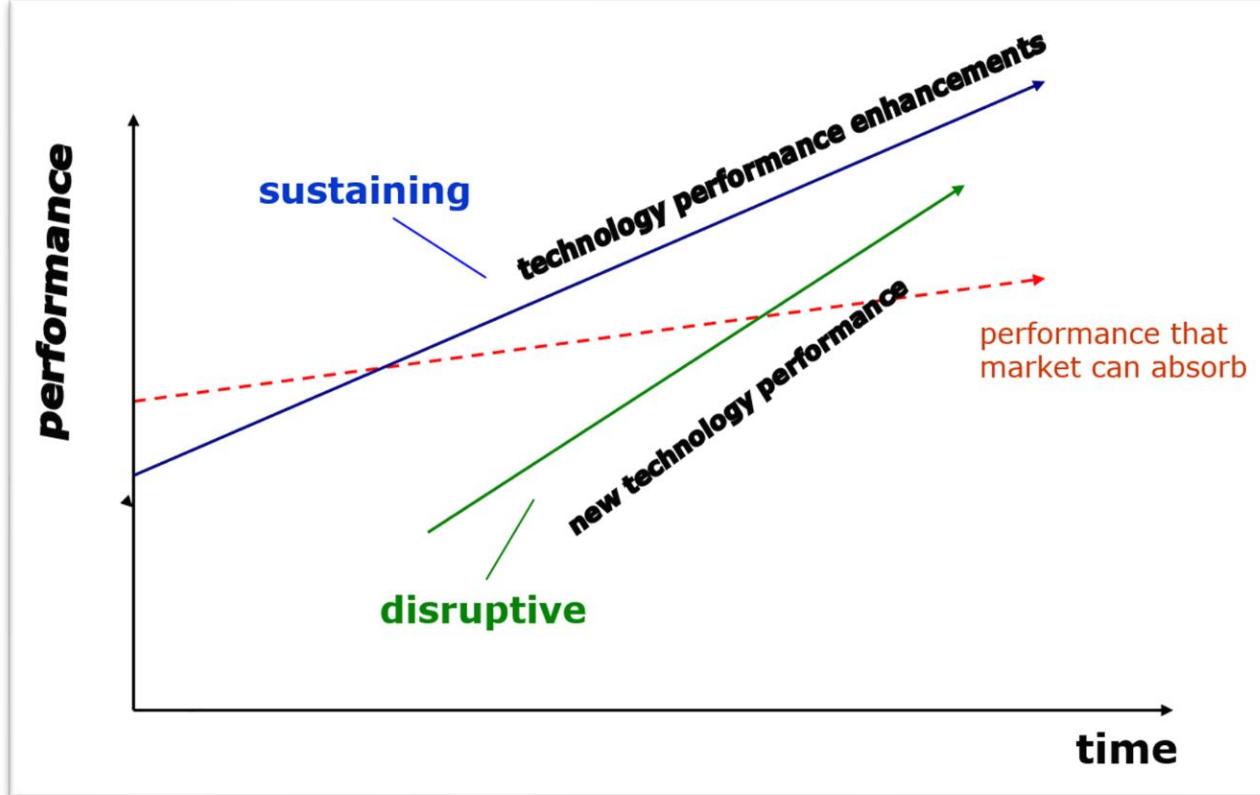
Disruptive innovation

Disruptive innovation (or technology) that brings sweeping change to businesses, industries, markets

- Examples: personal computers, smartphones, Internet, artificial intelligence, autonomous vehicles, social media
- First movers and fast followers
 - **First movers—*inventors of disruptive technologies***
 - Fast followers—firms with the size and resources to capitalize on that technology



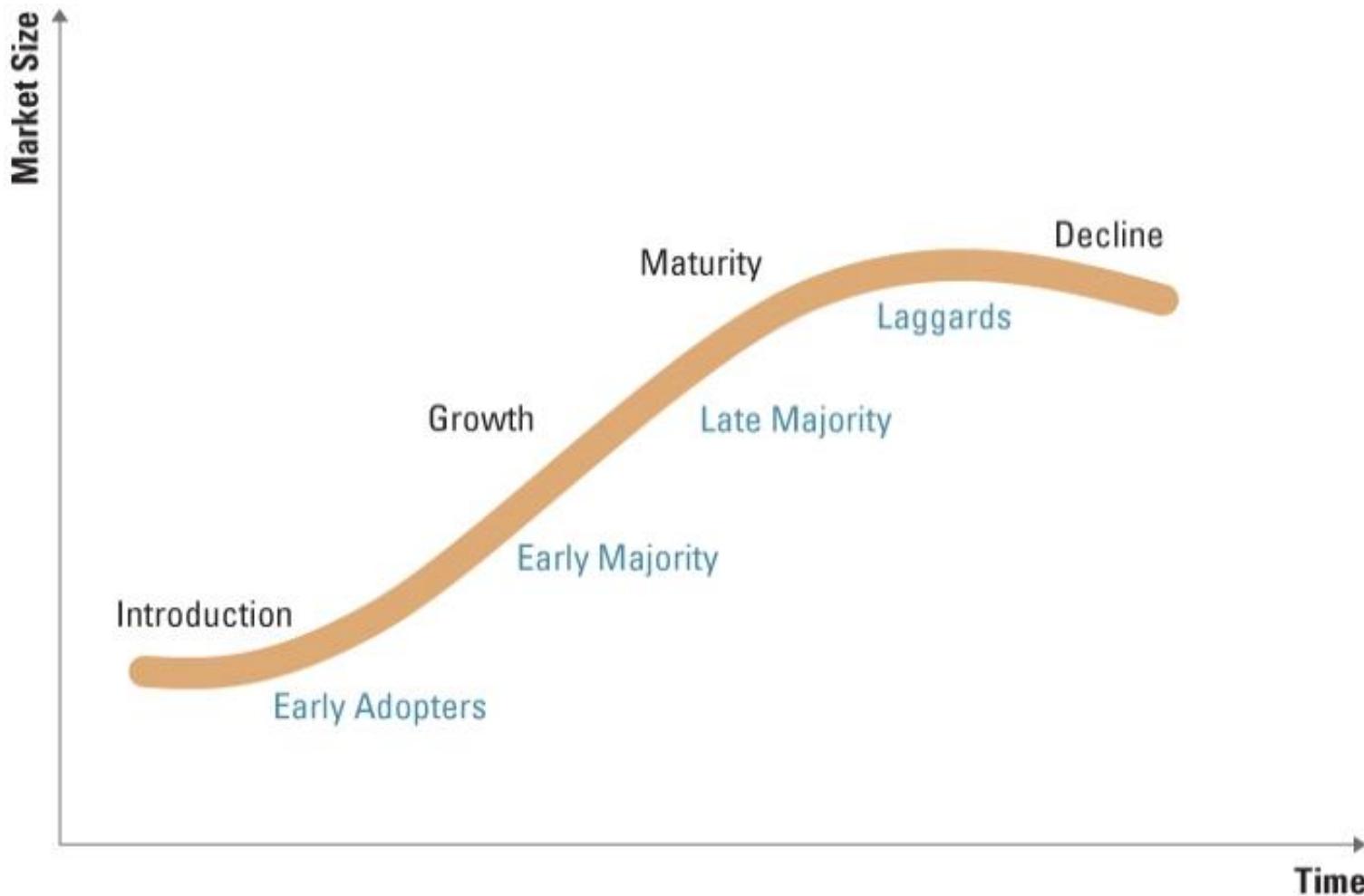
Disruptive innovation



- Innovations inevitably improve market when they scale-up and "disrupt" incumbents by gradually pushing them out of ever more complex and margin-rich product segments

Adapted from *The Innovator's Dilemma*, Clayton Christensen

Diffusion of Innovation (DoI)



Adapted from Rogers, *Diffusion of Innovations*

Diffusion of Innovation (DoI)

Classify consumers into groups, according to their tendency to adopt new products and which persuasive arguments will prompt them to adopt

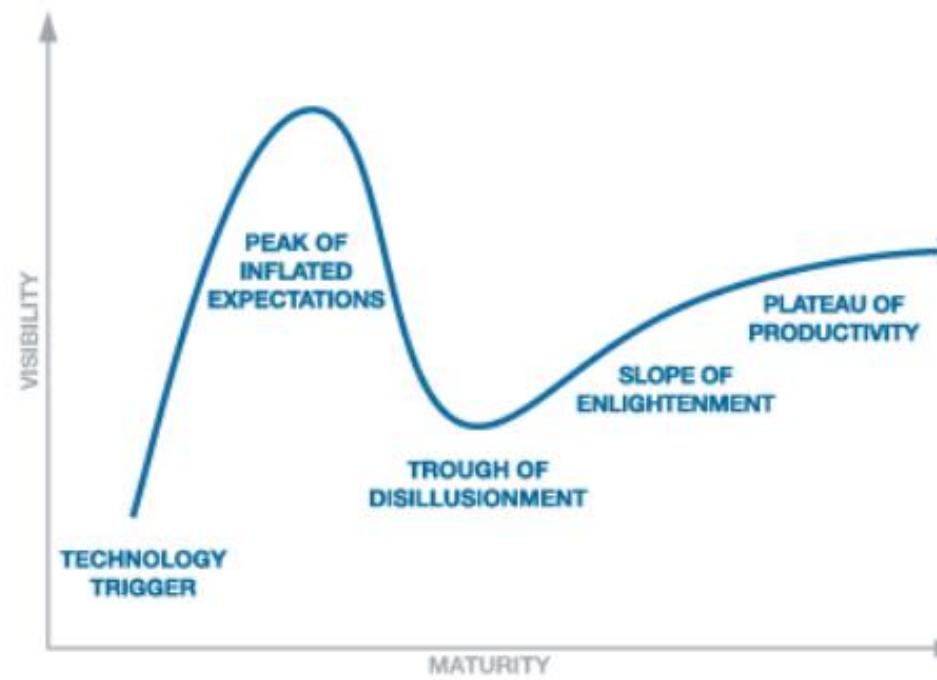
- **Adoption lifecycle** of an suggests five groups of potential users:

1. *Innovators* are the first to adopt, often before the new offering even is officially launched
2. *Early adopters* see the benefits of the new technology and are willing to adopt it after just a few references
3. The *early majority* consists of much more pragmatic consumers, who need to be convinced that the new product really works
4. Both of the last two groups, *late majority* and *laggards*, also want more evidence, but they are especially hard to persuade



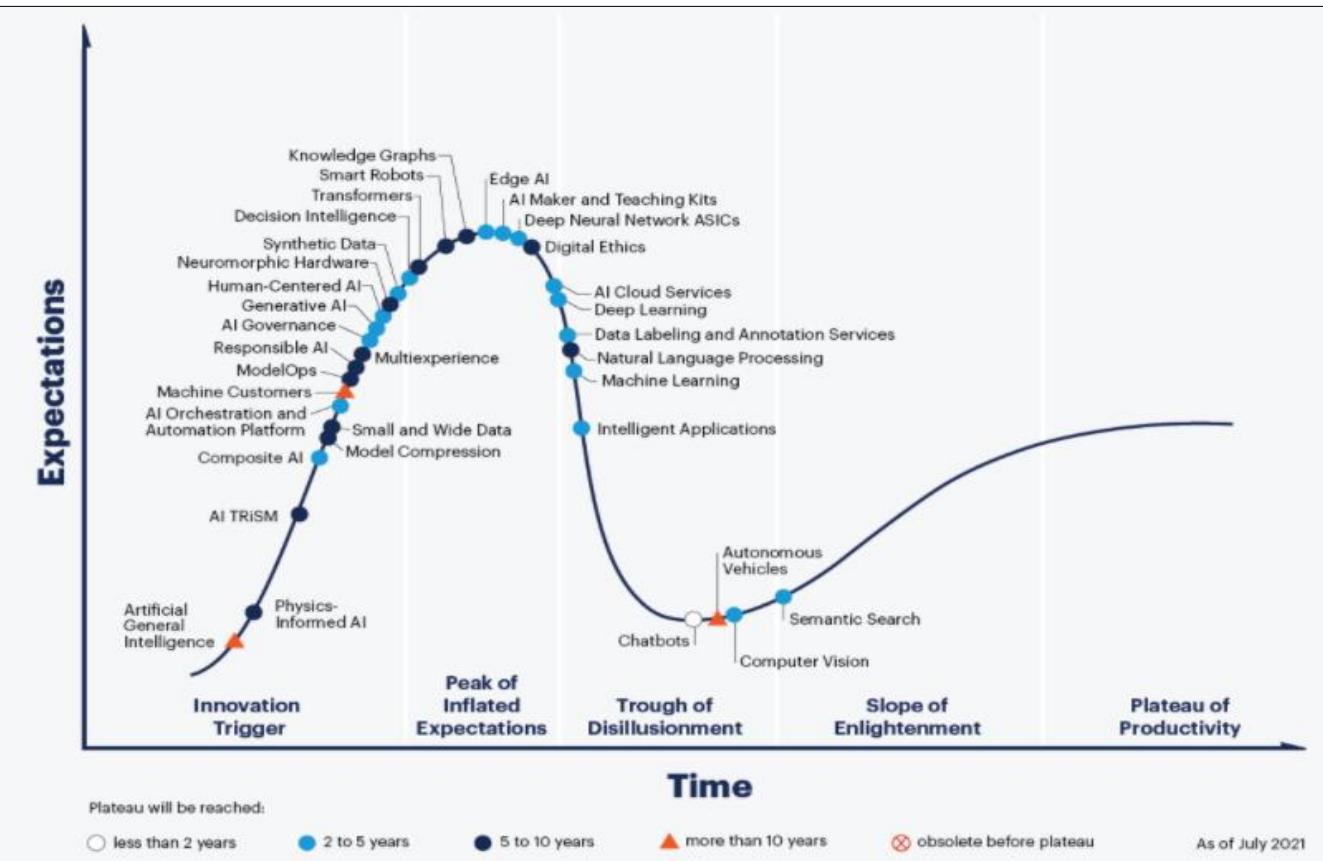
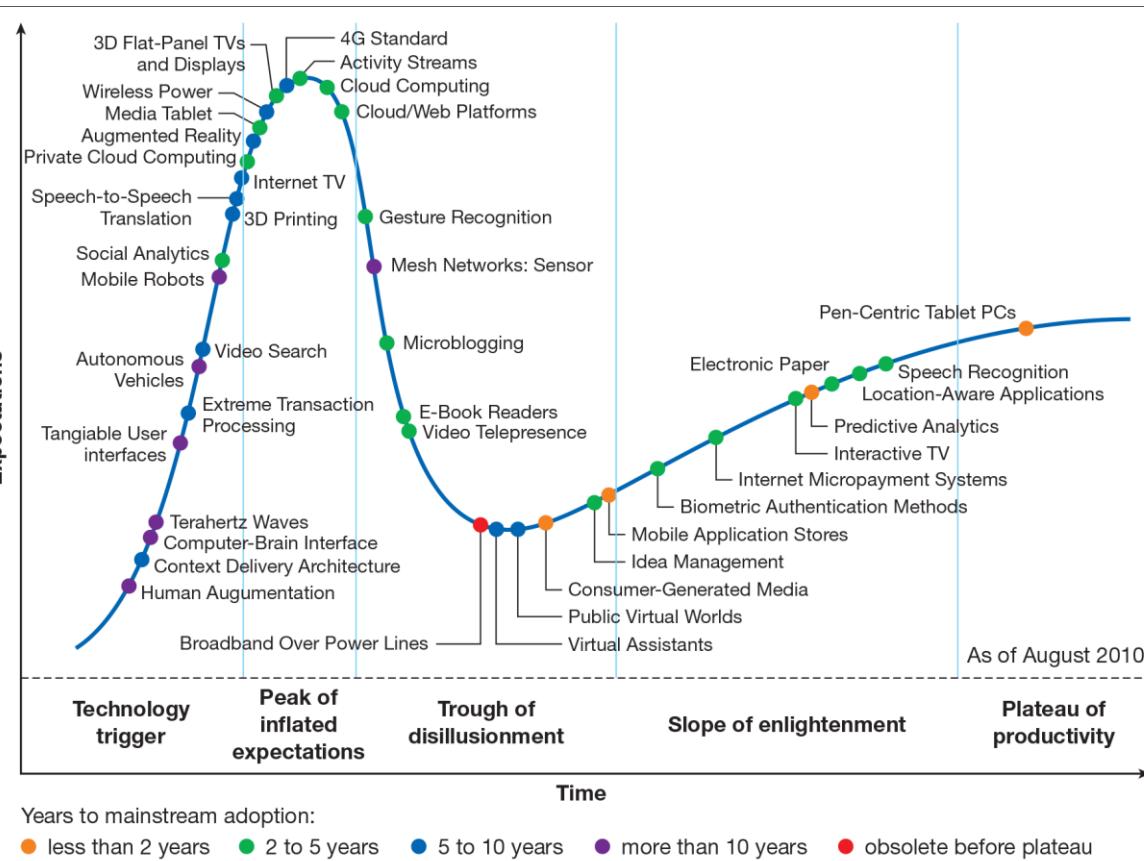
Diffusion of Innovation (DoI): examples

- Gartner Group shows how technology adoption evolves over time.
- It's hard to predict the future!



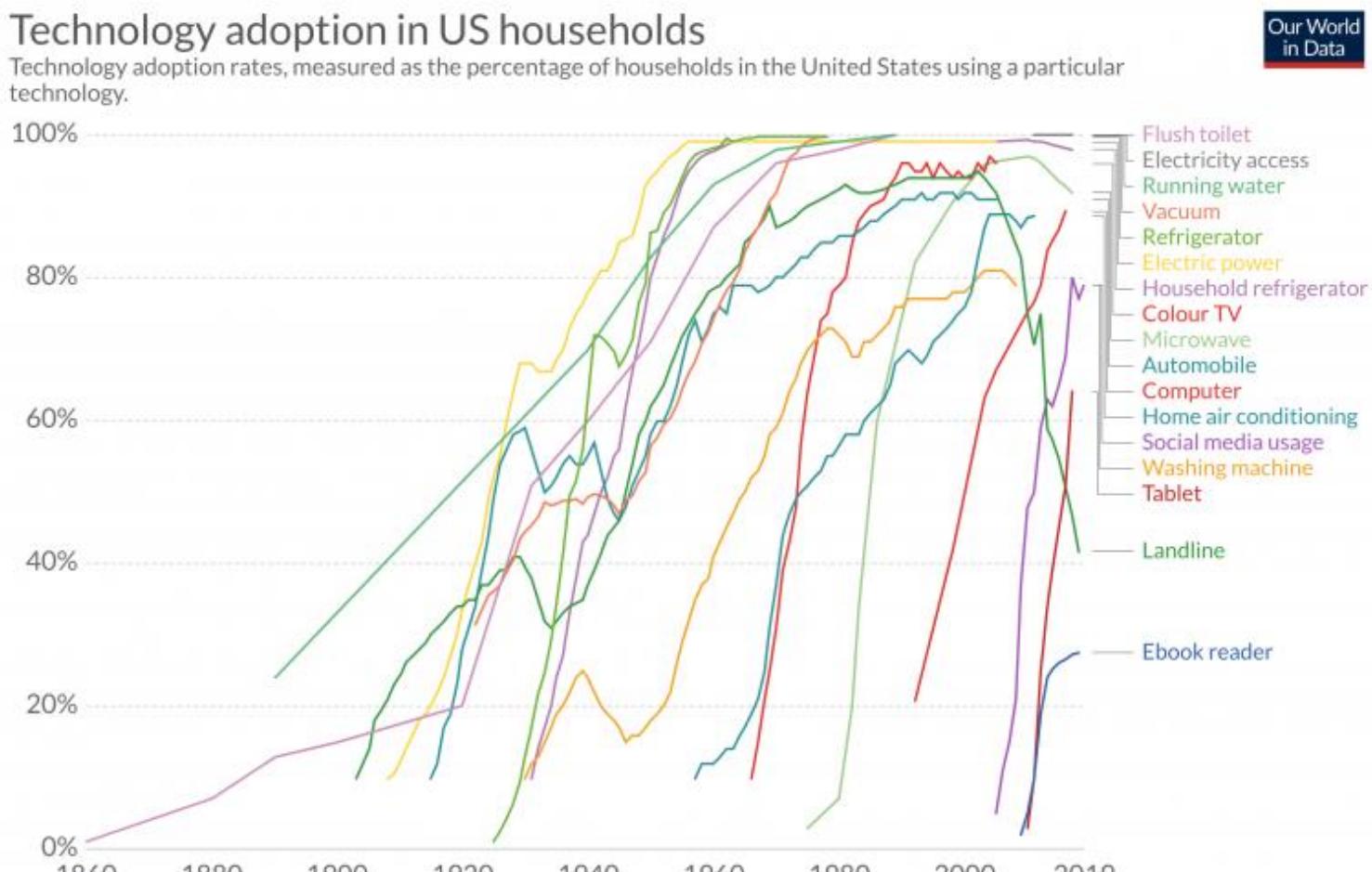
Gartner Hype Cycle

Diffusion of Innovation (DoI): examples



Adapted from Gartner

Diffusion of Innovation (DoI): examples



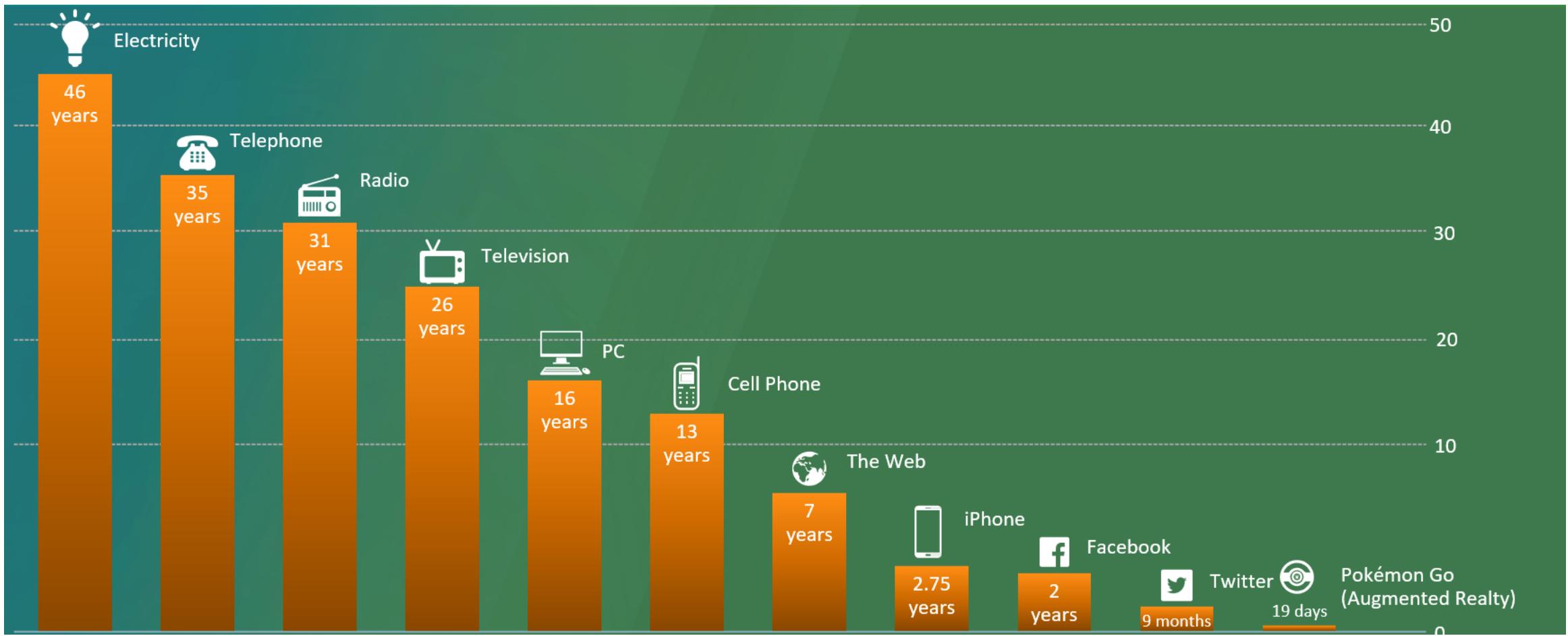
Source: Comin and Hobijn (2004) and others

Note: See the sources tab for definitions of household adoption, or adoption rates, by technology type.

OurWorldInData.org/technology-adoption/ • CC BY

Adapted from Our World in Data

Diffusion of Innovation (DoI): examples

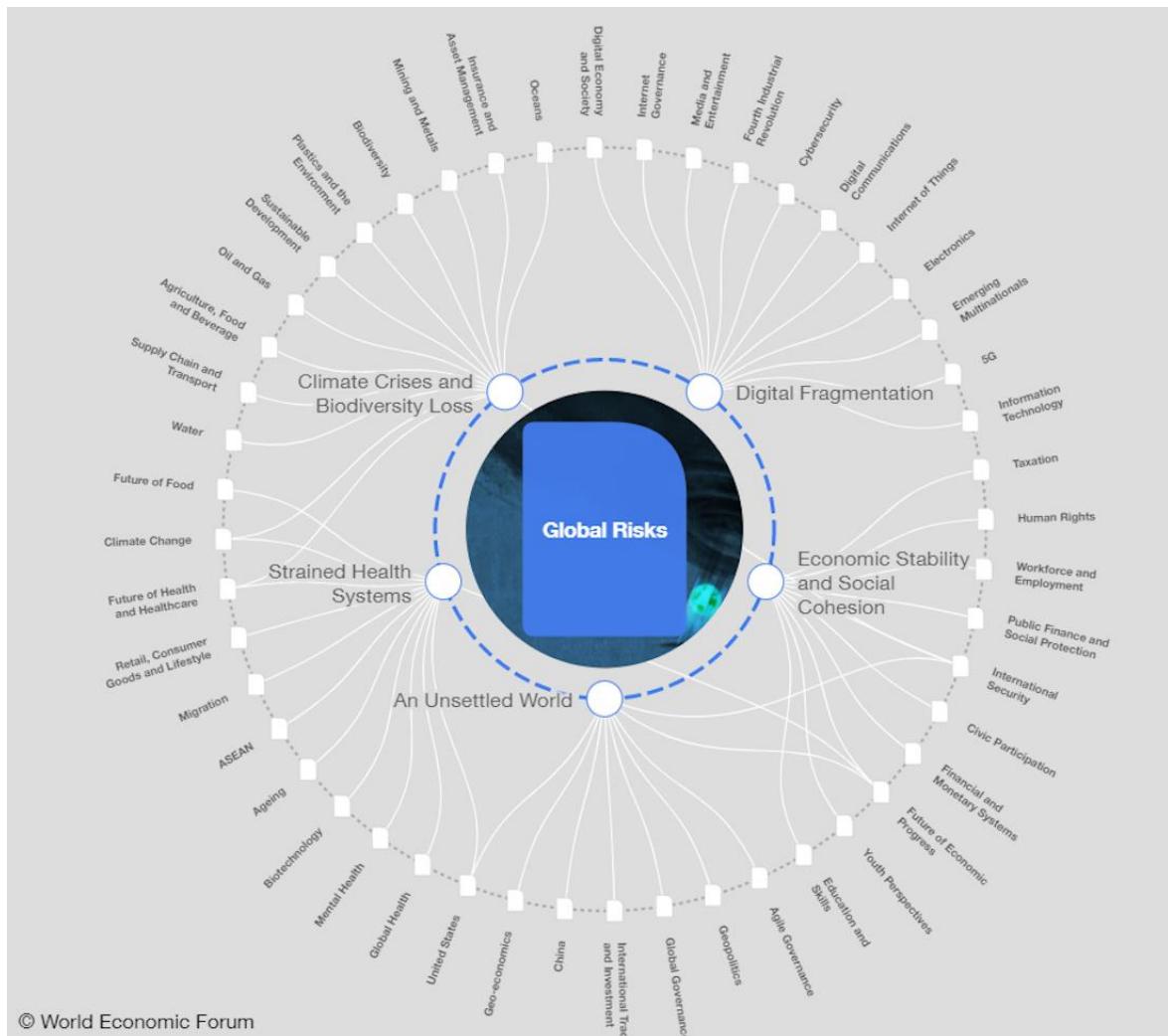


Adapted from Oracle

Digital disruption

Which new technologies should we focus on?

- Technology watch/observations
 - Evaluate benefits, challenges and risks



Adapted from WEF

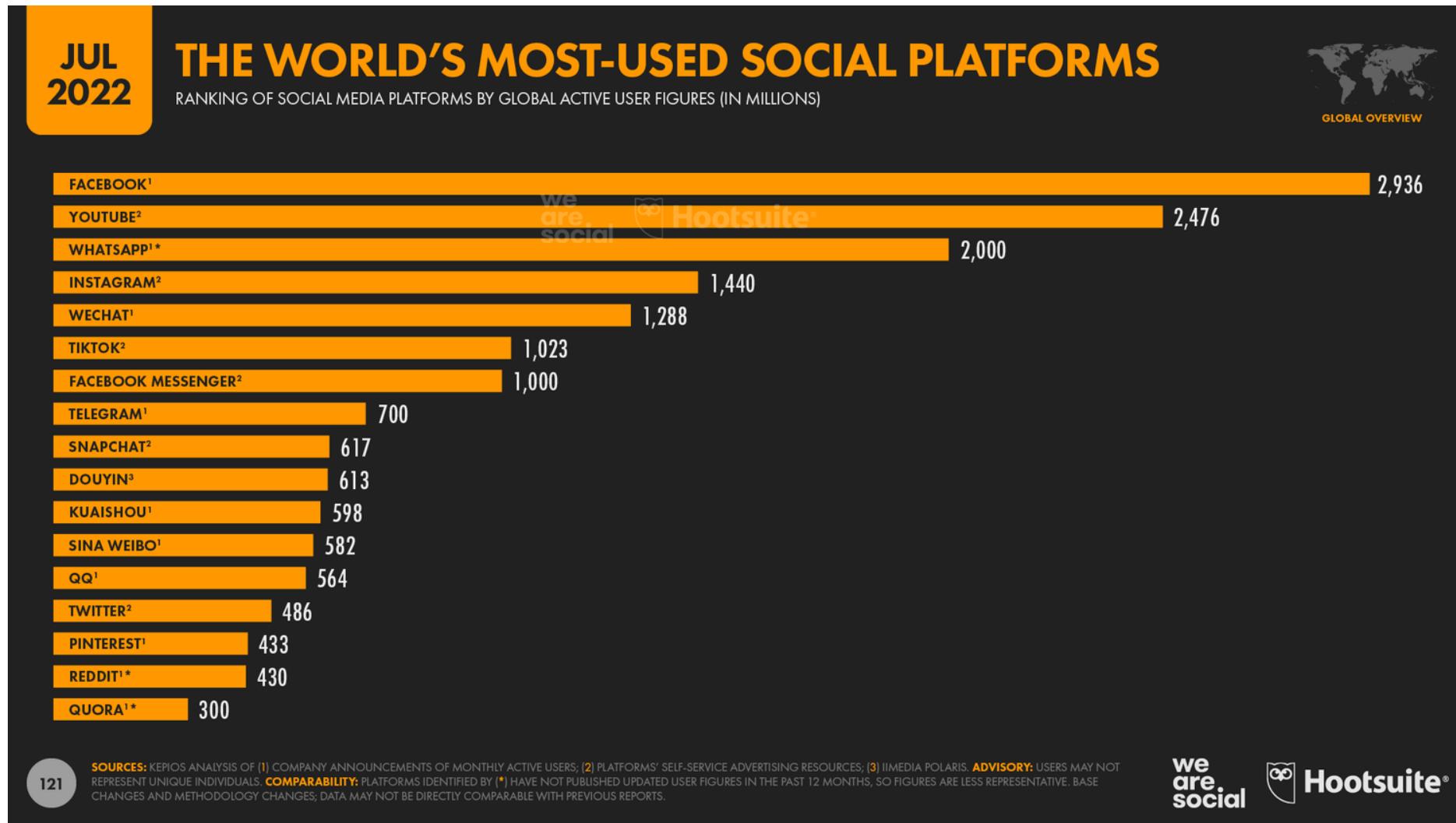


Interactive session – How they started? Case of Snapchat

URL: <https://obtaineudaimonia.medium.com/how-snapchat-started-dbee558bb40b>



Where is Snapchat on the social media market today?



Source: <https://datareportal.com/social-media-users>

Industry 4.0



Interactive session – How would you define Industry 4.0?



Industry 4.0: definition

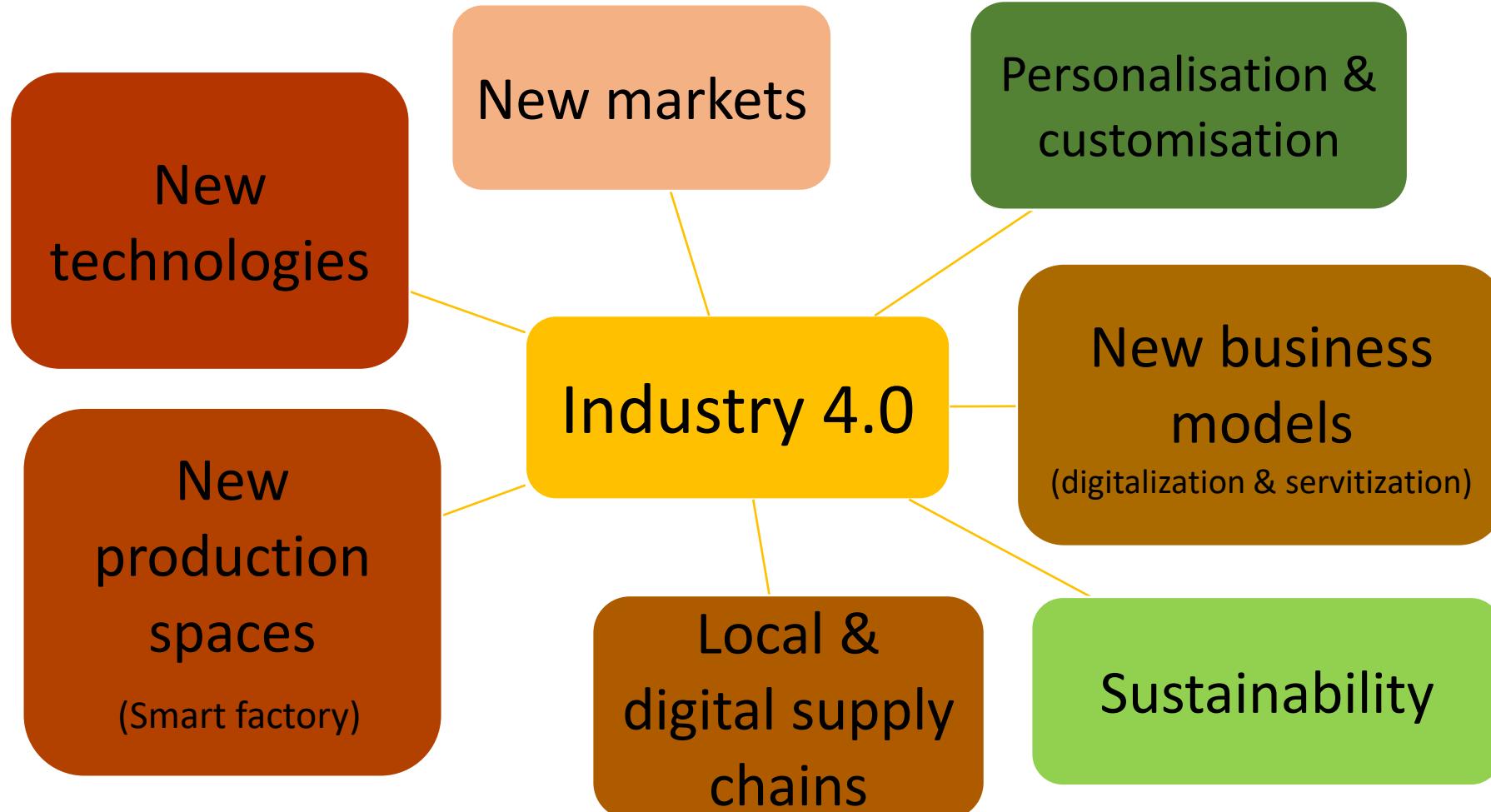
- Term initially coined in Germany at the Hannover Fair in 2011 as *Industrie 4.0*
- **I4.0** has been defined as “**a name for the current trend of automation and data exchange in manufacturing technologies**, including cyber-physical systems, the Internet of things, cloud computing and cognitive computing” (*i-scoop*)
- The term “Industry 4.0” widespread in the industrial and academic circles, generally as a **global expression comprising technological and organizational trends, including digitalization, automatization and data communication**

Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain in virtual computer models.

Adapted from UNIDO

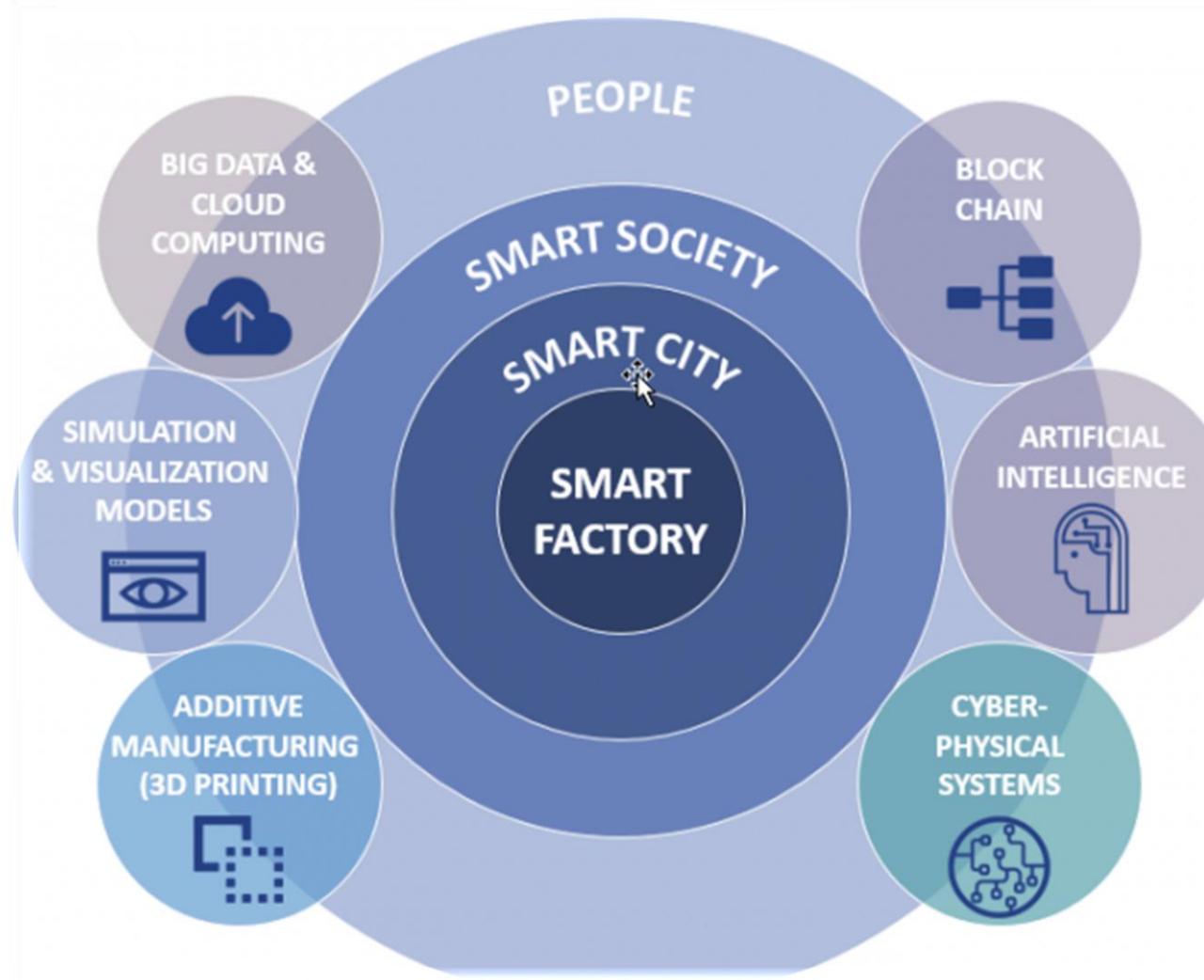


Industry 4.0: related concepts



Adapted from MAKERS - Smart Manufacturing for EU growth and prosperity

Industry 4.0: emerging related concepts



Partially adapted from UNIDO

Industry 4.0 vs Fourth Industrial Revolution

- Often the “4th Industrial Revolution” and “Industry 4.0” are used interchangeably
- However, Industry 4.0 is the major driver of the 4th Industrial Revolution

Industry 4.0 represents the economic point of view, focusing on industry, manufacturing/production and technology



The **4th Industrial Revolution** describes a technologically driven paradigm change that affects all spheres of life

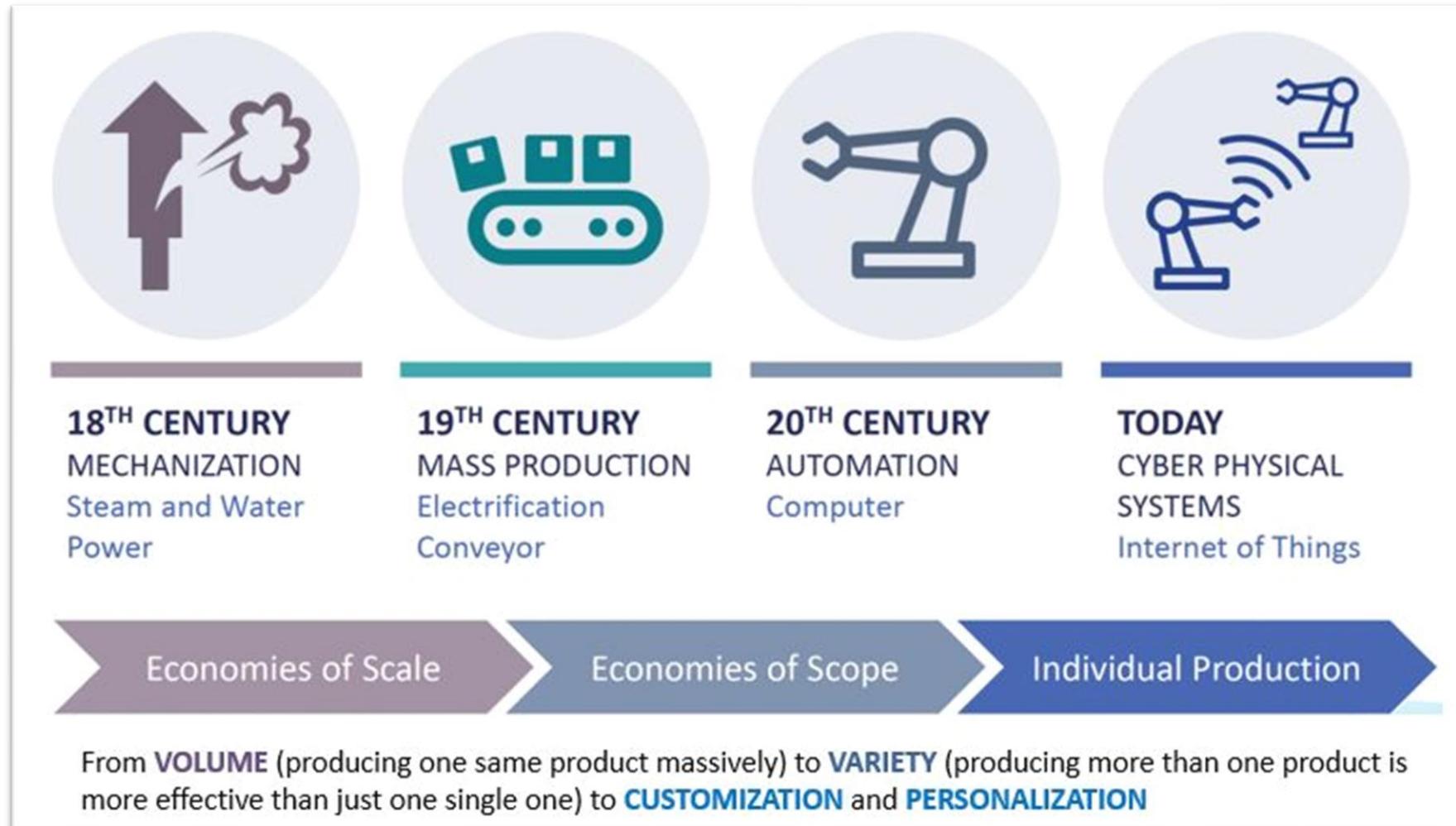
Historical perspective on I4.0



Interactive session – Who can briefly name all stages of Industrial Revolution and their implications?



Historical perspective

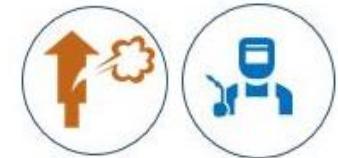


Partially adapted from UNIDO

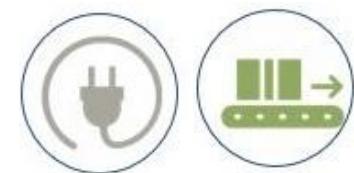
Historical factors: industrial development

Human history is characterized by continuous innovation and technological progress since the early ages.

First Industrial Revolution: triggered by water and steam power, which helped to move from human labour to mechanical manufacturing. Emergence of railroads and advancement in material exchanges and demographic movements.

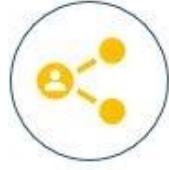
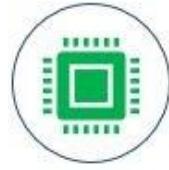


Second Industrial Revolution: built on electric power, to enable mass production. Gas and oil came into mass utilization. The combustion engine, the telegraph and the telephone revolutionized the transportation and communication methods.



Historical factors: industrial development

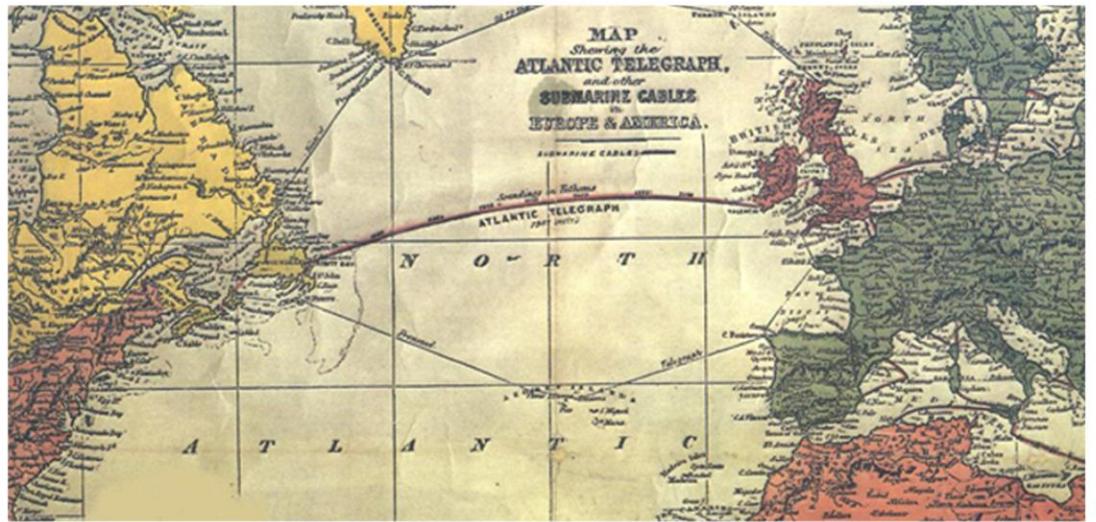
Third Industrial Revolution: characterized by the introduction and rise of electronics, information and communication technology, and computers, leading to high-level automation in production. Nuclear energy, space research and biotechnology are also elements to consider.



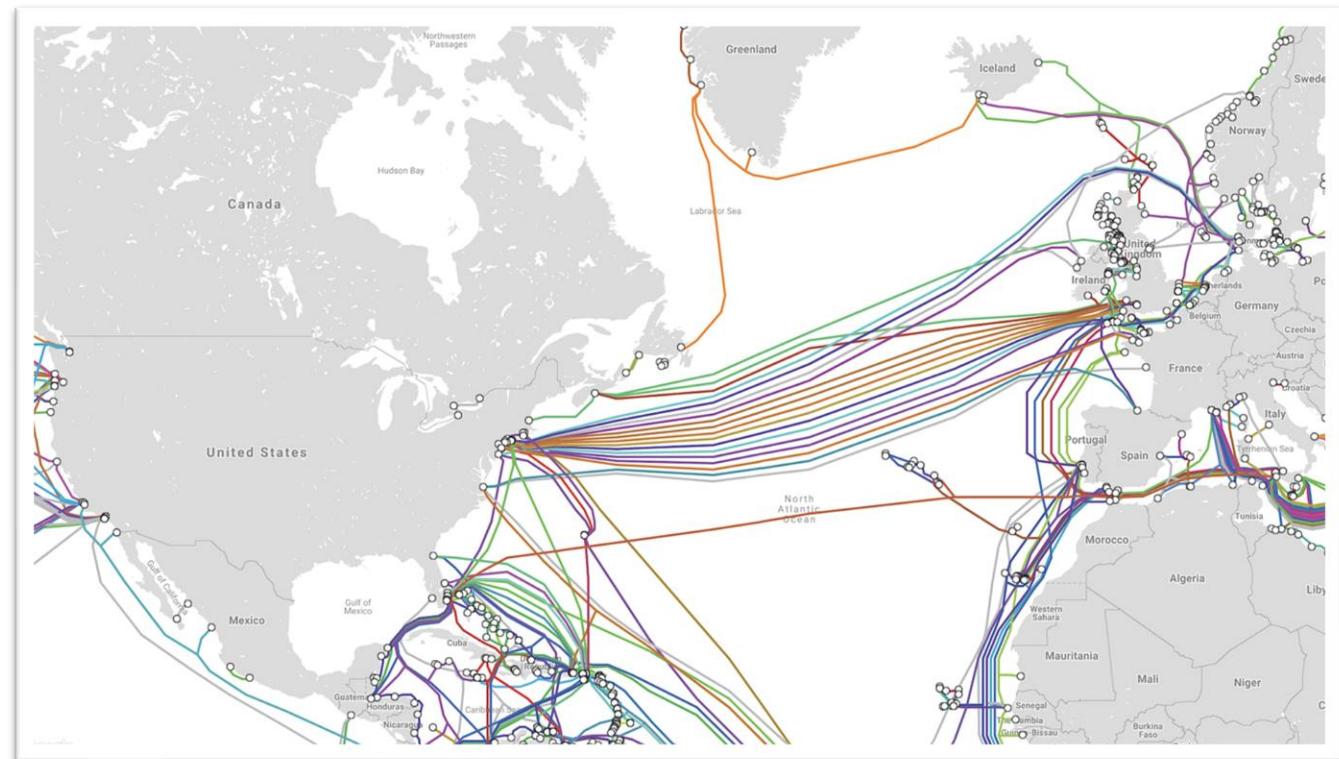
Fourth Industrial Revolution : refers to the current trend of automation and data exchange in manufacturing technologies. Digital technologies allow for **new business models** and **value-producing opportunities**.

Technologically speaking, Industry 4.0 is based on technologies that have been around since the 3rd Industrial Revolution, however, when compared with previous industrial revolutions, the **Fourth is evolving at an exponential rather than a linear pace**.

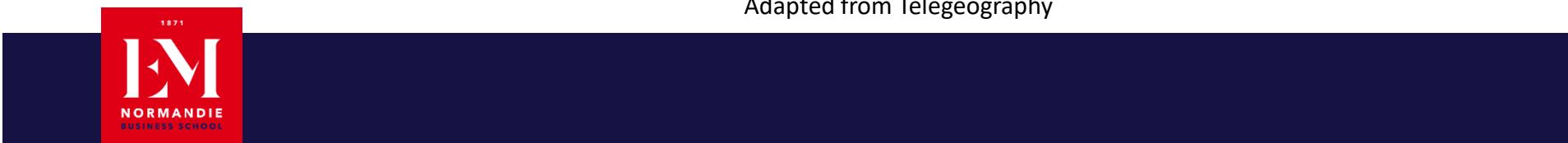
Overlap between industrial revolutions (from 1866 to 2021)



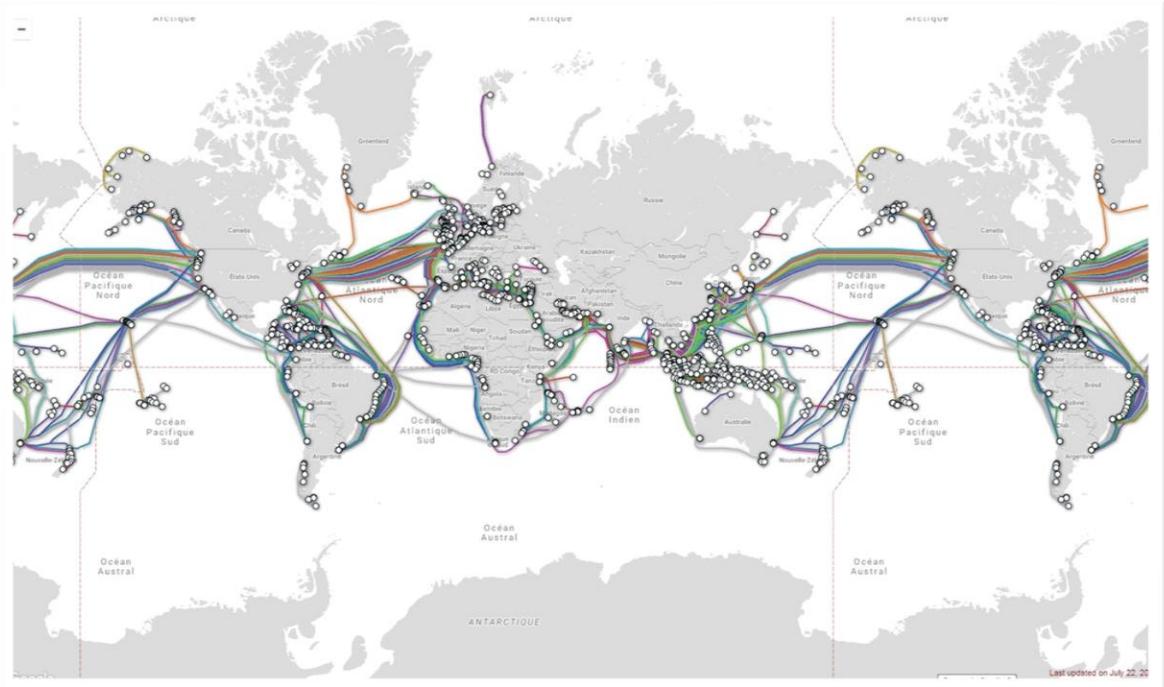
Adapted from The Atlantic



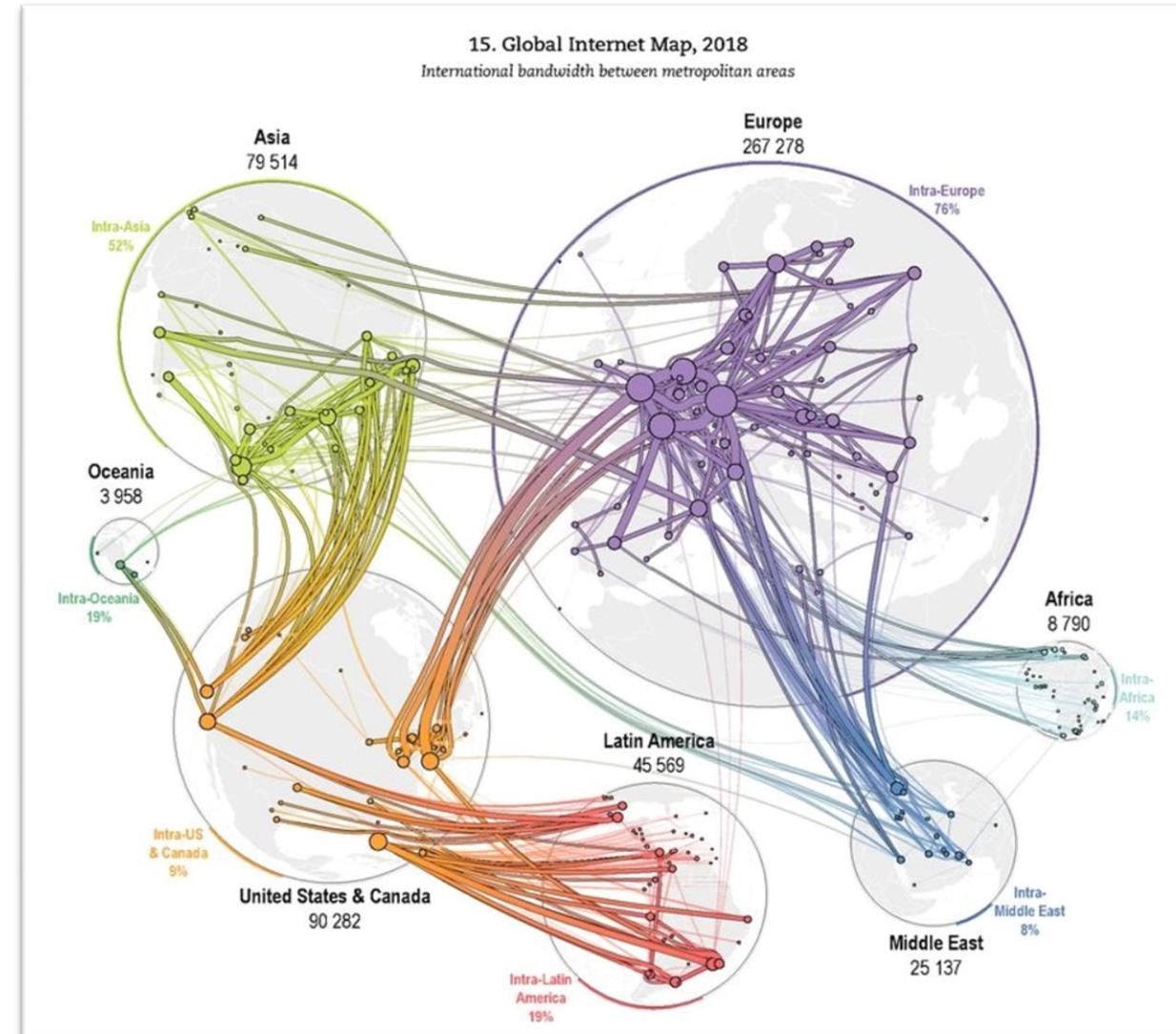
Adapted from Telegeography



Overlap between industrial revolutions (from 1866 to 2021)



Adapted from Telegeography

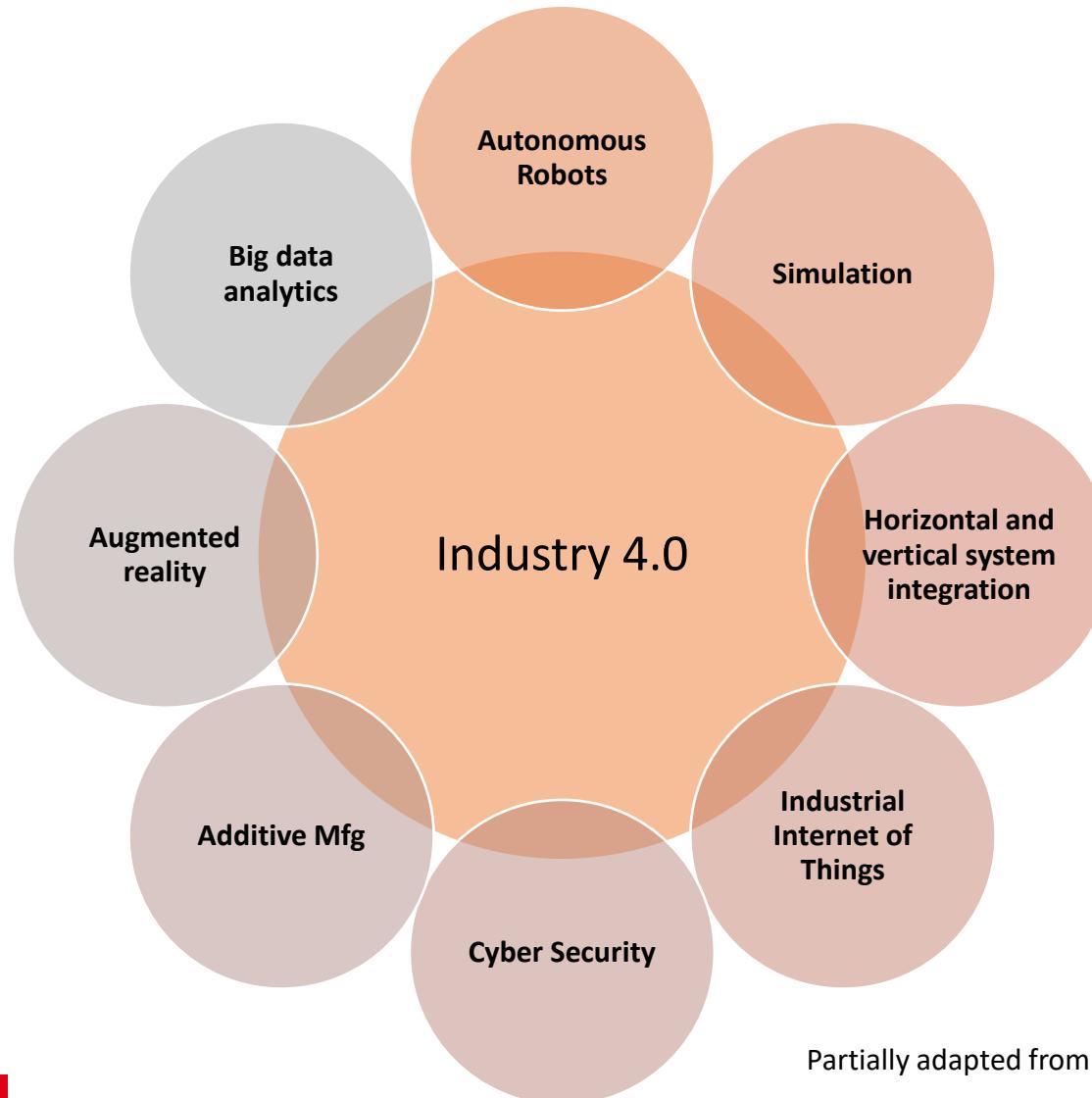


Adapted from OECD

Technological perspective on I4.0

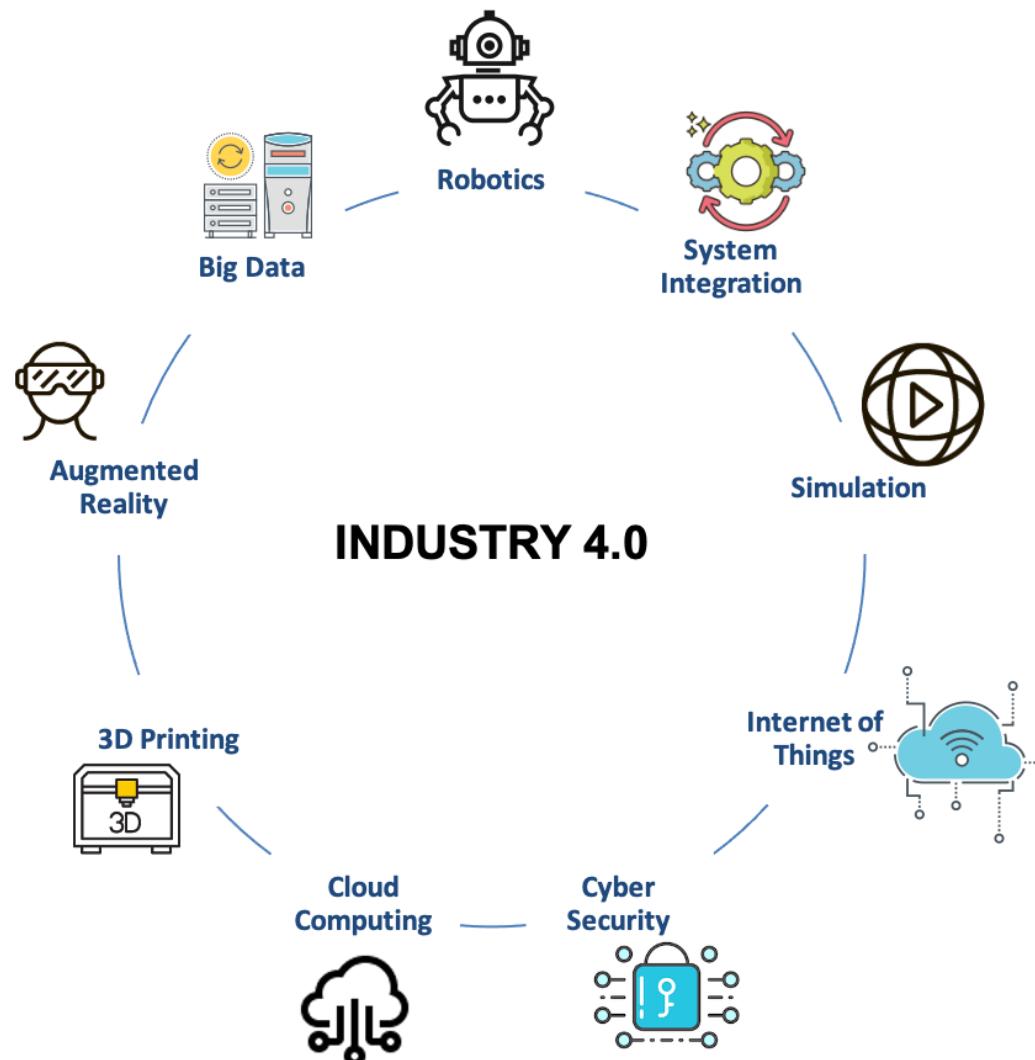


Building blocks of I4.0



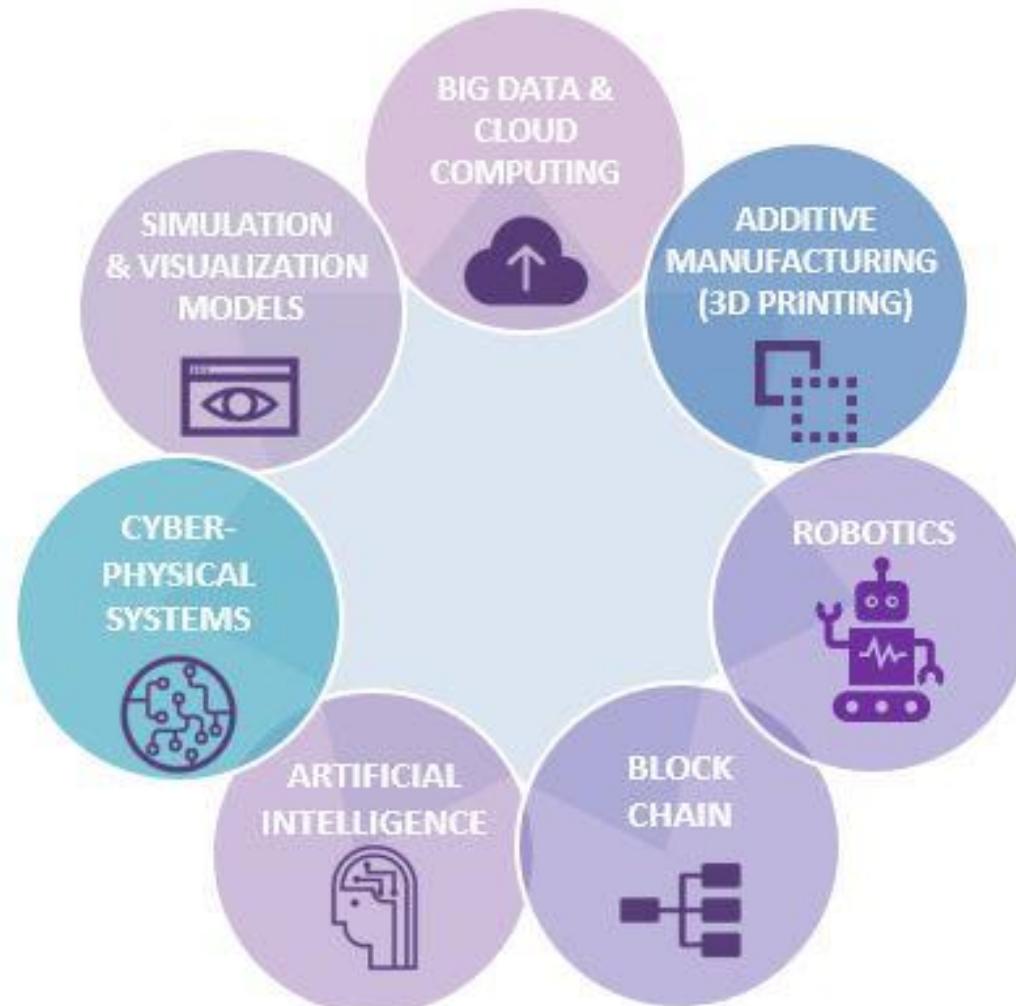
Partially adapted from BCG definition of Industry 4.0 (2014)

Building blocks of I4.0



Partially adapted from UNIDO (2015)

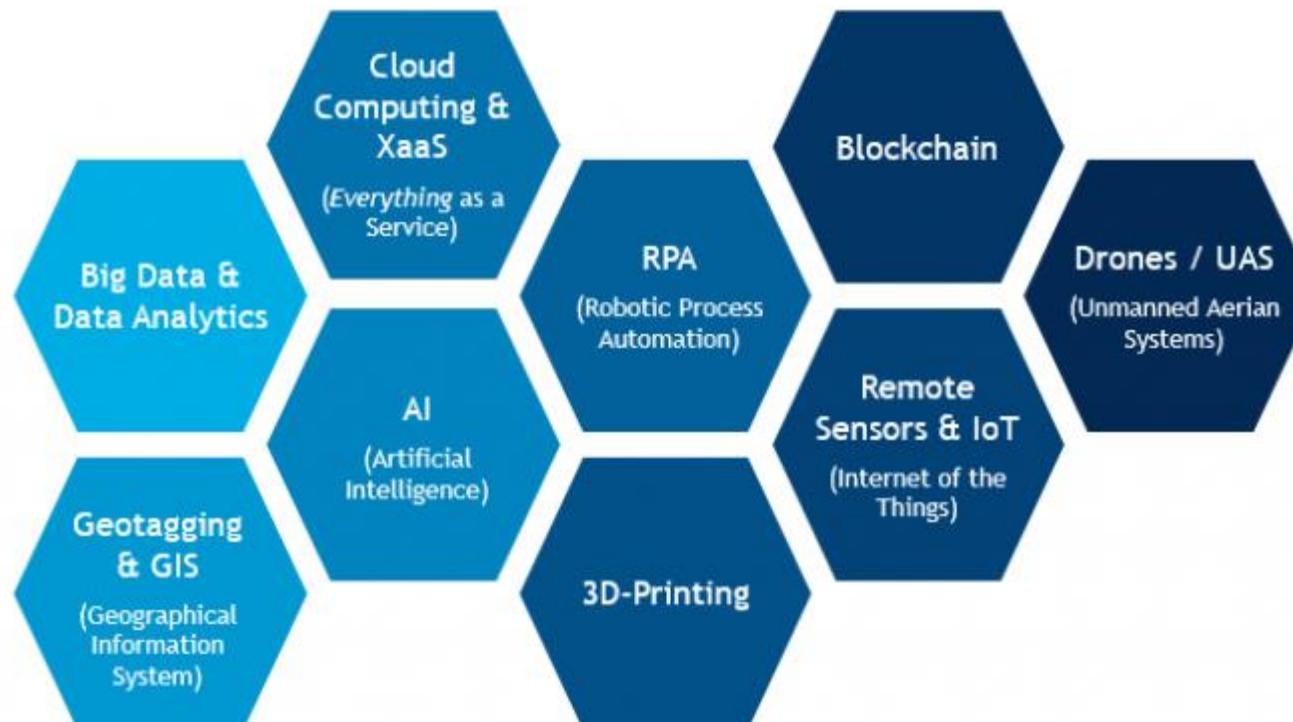
Building blocks of I4.0



Partially adapted from UNIDO (2016)

Building blocks of I4.0

9 DISRUPTIVE TECHNOLOGIES



Adapted from World Bank (2016)

Industry 4.0: Open questions

- Need for high investment on national, regional and local levels
- Lack of clarity on the economic advantage (ROI)
- Issues with expertise & management support
- Social issues & tensions:
 - Job threats/unemployment
 - Lack of skills
 - Employees training & education
 - Resistance to change

Industry 4.0: Open questions

- Lack of standards & policy regulations
- Security of data and communication networks
 - Data privacy (EU GDPR)
 - Cybersecurity
 - Security of workers
 - Security of critical infrastructure and assets
- Ecological/environmental concerns
 - Resources efficiency
 - Environmental protection
 - Pollution



Measuring performance in I4.0



Measuring implications of I4.0 - role of international organizations

International Organizations

- International Organizations, including WEF, WTO, WB, UN, UNIDO, etc. have many important roles to play depending on the nature of their mission
- They can provide knowledge and technology, connect actors in different markets and cultures, and provide education and training
- International organizations may provide not only the implementation of Industry 4.0, but also spread awareness for its social and ethical implications, i.e., create inclusive and sustainable industrial platforms
- International organizations can also serve as catalysts for the private and public sector and balance the demand and needs of both sectors



Measuring impact of digitalization and I4.0



- EU – Shaping Europe's Digital Future.
URL: <https://ec.europa.eu/digital-single-market/en>
- European Commission (2020). Digitising European Industry.
URL: <https://ec.europa.eu/digital-single-market/en/digitising-european-industry>
- European Commission (2018). Pillars of the Digitising European Industry Initiative.
URL: <https://ec.europa.eu/digital-single-market/en/pillars-digitising-european-industry-initiative>
- European Commission (2020). Fourth industrial revolution.
URL: <https://ec.europa.eu/digital-single-market/en/fourth-industrial-revolution>



Measuring impact of digitalization and I4.0



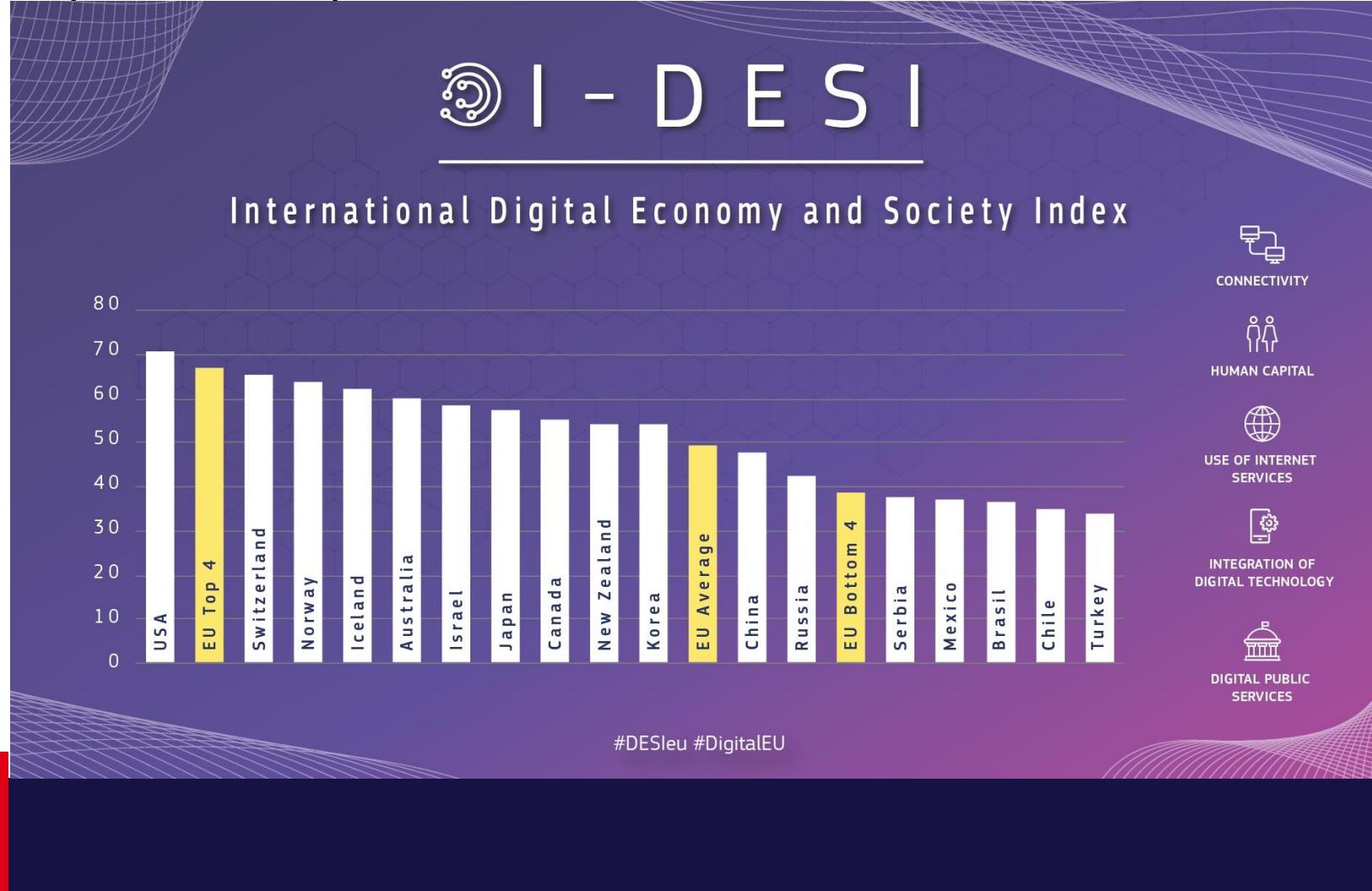
- EU – The Digital Economy and Society Index (DESI) monitors Europe's overall digital performance and tracks the progress of EU countries in their digital competitiveness.



Measuring impact of digitalization and I4.0



- EU – The Digital Economy and Society Index (i-DESI) – comparison with the rest of the world (2020 data).



Measuring impact of digitalization and I4.0

- Business growth is based on economic competitiveness, respective which sets a country up for success.
- According to the **World Economic Forum**, efficient markets, economic stability and social protection are the long-term determinants of productivity, growth, income levels, and well-being.
- Each year, the **Global Competitiveness Index (GCI)** tracks the performance of close to 140 countries on 12 pillars of competitiveness
- It measures the aspects that are most important for long-term growth, putting emphasis on less tangible factors that are becoming more important.



Measuring impact of digitalization and I4.0

World Economic Forum (WEF):
 Global Competitiveness Report
 2020.

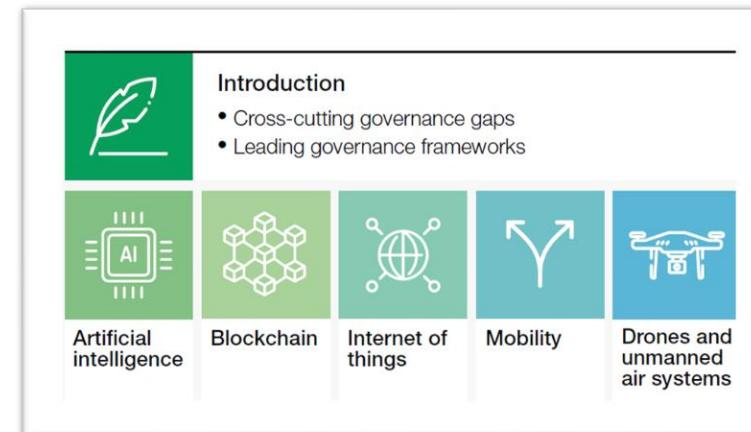
- URL:
<https://www.weforum.org/reports/the-global-competitiveness-report-2020#report-nav>
- Priorities for recovery and revival and consider the building blocks of a transformation towards new economic systems that combine “productivity”, “people” and “planet” targets.

Flexible work arrangements	Digital skills	Digital legal framework
1. Netherlands	1. Finland	1. United States
2. New Zealand	2. Sweden	2. Luxembourg
3. Switzerland	3. Estonia	3. Singapore
4. Estonia	4. Iceland	4. United Arab Emirates
5. United States	5. Netherlands	5. Malaysia
6. Luxembourg	6. Singapore	6. Estonia
7. China	7. Israel	7. Sweden
8. Australia	8. Denmark	8. Finland
9. Finland	9. Saudi Arabia	9. Germany
10. Denmark	10. Korea, Rep.	10. Netherlands

Measuring impact of digitalization and I4.0

World Economic Forum (WEF): Global Technology Governance Report 2021: Harnessing Fourth Industrial Revolution Technologies in a COVID-19 World (2020).

- A practical handbook to examine some of the Fourth Industrial Revolution's most critical applications. The report aims to address these technologies' governance challenges in a post-pandemic world.
- URL: <https://www.weforum.org/reports/global-technology-governance-report-2021>



Measuring impact of digitalization and I4.0



OECD - Going Digital Toolkit.

- Assess countries state of digital development to help formulate policy strategies and approaches in response. Data exploration and visualisation are key features of the Toolkit.
- URL: <https://goingdigital.oecd.org/en/>

OECD (2019). Measuring the Digital Transformation: A Roadmap for the Future.

- Report about the state of the digital transformation by mapping indicators across a range of areas – from education and innovation, to trade and economic and social outcomes.
- URL: https://www.oecd-ilibrary.org/science-and-technology/measuring-the-digital-transformation_9789264311992-en



Measuring impact of digitalization and I4.0



United Nations – Roadmap for Digital Cooperation.

- URL: <https://www.un.org/en/content/digital-cooperation-roadmap/>



World Bank – Doing Business: <https://www.doingbusiness.org/>

- Europe 4.0: Addressing Europe's Digital Dilemma
- URL: <https://www.worldbank.org/en/region/eca/publication/addressing-europes-digital-dilemma>
- Doing Business provides objective measures of business regulations for local firms in 190 economies. URL: <https://www.doingbusiness.org/>



Digital Nations – Leading Digital Governments

- An international forum of leading digital governments.
- URL: <https://www.leadingdigitalgovs.org/>

Additional indicators to consider

The following **main indicators of relevance to address today's economic and business challenge** give evidence of a country's economic challenges and development stages, for reference in business development, digitalization or I4.0

- **The Index of Economic Freedom (IEF)**
- **The Global Creativity Index (GCI)**
- **The Global Innovation Index (GII)**
- **The Corruption Perceptions Index (CPI)**
- **The E-Government Development Index (eGov)**
- **The Global Competitiveness Report & The Global Competitiveness Index (GCI)**
- **The UN 2030 Agenda for Sustainable Development & Sustainable Development Goals (SDG)**



Global innovation index

Global Innovation Index (GII)

- Innovation is nowadays widely recognized as a central driver of economic growth and development.
- The Global Innovation Index (GII) aims to **shape the innovation measurement** and the **innovation policy agenda** by providing a rich database of **detailed metrics** for 126 economies, which represent 90.8% of the world's population and 96.3% of global GDP.
- Its 80 indicators explore a **broad vision of innovation, including political environment, education, infrastructure and business sophistication**.
- Today a wide range of high-, medium-, and low-income countries are using the GII as a tool for action **to improve innovation performance** — including a large variety of relevant innovation stakeholders



Global innovation index

- The GII is **co-published** by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), a specialized agency of the United Nations, and draws on the expertise from international knowledge partners and experts
- **By identifying and leveraging strengths and challenges, the GII helps countries to improve their multi-dimensional facets of innovation.**



The full *Global Innovation Index* report can be downloaded at: <https://www.globalinnovationindex.org>

e-government development index

e-Government Development Index (eGov)

- The e-Government Development Index (eGov) is a United Nations creation and has its roots in the UN General Assembly Resolution 66/288 'The Future We Want'.
- This strand of the resolution takes an **ICT focus and looks at the flow of information between governments and the public** and recognises the power of communication technologies to promote knowledge exchange, technical cooperation and capacity building for sustainable development.
- The **index scale** is 0-1 with higher scores representing countries with the more developed e-government processes.



The *e-Government Survey* report can be downloaded [here](#).

UNIDO's Department of Digitilization, Technology and Innovation offers specialized support to successfully achieve the **Sustainable Development Goals (SDGs)**, in order to help both countries and companies to:

- develop more efficient operations
- improve conformity with market requirements
- create new business opportunities
- connect to international markets



Download [here](#) the brochure about the UNIDO's Department of Digitilization, Technology and Innovation.

UN agenda 2030 for sustainable development

- At the Sustainable Development Summit on 25 September 2015, UN Member States adopted the **2030 Agenda for Sustainable Development, including a set of 17 Sustainable Development Goals (SDGs)**
- The SDGs, effective since 1 January 2016, are a new, universal set of goals, targets and indicators that **UN Member States are expected to use to frame their agendas and political policies by 2030**

- These targets will guide the decisions on political strategies and policies over the next 15 years.
- In all countries. For all people.



Industry 4.0 and the SDGs



Examples of SDGs in the context of Industry 4.0, and how Industry 4.0 can support the SDGs

Industry 4.0 and the SDGs

Can you think of an interrelation between I4.0 and the SDGs?

- **Health and Safety (SDG 2&3)**
- **Education (SDG 4)**
- **Gender Equality (SDG 5&10)**
- **Environment (SDG 6,11,13,14&15)**
- **Production and Energy Management (SDG 7&12)**
- **Employment and Economic Growth (SDG 8)**
- **Infrastructure and Innovation (SDG 9)**

Adapted from UNIDO



Examples of national initiatives with I4.0



Example of Japan: Society 5.0

According to this concept, the future of society, Society 5.0, is not based on the industrial revolutions, but based on society, taking its starting point with Society 1.0 and successively to Society 5.0

Development stages of societies are:

Society 1.0: Hunter-gatherer society

Society 2.0: Agrarian Society

Society 3.0: Industrial Society

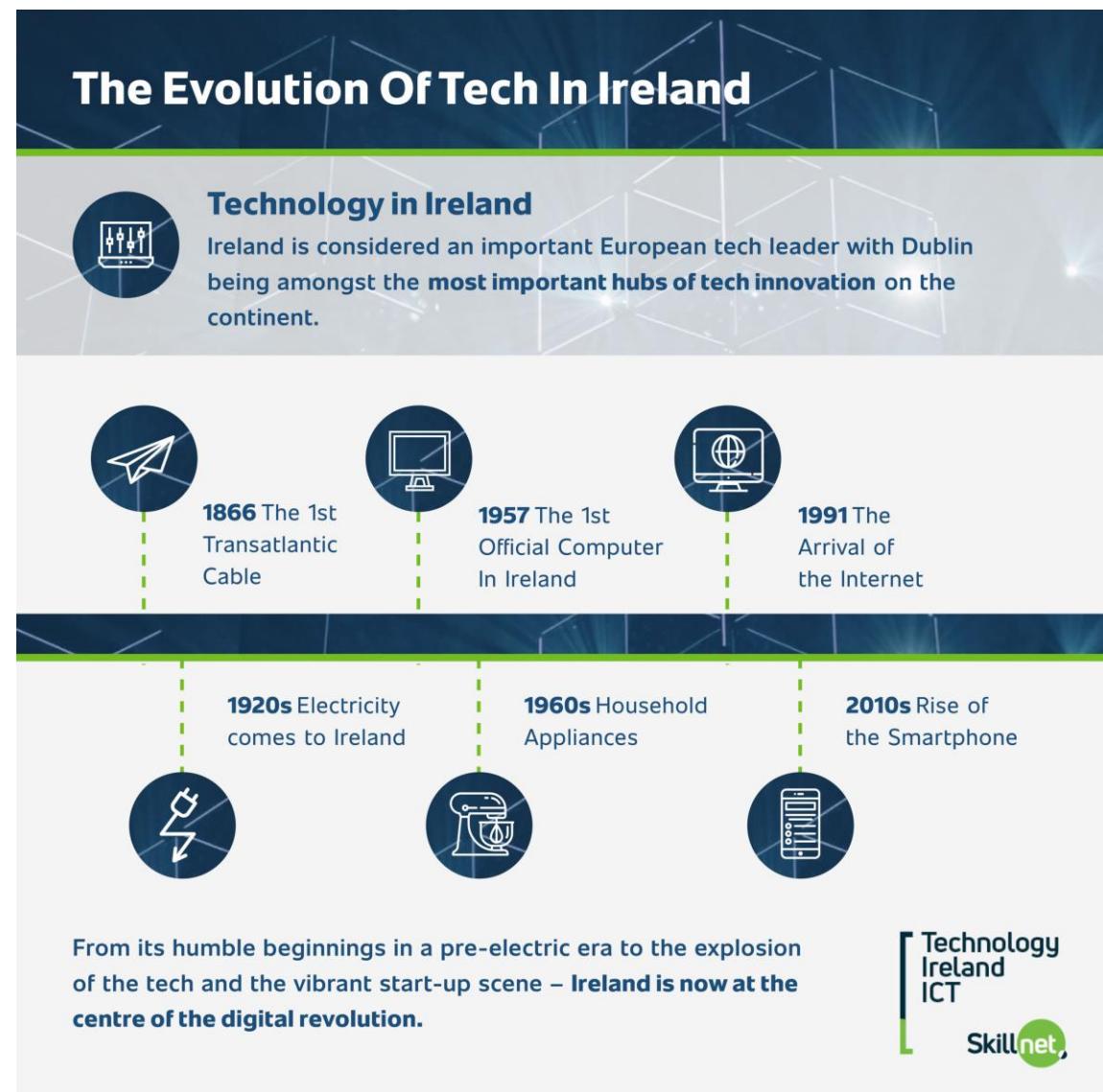
Society 4.0: Information society

Society 5.0: A technology-based human-centered society



Example of Ireland

- Small country of 4.5 million, but with an access to almost half a billion people across Europe
- “*(...) a highly educated and English-speaking workforce in the EU, Ireland has become a very attractive and viable option. This is particularly true for US firms. So far this century, companies such as Google, Yahoo, Amazon, eBay, Facebook, Twitter, LinkedIn, and Electronic Arts have all set up operations in Ireland. Ireland has also become quite an important hub for data centres (...)*”



Sources: <https://www.ictskillnet.ie/news/the-evolution-of-tech-in-ireland/>

Example of Estonia



LIFT99



- Population: 1.3 million
- Project of transformation started in mid-90s – *Tiger leap* into ICTs
- 99% state services are available online
- e-Residency initiative
- Competitive ICT sector, R&D outputs & university education system to support market needs
- Headquarters of the NATO Cooperative Cyber Defence Centre of Excellence and EU IT Agency:
<https://ccdcoc.org/>
- Estonian (tech) companies (unicorns >=\$1B value): <https://startupestonia.ee/why-estonia/value-for-startups>

Sources: <https://e-estonia.com/> or <https://www.france24.com/en/20190104-tech24-estonia-enation-digital-egovernment-xroad-guardtime-evoting-baltic-linnar-viik> or <https://e-estonia.com/estonia-a-european-and-global-leader-in-the-digitalisation-of-public-services/>



Interactive session – Any final questions?





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