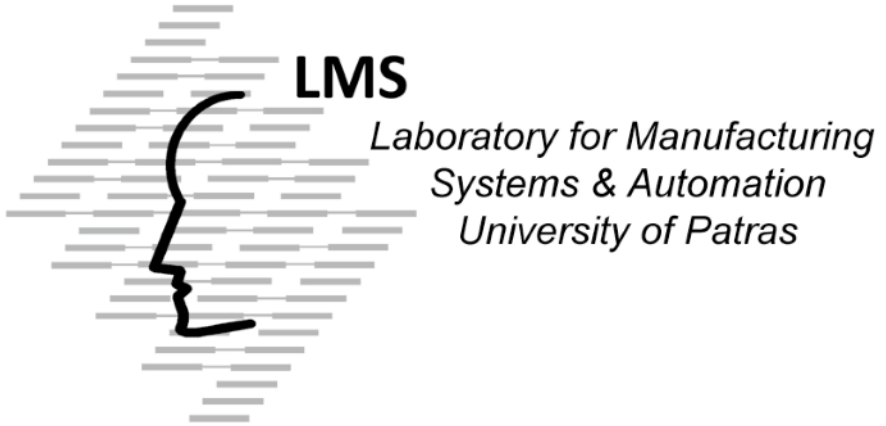
Laboratory for Manufacturing Systems and Automation
Department of Mechanical Engineering and Aeronautics
University of Patras, Greece



"Industry 4.0 Paradigm: Its Impact on Future Technology Innovation & Engineering Education – ManuHub@WG"

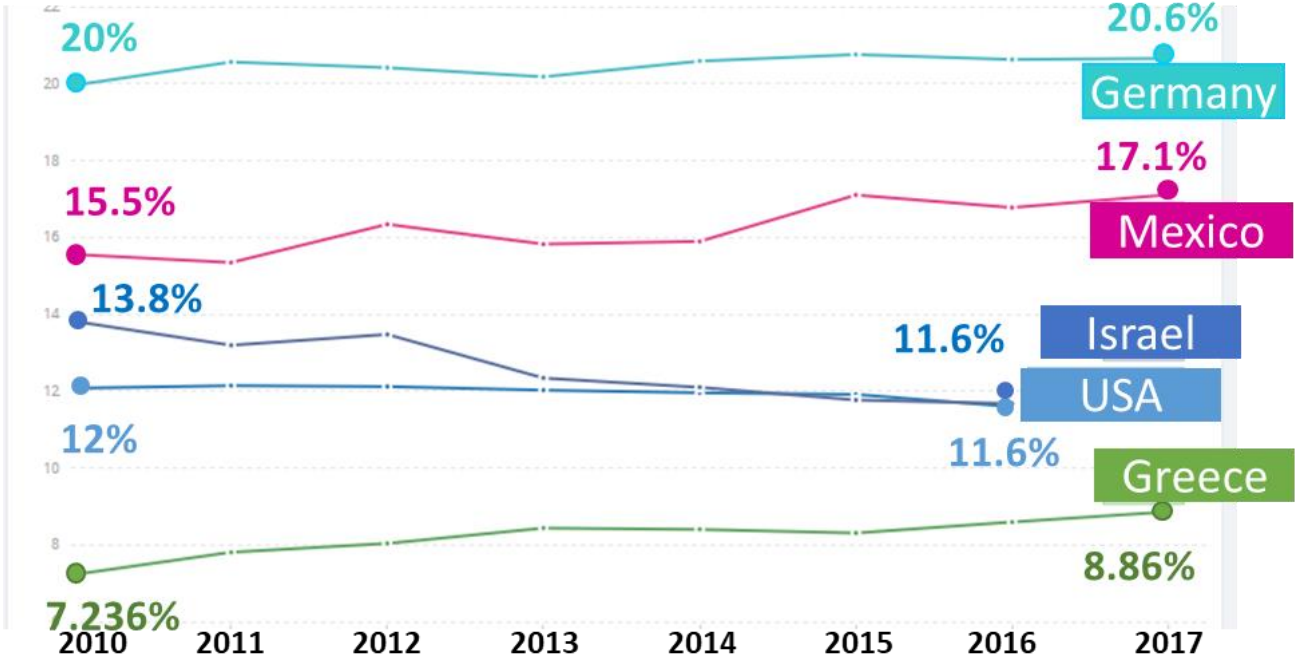
Professor Dimitris MOURTZIS

Patras, 2019

CONTENTS

WHY Manufacturing Matters?

- **15.6%** manufacturing share of global GDP
- **77%** share of Global R&D spending in manufacturing nations
- **70%** manufacturing share of entire Global trade
- **28.4%** of GDP in Europe in todays economic recession



For GREECE 9% of GDP the Manufacturing value added

❑ Manufacturing value added (9% of GDP)

[The World Bank, 2018]

Industry 4.0 across the globe

[I-scoop.eu, 2019]

Digitalization - An Overview

From Traditional to Digitalised Manufacturing

Distributed Manufacturing

Transformation

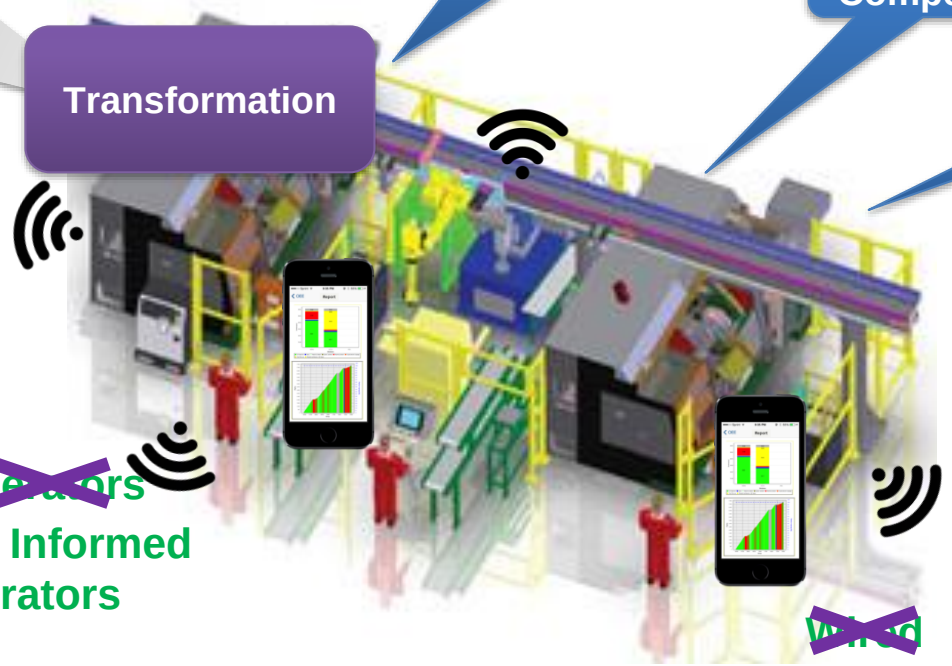
Challenges

Shorter product lifecycle

International Competition

Customized products

IoT



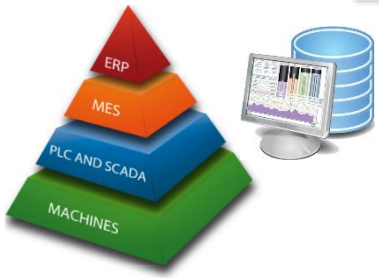
Collaborative, Aware and Adaptive IT tools

Operators

Aware / Informed Operators

IT Tools working in isolation

Cloud Technology



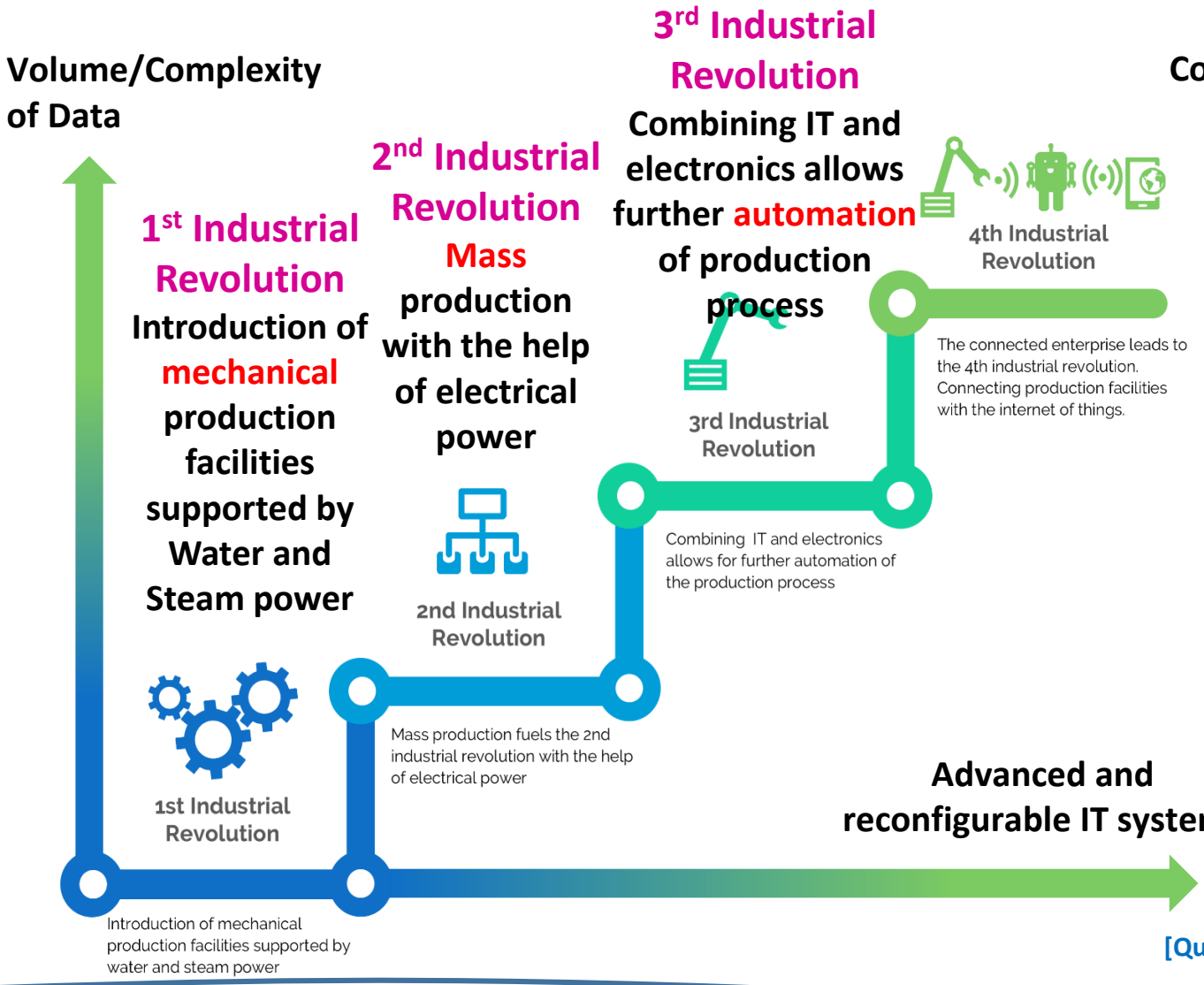
Wired

Wireless

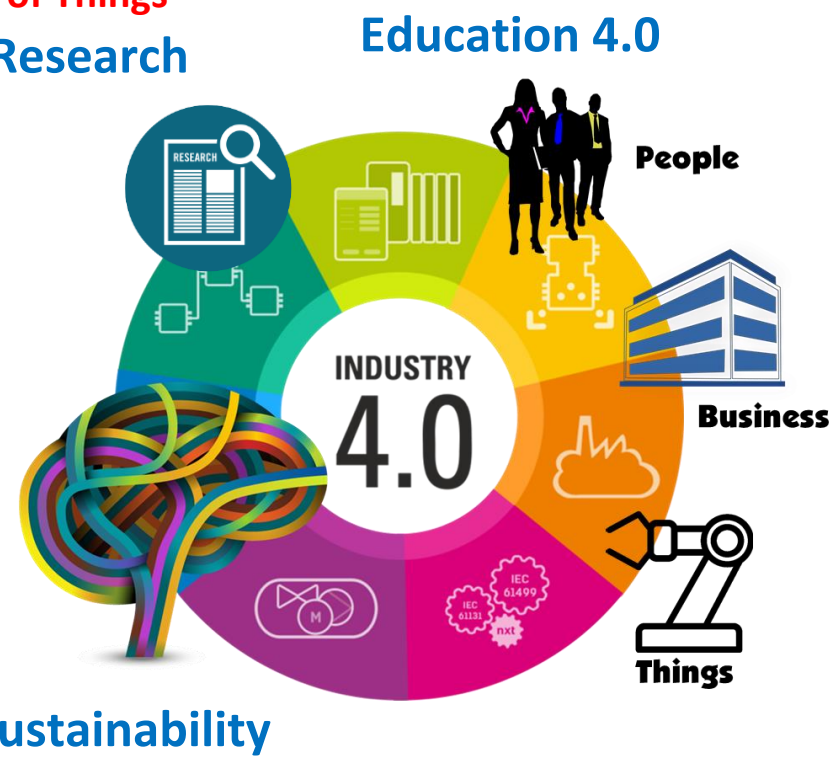
Big Data Analytics

Wireless Sensor Networks

The evolution from the 1st Industrial Revolution to Industry 4.0



How Industry 4.0 can be described in 5 words?



[Quelle: BMBF – Umsetzungsempfehlungen für das Zukunftsprojekt Industrie 4.0, 2013]

Industry 4.0 – Digitalization Impact around the Globe (150 countries)

Metrics

Ubiquity	Access to digital services and applications
Affordability	Availability through low pricing
Reliability	Quality and consistency of connection
Speed	Real-time throughput rates
Usability	Easy of getting online and ease of use
Skill	Incorporation of digital services into lives and business

[Strategy and Maximizing-the-Impact-of-Digitization]

Results

65 countries are still in a constrained stage

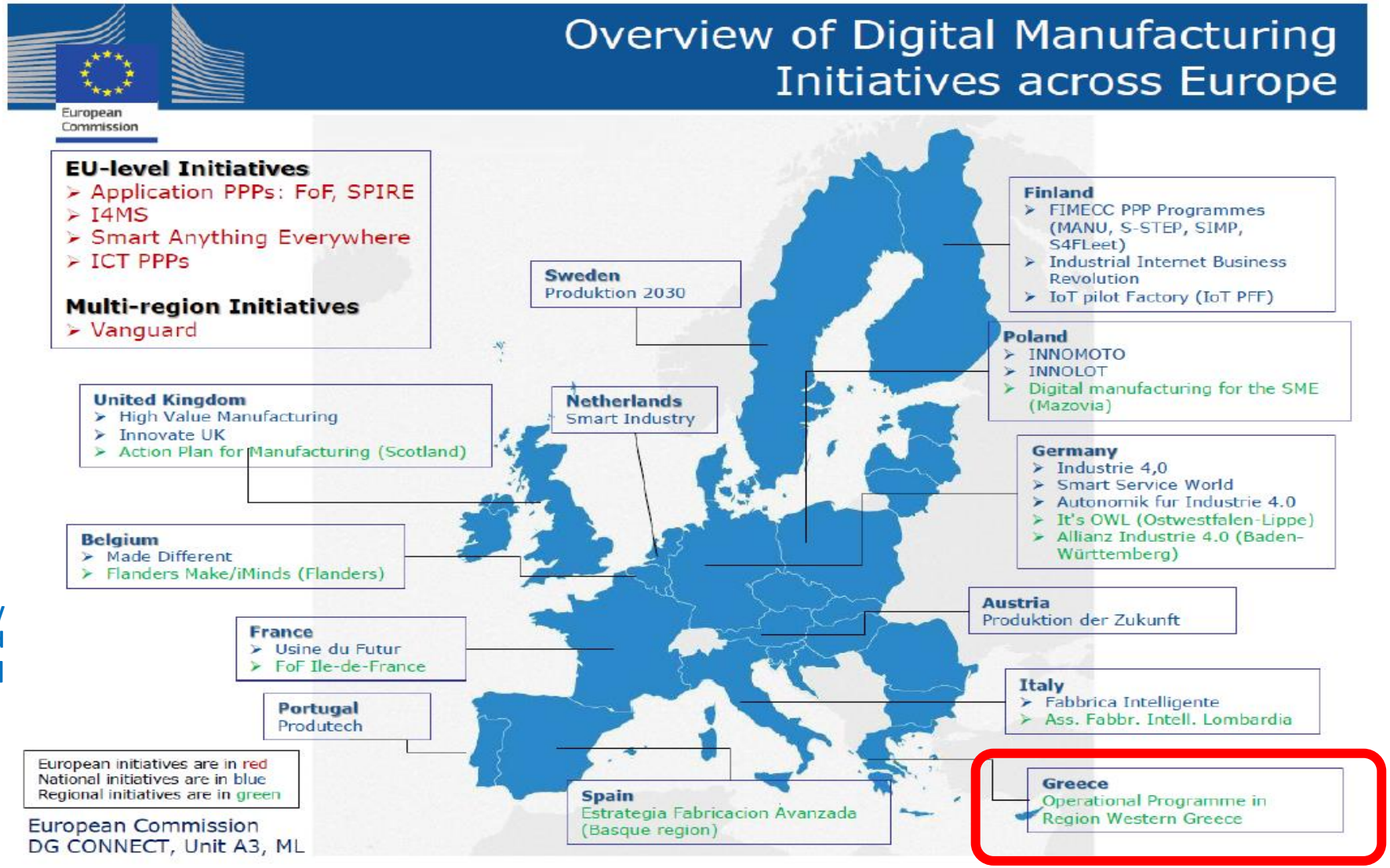
19 countries are in an emerging stage

28 countries are in transitional stage

38 countries are in advanced levels of ICT adoption and use

Source: Booz & Company

Industry 4.0 – in Europe and Greece

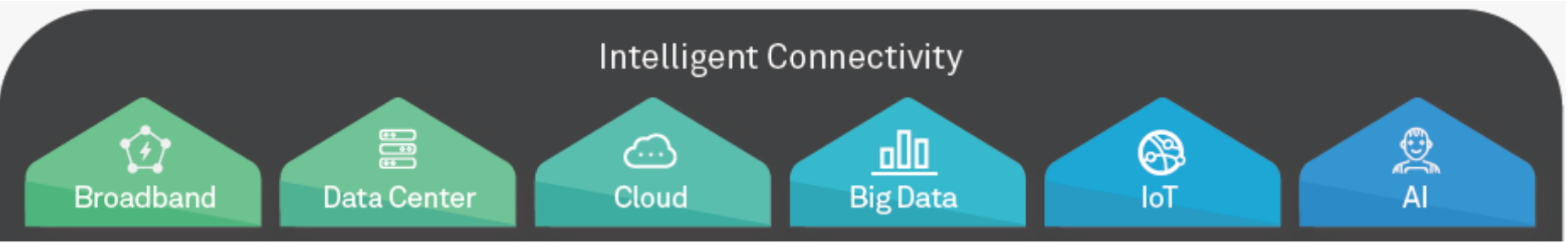


[European Parliament, Policy department a: economic and scientific policy, report 2016]

Industry 4.0 – Digitalization Impact on Industry: Intelligent Connectivity

From Connectivity to Intelligent Connectivity

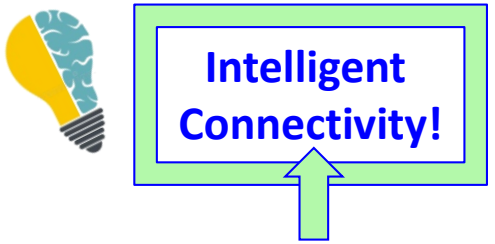
Path towards Intelligent Connectivity



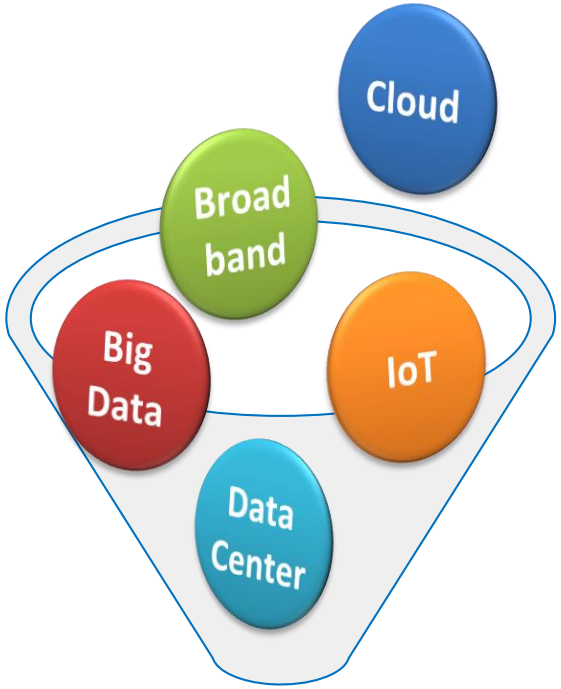
Increase 8% investment in ICT every year

$23 trillion by 2025!

GLOBALLY!



Enabling technologies

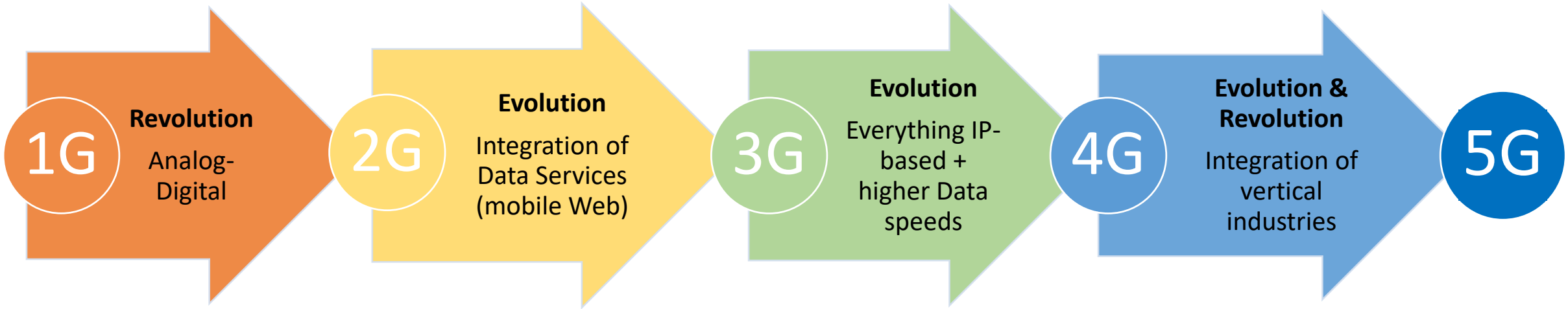


Integration with AI

[GCI 2018 whitepaper, Tap Into New Growth With Intelligent Connectivity]

Industry 4.0 and 5G

The generation of Connectivity



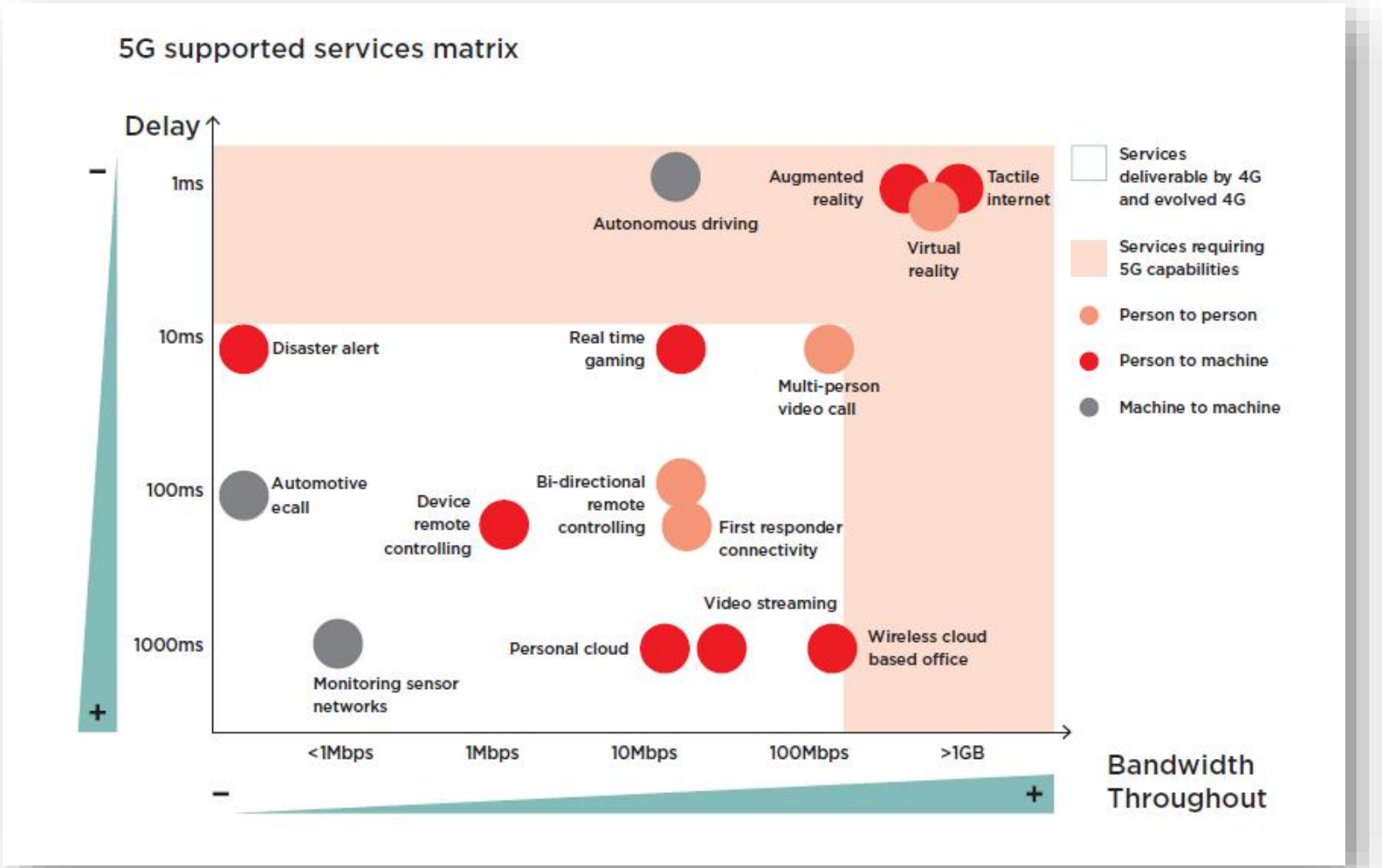
1G	2G	3G	4G	5G
Analog voice Services (car phone)	**Digital voice services + SMS texting** (globally available)	**Voice + data** (call- based + packet based)	**IP Data** (voice, e-mail, web, audio/ video streaming)	**Control & Management** (Machine type communication, IoT + AR, VR, Ambient Assistant Living)
2kbps	**14-64 kbps**	**2 Mbps**	**200 Mbps**	**>1 Gbps**

Industry 4.0 and 5G

**5G is intended to be very versatile,
supporting three classes of applications:**

- ✓ **eMBB (Enhanced Mobile Broadband)**
- ✓ **mMTC (Massive Machine Type Communications)**
- ✓ **URLLC (Ultra-reliable and Low Latency Communications)**

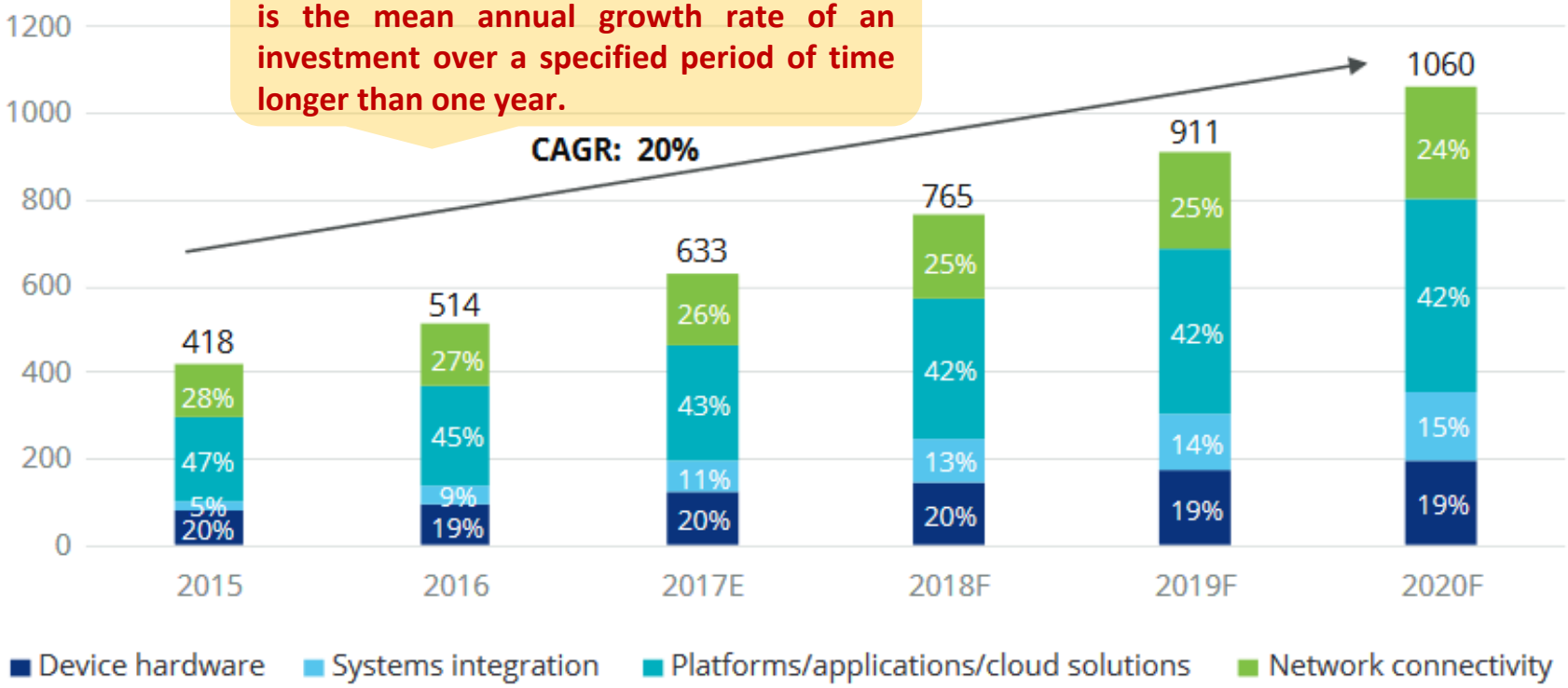
[GSMA paper: Unlocking Commercial Opportunities From 4G Evolution to 5G]



Industry 4.0 – Benefits

Forecasted Global IoT market spending ($ billion)

The Compound Annual Growth Rate (CAGR) is the mean annual growth rate of an investment over a specified period of time longer than one year.



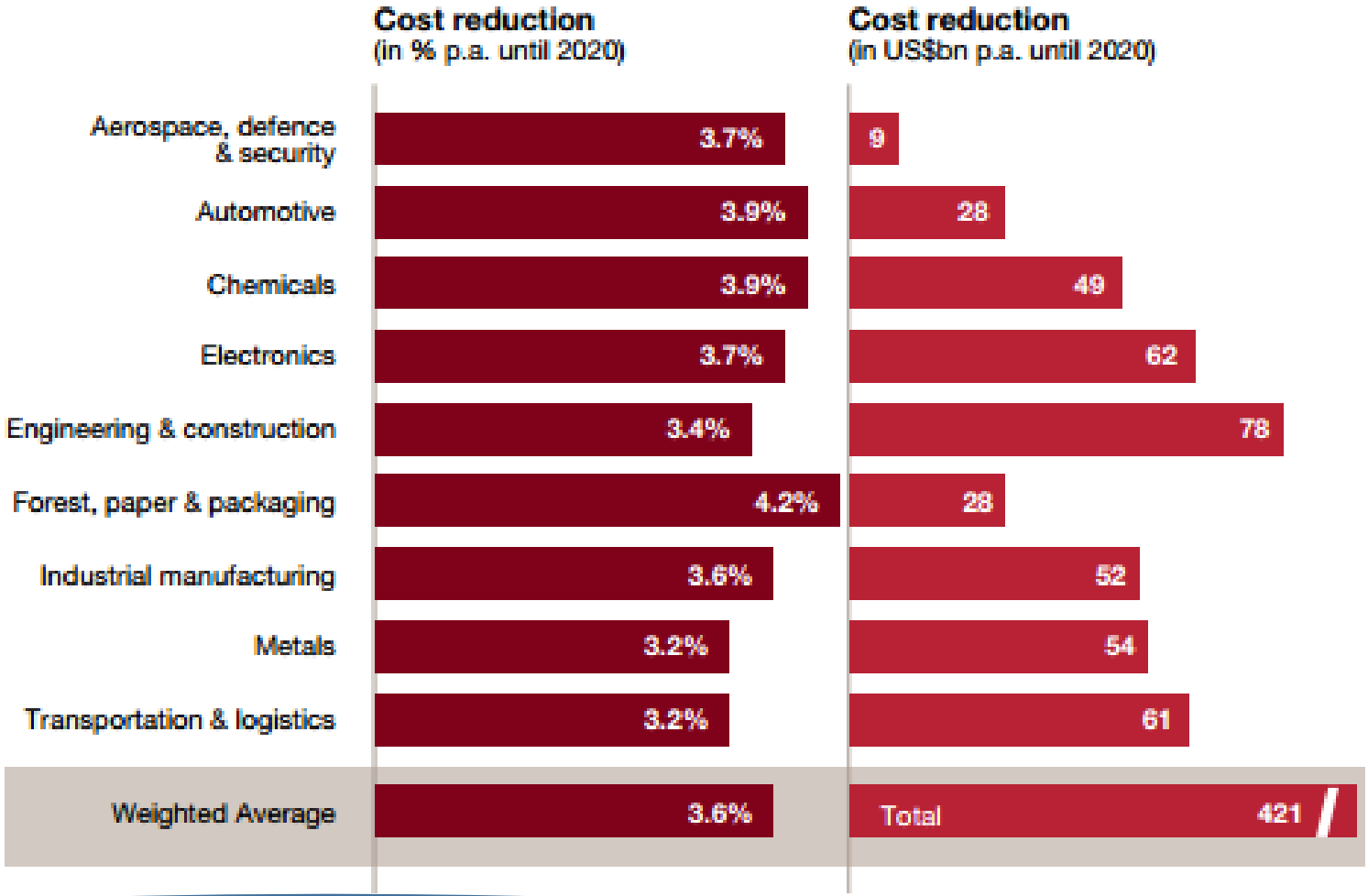
The manufacturing industry is expected to spend $189 billion on IoT solutions in 2018, continuing to make IoT in manufacturing by far the largest spending category. Consumer IoT, fourth in 2018, has the highest CAGR until 2021, with strong spending growth for smart appliances, and an overall CAGR of 21%

[Deloitte Report IoT, 2018]

[PWC Report Industry 4.0, 2017]

Industry 4.0 – Benefits

Expected Cost Reduction in every industry sector:



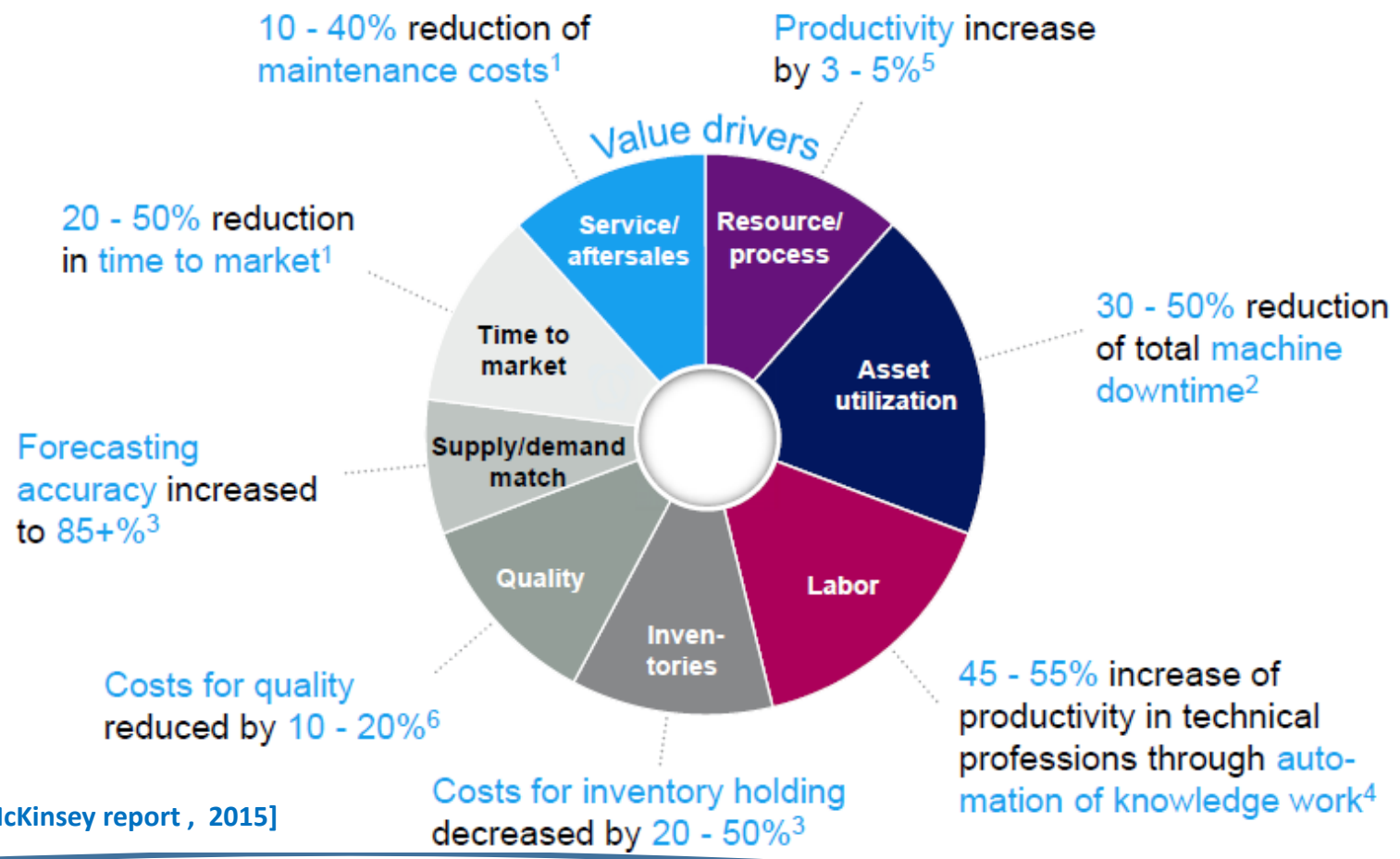
Expected cost reduction per industrial sector after the adoption of Industry 4.0 paradigm. An average percentage of 3,6% is expected in industry in general

[2016 Global Industry 4.0 Survey]

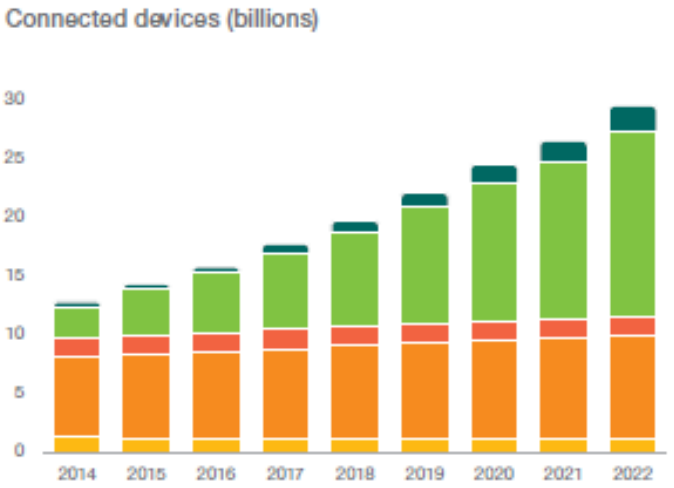
Industry 4.0 – Benefits

The way towards Internet of Things (IoT):

Indicative quantification of value drivers



[McKinsey report , 2015]



Compound Annual Growth Rate

	2016	2022	CAGR
Wide-area IoT	0.4	2.1	30%
Short-range IoT	5.2	15.5	20%
PC/laptop/tablet	1.6	1.7	0%
Mobile phones	7.3	8.6	3%
Fixed phones	1.4	1.3	0%
	16 billion	29 billion	

[Ericsson Mobility Report, 2017]

Industry 4.0 – Application Fields

Big Data Driven Quality Control

Algorithms based on historical data identify quality issues and reduce product failures

Robot-Assisted Production

Flexible, humanoid robots perform other operations such as assembly and packaging

Self-Driving Logistics Vehicles

Fully automated transportation systems navigate intelligently within the factory

Production Line Simulation

Novel software enables assembly line simulation and optimization

Smart Supply Networks

Monitoring of an entire supply network allows for better supply decisions

Machines As a Service

Manufacturers sell a service, including maintenance, rather than a machine

Self Organizing Production

Automatically coordinated machines optimize their utilization and output

Additive Manufacturing of Complex Task

3-D printers create complex parts in one step, making assembly redundant

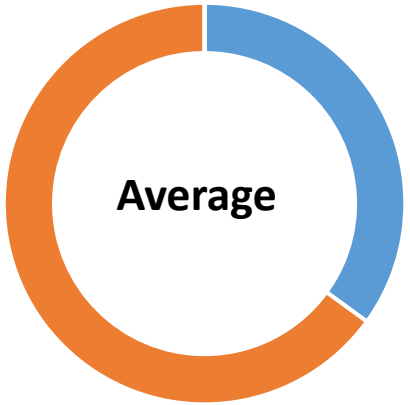
Augmented Work, Maintenance, and Service

Fourth dimension facilitates operating guidance, remote assistance, and documentation

Predictive Maintenance

Remote monitoring of equipment permits repair prior to breakdown

[BCG, 2015]



35%

Of core skills will change between 2015 and 2020

Top 10 Skills in 2015-2020

In 2020

1. Complex Problem solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with others
6. Emotional intelligence
7. Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive flexibility

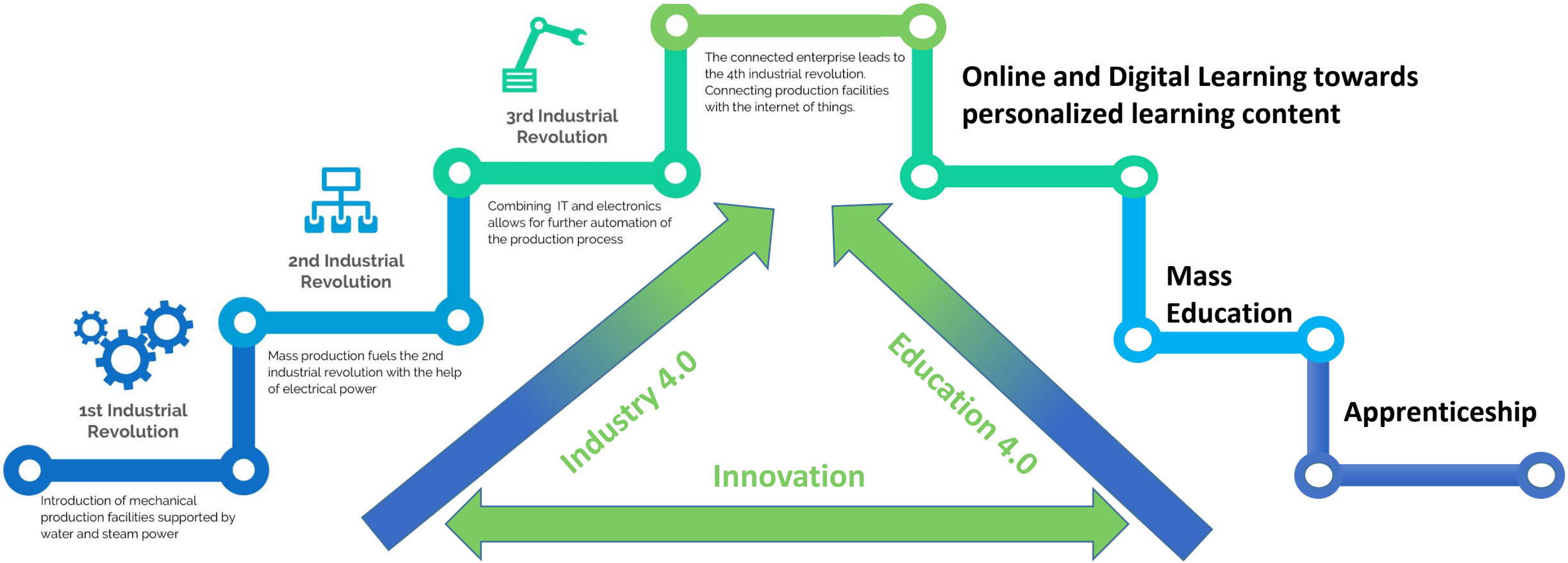
In 2015

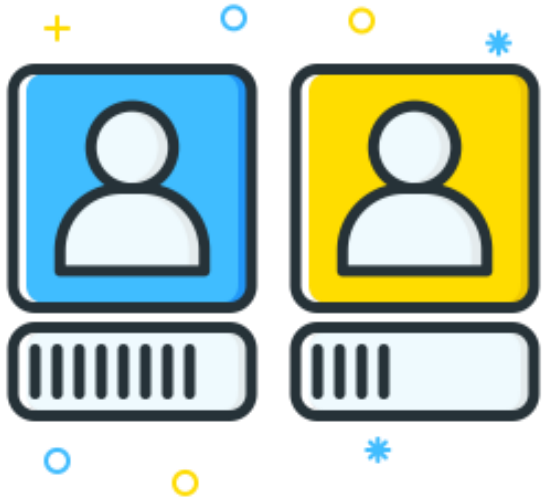
1. Complex Problem solving
2. Coordinating with others
3. People Management
4. Critical Thinking
5. Negotiation
6. Quality control
7. Service Orientation
8. Decision Making
9. Active Listening
10. Creativity

[WEF, 2017]

Industry 4.0 – Education 4.0

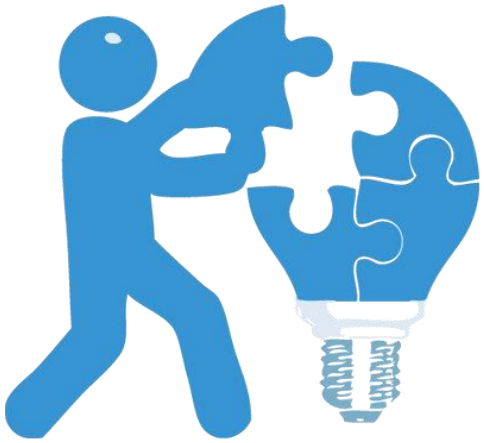
Cyber-Physical Systems
&
Cyber-Physical Education





Skills give us the "WHAT."

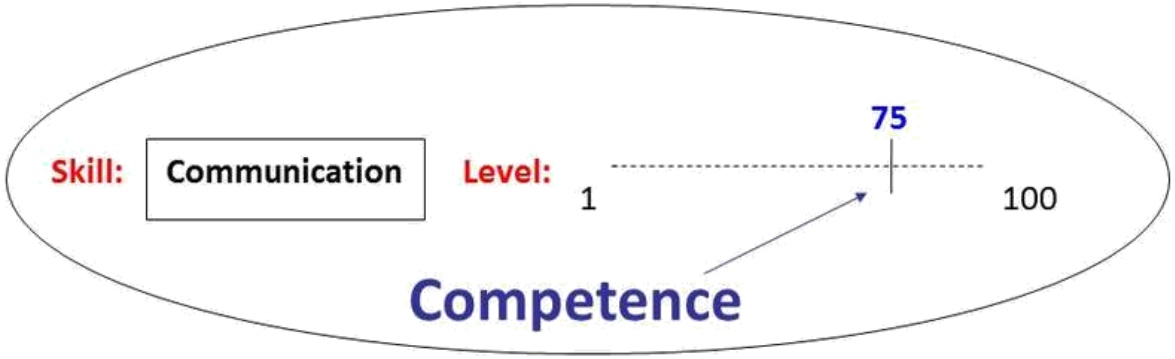
Skills define specific learned activities, and they range widely in terms of complexity.



Competencies give us the "HOW."

Competencies provide that missing piece of the puzzle by translating skills into on-the-job behaviours that demonstrate the ability to perform the job requirements competently.

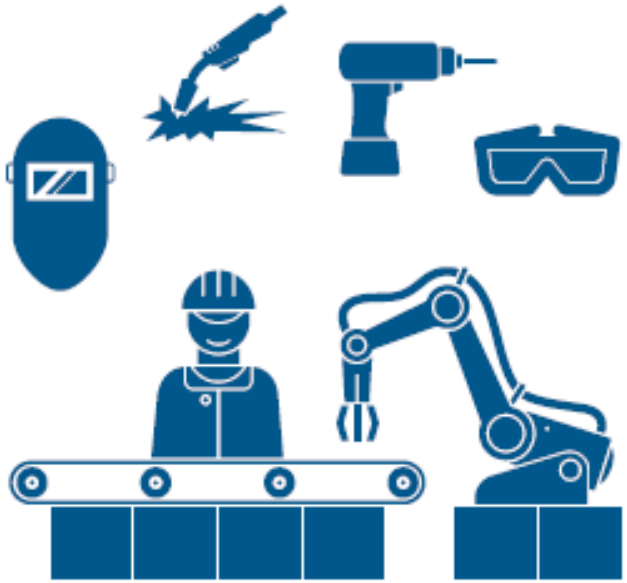
To measure the actual ***level of mastery*** of certain skill we use the concept of **Competence**.



https://anyaworksmart.com/2012/11/12/skills-competence-expertise-what-is-what/
https://talentguard.com/whats-the-difference-between-skills-and-competencies/

Industry 4.0 – Education 4.0

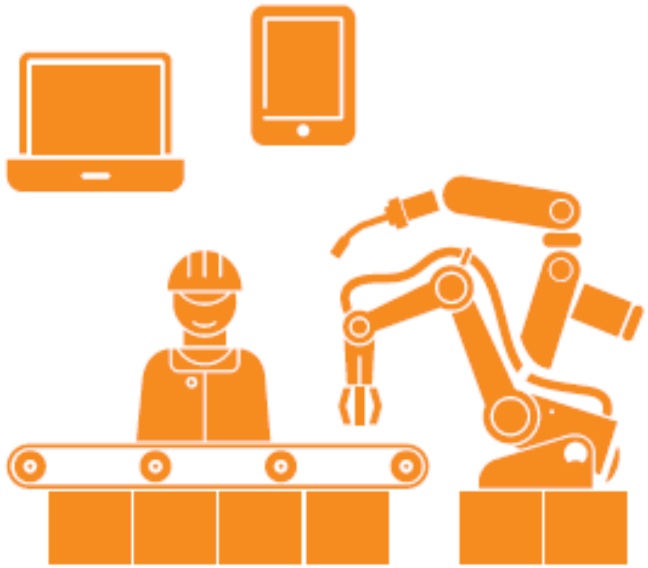
MODERN FACTORY WORKER



- Basic general knowledge
- Experience
- Ability to improve
- Creativity
- Knowledge on using manufacturing equipment and specific IT tools

What Skills were needed?

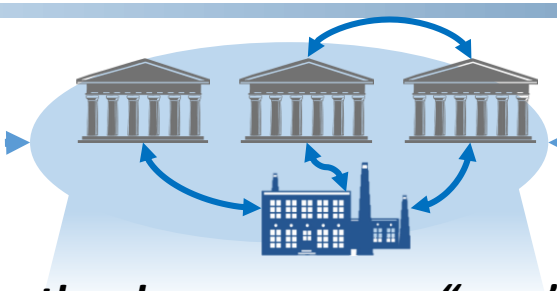
DIGITAL FACTORY WORKER



- Intelligence
- Senses to perception
- Advanced Knowledge on using various IT tools
- Learning aptitude
- Experience
- Ability to improve
- Creativity
- Social Interaction

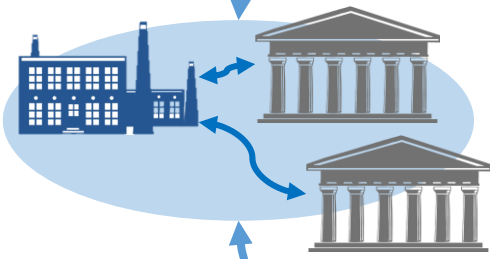
What Skills are needed now?

Industry 4.0 – Education 4.0-Teaching Factory 4.0 Network



… industrial practices to the classroom

… "new" knowledge to the factory

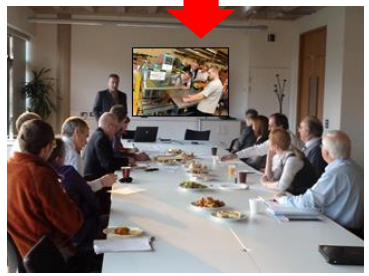


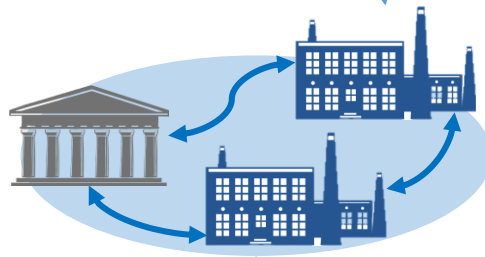
research

KNOWLEDGE

education

innovation





Teaching Factory as a 2-way knowledge communication channel

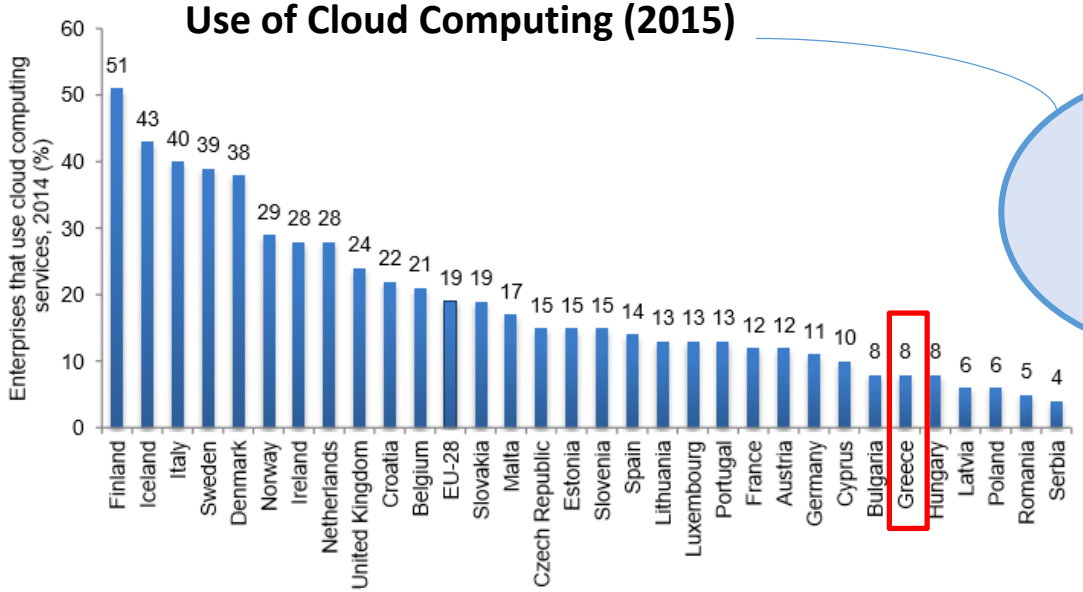
Two pilots :VOLVO and FESTO

Communication channels

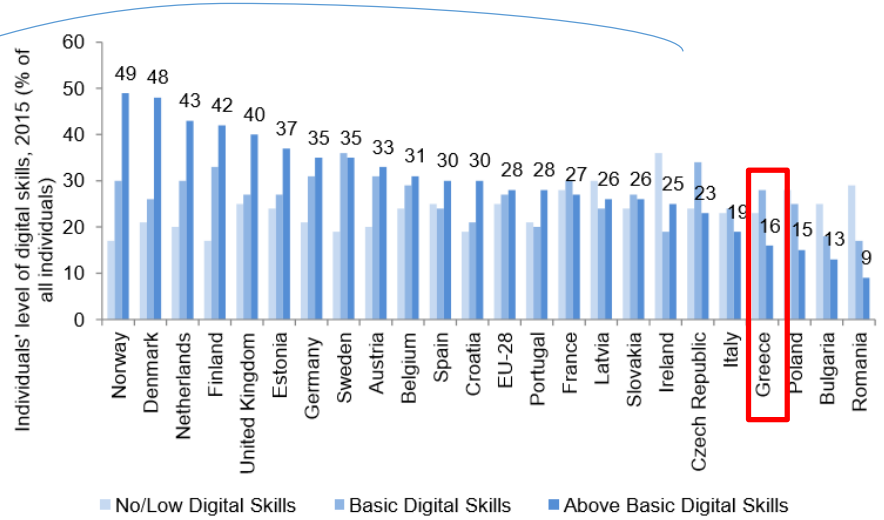
[Mourtzis et al., "Cyber-Physical Systems and Education 4.0-The Teaching Factory 4.0 Concept", 2018]

Industry 4.0 – Educations 4.0 – Greece

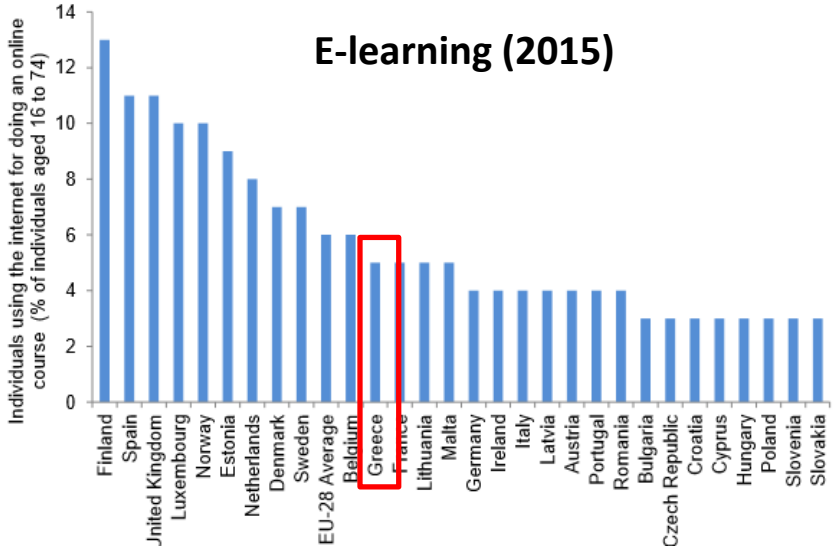
Use of Cloud Computing (2015)



Room for Improvement



E-learning (2015)



[Thor Berger, Carl Benedikt Frey, Report 2016, Digitalization, jobs, and convergence in europe: strategies for closing the skills gap]

Western Greece HUB for Innovative & Digital Manufacturing

ManuHub@WG

LMS

Laboratory for Manufacturing Systems & Automation

Laboratory for Manufacturing Systems and Automation (LMS)

Assoc. Professor - D. Mourtzis
Dr. P. Stavropoulos

ManuHub@WG: Consortium

Public Partners

LMS

RWG

ManuHub@WG

Private Partners

STEDE

SEVIPA

MoU of Alliance for Entrepreneurship and Development in Western Greece

ManuHub@WG: Mission & Objectives

MISSION

Hub's mission is to **create added value** for the services and products of **local manufacturing companies** through innovative technologies and research activities performed by academia

OBJECTIVES

- Accelerate Innovation in RWG
- Connect Academia with Industry
- Develop a strategy for Innovative & Digital MFG & RIS3 priorities
- Develop an added value Manufacturing community
- Provide Technological & Engineering support
- Create Training & Education programs
- Connect start-ups with SMEs for testing & piloting

Impact to Companies

- Reduced barriers to implement new technologies
- Networking
- Increased visibility

Impact to Community

- 6 + 4 new job positions
- Increased entrepreneurialism
- Business development
- Increased tax revenue

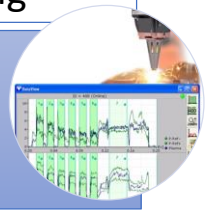
ManuHub@WG: Products & Services

Bridging the Gap

- MFG process simulation
- Process experimentation
- Process optimization
- Process planning development
- Process planning optimization
- Product design/development
- Process monitoring development / integration
- Equipment assessment
- Equipment commissioning
- Production line simulation / development
- Production monitoring

Pylon 1:

Technical Services



- SOP development
- On job training
- Workshops
- Seminars
- Webinars
- Access to knowledge repository (basic research)
- TBD……
-
-
-
-

Pylon 2:

Training Services

- Regional R&D call development
- Funding search
- Match-making
- Sharing infrastructure / equipment
- Patents
- Business plan development
- Product marketing planning
- TBD……
-

Pylon 3:

Consulting Services

Thank you for your attention !!!

For more information:

Professor Dimitris MOURTZIS
(mourtzis@lms.mech.upatras.gr)

LMS
Laboratory for Manufacturing Systems & Automation

Laboratory for Manufacturing Systems and Automation (LMS), University of Patras

http://www.lms.mech.upatras.gr/