Impact of Digitisation, Key Strategic Technology Roadmaps and Importance of Edge Computing



Haydn Thompson



History (1980s-2012)



BAC1-11 Autoland



Flight Control Boeing



ESA Columbus Project



US Army Lasers



Concorde Engine Control



Tornado Engine Control



Engine Control Challenger Tank



743D Radar



JAS 39



EMPAR Radar



Programme Manager Rolls-Royce Control and Systems UTC



Over 400 projects in 20 years covering Aerospace, Energy, Marine and Nuclear Worldwide







Smart Anything Everywhere (Anytime)



Technology and Innovation Radar



Agriculture Introduction Barriers to Uptake Arable Farming Livestock Monitoring and Meat Production Fruit Farming Home Automation Green Applications Wearables Technologies to Combat COVID-19 Food and Beverage Art, Entertainment, Music and Literature Feedback and Suggestions for New Technologies

http://www.thhinkbv.com/docs/New1Radar/index.html



Digitisation Potential



McKinsey&Company

Source: McKinsey Global Institute (MGI) analysis; see "Digital Europe: #E Realizing the continent's potential," MGI, June 2016, on McKinsey.com

#DigitalEurope



Changes from Digitisation





Importance of Digitisation



Importance for Europe 30% of market

McKinsey estimates that digitisation will potentially add 1 trillion EUR to the GDP in Europe Automotive - The EU is among the world's biggest producers of motor vehicles, and the sector represents the largest private investor in research and development (R&D) within Europe. The sector provides jobs for 12 million people and accounts for 4% of the EU's GDP. Manufacturing accounts for 3 million jobs, sales and maintenance for 4.3 million, and transport for 4.8 million. The global car fleet is predicted to double from currently 800 million vehicles to over 1.6 billion vehicles by 2030. Markets and Markets predicts that the global traffic management market will grow from \$4.12 Billion in 2015 to \$17.64 Billion by 2020 and the self-driving car market will grow from \$42 Billion in 2025 to \$77 Billion by 2035.

Rail - The overall rail sector in the EU, including the rail operators and infrastructure managers, employs approximately 1.8 million people with an estimated 817,000 dependent individuals. The European rail supply industry employs nearly 400,000 people and is a top exporter, accounting for nearly half of the world market for rail products with a market share of 84% in Europe and a total production value of €40 billion (2010). Markets and Markets predicts that the railway management system market will grow from \$29.27 Billion in 2016 to \$57.88 Billion by 2021.

Aerospace - The European aerospace industry is a world leader in the production of civil and military aircraft, helicopters, drones, aero-engines, and equipment, exporting them all over the world. Aerospace within the EU provides more than 500, 000 jobs and generated a turnover of €140 billion in 2013. The commercial aircraft market is expected to grow steadily to 2035. The aircraft flight control system market projected to grow from \$11.85 Billion in 2016 to \$16.59 Billion by 2021, and the aircraft health monitoring systems market to grow from \$3.43 Billion in 2016, to \$4.71 Billion by 2021. The Unmanned Aerial Vehicle market was estimated to be \$13.22 Billion in 2016 and is projected to reach \$28.27 Billion by 2022 with opportunities in software (\$12.33 Billion by 2022) and services (\$18.02 Billion by 2022). The Air Traffic Management (ATM) market is projected to grow from \$50.01 Billion in 2016 to \$97.30 Billion by 2022.

Manufacturing - The manufacturing sector accounts for 15.0% GDP and provides around 33 million jobs in Europe. Europe is a front runner in manufacturing excellence with the vision of smart and connected factories swiftly becoming a reality. The industrial control and factory automation market, comprising control system manufacturers, field components manufacturers, system integrators, and software manufacturers, is projected to reach \$153.30 Billion by 2022. By 2025 additive manufacturing is expected to create a 6.3 BEuros opportunity in the consumer electronics, automotive and aerospace industries.

Health - Health care and long-term care expenditure accounted for 8.7% of GDP and about 15% of total government expenditure in the EU in 2015. Spending is rising faster than GDP and it is estimated that it will reach 16% of GDP by 2020 in OECD countries. The health sector accounts for 10% of all employment and is expected to grow by a further 1.8 million jobs up to 2025. Life expectancy currently increases with "one weekend per week" in Europe. The ageing population and prevalence of chronic diseases will increase public health and care budgets significantly due to the need to provide long term care driving the need for new solutions. The healthcare IT market is projected to reach \$280.25 Billion by 2021 from \$134.25 Billion in 2016. The global medical device connectivity market is projected to reach \$1.34 Billion by 2021 and the telehealth market is projected to reach \$9.35 Billion by 2021.

Source THHINK



Electronic Components and Systems





ECS Market in 2018





Opportunity for Europe is IoT





Digital Initiatives Across Europe



Fragmentation!



Issue of Fragmentation



Horizontal/Telecommunication

CREATE-IoT



Impact of COVID



What Happened?



Changes in Manufacturing



Generations

Industrial Robot Sales

Annual installations of industrial robots - World THE ADOPTION PLATEAU

Fast Pace of Change

Easter 1900, NYC Spot a Car

Easter 1913, NYC Spot A Horse

Technology Adoption - Rapid

Industry 4.0 and 5.0

Industry 4.0

 Brings together robots, interconnectivity and networking of data in a factory to improve production and to do routine tasks that are best done by robots. There are increases in safety, quality and reductions in waste.

Industry 5.0

- Allows customers to customise what they want.
- People working alongside robots and smart machines collaboratively to help humans work better and faster by exploiting advanced technologies like the Internet of Things (IoT) and big data.
- Closed loops with smart products

Robots in Cages ... to Cobots

Robots for dangerous, monotonous or physically demanding work, such as welding and painting in car factories and loading and unloading heavy materials in warehouses. Robots operated separately from workers and behind safety cages

Robots to Cobots

- Higher value jobs giving the freedom of design responsibility back to the human.
- Operators get more involved in design process as manufacturing gets more automated.
- This opens opportunity to produce bespoke and personal products.
- Human has more responsibility, and end up with bigger, lighter environment that is safer.

Exoskeletons

Wearable machine to improve strength and endurance

About 10,000 sold in 2020!

Growth Area – Personal Robots

Annual global robot unit sales for enterprise use, 2016–2020

Industrial Service Total

Source: Deloitte

Closing the loop on Products – Digital Twins

Close loop with products for diagnostics with real time data coming in from products in the field, e.g. Rolls-Royce

- 50% reduction in time and cost using HPC
- Can run many "what if?" scenarios

Largest growth in digital twins is expected in automotive

- Every Tesla has its own digital twin
- Cars are always connected and they can analyse across all vehicles and look at scenarios experienced and then update algorithms over the air

Digital Twin at a National Level

• UK is trying to produce a digital twin of the country!

Key Technologies

Edge Connectivity

- Data
- Energy
- Privacy
- Latency

"Internet of Intelligent Things"

www.business-sweden.se

Platform Dependency

- GAFA platforms
 - Google \$364.99 billion
 - Apple \$598.73 billion
 - Facebook \$245.00 billion
 - Amazon \$247.60 billion
 - (Also Alibaba \$231 billion)
- Opportunity for platforms targeted at manufacturing, autonomous cars, etc.
- To be successful it needs to be "industrial strength", and supported by developers and users

Key Capabilities of IMT-2020 defined by ITU

Source: Recommendation ITU-R M.2083

5G is characterized by increased data rate, enhanced spectrum efficiency and reduced latency.

AI OTI 1000 times higher mobile data volume per geographical area., 10 to 100 times more connected devices. 10 times to 100 times higher typical user data rate., 10 times lower energy consumption. End-to-End latency of < 1ms.. Ubiquitous 5G access including in low density areas.

6

Cellular IoT/IIoT use case segments

• 5G largely driven by streaming HD video to devices, but now more realisation of different use cases

9

IIoT Value Chain – Communications, Cybersecurity, Big Data, Al...

Source: IDEA Consult

Overlapping areas – data is the new oil!

EC IIoT Strategy

Key Competitive Factors for IIoT Value Chain

INDUSTRIAL IOT

Competitive fit – we evaluate key factors supporting competitive strength for the IIoT value chain

1 Per capita ratio: 1.5 in EU vs. 2.5 in US 2 E.g. Digitising European Industry, European Data Economy Initiative 3 E.g. "Plattform Industrie 4.0" in Germany, "Alliance pour Industrie du Futur" in France

SOURCE: McKinsey Global Institute analysis; McKinsey project team

McKinsey & Company 13

FOR DISCUSSION

Strong performance On par Lagging

PRELIMINARY

NON-EXHAUSTIVE

McKinsey, Industrial Internet of Things Strategic Value Chain, July 2019

Draft Recommendations for IIoT

Al is everywhere!

AI is many things

Which girl is computer generated?

Artificial Intelligence

Source: PwC analysis

 To widely deploy these technologies, specific attention has to be given to standardisation, synchronising EU and Member States activities, and to international collaboration -> AI that supports European Values

National AI Strategies...

Very Sudden Emergence

2018-07-13 | Politics + AI | Tim Dutton

State of Play 2020

State of Play in Europe: competitive advantage lies in industrial applications

Revenues from AI software market in Europe set to quintuple until 2025 (in million USD)

- 42% of companies in the EU use AI; 18% plan to use AI
- AI companies in the EU are mainly active in ICT, professional services and the manufacturing sector

EU Artificial Intelligence

European Coordinated Plan

The EU Coordinated Plan targets harnessing excellence and has a number of key actions including:

- Creation of networks of European AI research excellence centres
- Provision of world reference testing facilities
- Fostering AI take-up through the Digital Innovation Hubs
- Attracting talent and stimulating life-long learning
- Creation of European Data Spaces based on European values

Further information on these initiatives is available in three key documents:

- Strategic Research, Innovation and Deployment Agenda for an AI PPP
- EFFRA Vision for a Manufacturing Partnership in Horizon Europe
- Policy and Investment Recommendations for Trustworthy AI

Technological Autonomy

- The world has changed it is not business as usual!
- Enhancing Europe's technological autonomy has been prominently presented under the new mandate of the EC.
- EC industrial strategy is to concentrate on key value chains to support European autonomy.
- Strategic Value Chain (SVC) on IIoT must build upon European strengths in AI, data economy, cloud, 5G, cybersecurity and verticals.
- Plan is to mobilise public and private investments with EC Horizon Europe and Digital Europe Programmes.
- Strategic Institutionalised Partnership has been proposed on IoT/IIoT – "Smart Networks and Services".

Strategic Value Chains

social, environmental and climate challenges

Autonomy, security

Potential for

Microelectronics* Batteries* *High-performance computing** Connected, clean and autonomous vehicles Smart health Low-carbon industry Hydrogen technologies and systems **Industrial Internet of Things** Cybersecurity

* already ongoing initiatives.

Horizon Europe

• Wanted €94.4Bn – agreed €80.9Bn in September

What's New?

- European Innovation Council
 - SMEs 70% funding
 - Pathfinder grants for new areas
 - Accelerator grants to finance pre-commercial work
- R&I Missions portfolio of actions across disciplines. 5 Missions
 - Ms Connie Hedegaard, former European Commissioner for Climate Action, for the mission on 'Adaptation to Climate Change including Societal Transformation'
 - Professor Harald zur Hausen, Nobel Prize Laureate in Physiology or Medicine, for the mission on 'Cancer'
 - Mr Pascal Lamy, former Trade Commissioner and Director-General of the World Trade Organisation, for the mission on 'Healthy Oceans, Seas, Coastal and Inland Waters'
 - Professor Hanna Gronkiewicz-Waltz, former Mayor of Warsaw, for the mission on 'Climate-Neutral and Smart Cities'
 - Mr Cees Veerman, former Dutch Agriculture Minister, for the mission on 'Soil Health and Food'.
- Pillar 2 Clusters to support circular economy, trustworthy AI, European social and ethical values.
- New approach to partnerships
 - Co-programmed, cofunded and institutionalised 5 areas
 - KDT electronic components and systems + software and photonics
 - Made in Europe link to Green Deal with the concept of urban/local manufacturing
- Strategic plan for 2021-2024 and workprogramme 2021-2022 (Launched 2 days ago!)

Digital Europe Programme

• PPPs, e.g. KDT and Sector Reports

Roadmaps

CPS/IoT

- AI Various National, e.g. Finland, AI-PPP
- CPS Road2SoS, CyPhERS, CPSoS, Road2CPS, HiPEAC, Platforms4CPS
- CPS (EU-US) CPS Summit, TAMS4CPS, PICASSO
- IoT Create-IoT
- IIoT Smart Networks and Services
- NIST cybersecurity
- Telecoms 5G, AIOTI, ITU
- HPC
- BDVA
- Data economy
- Cloud
- Cybersecurity

Applications

- Manufacturing Industrie 4.0, Road4Fame, ARTEMIS-IA, **EFFRA**, MANUFUTURE, sCorPiuS
- Applications Automotive, Energy, Construction, Platforms
- Electronic Components and Systems ECSEL SRA, Boosting European Electronics, Sector Reports, KDT
- Sustainability Green Deal

- Horizon Europe
- Digital Europe
- PPPs KDT, IIoT
- National Initiatives

*Highlighted would encourage to look at

AI PPP

Strategic Research, Innovation and Deployment Agenda for an AI PPP

A focal point for collaboration on Artificial Intelligence, Data and Robotics

Second Consultation Release September 2019

A joint initiative by

Trust

• Trust brings together many attributes

Public consultation: Ecosystem of trust **Only 3%** think that current legislation is fully Can these concerns be addressed by existing EU legislation? sufficient. 2,9% Industry and business 18,4% Current legislation is representatives mainly support the fully sufficient need to cover gaps in existing 4.1% legislation. 32,5% Current legislation may have some gaps There is a need for a new legislation 42.0% No opinion Main concerns of respondents (share who find concerns important and very important): Other 90% **Breaching fundamental rights** 87% **Discriminatory outcomes** European

A Real Concern...

Platforms4CPS – Most Recent

Haydn Thompson, Meike Reimann (Lead Authors) | Daniela Ramos-Hernandez, Steve Bageritz, Adrien Brunet, Charles Robinson, Björn Sautter, Johannes Linzbach, Holger Pfeifer, Vincent Aravantinos, Martin Törngren, Fredrik Asplund, Xinhai Zhang, Isabelle de Sutter

Platforms4CPS

Key Outcomes and Recommendations

Consensus Areas

Development/Integration

Engineering of large, more and more complex systems and model-based systems engineering including integrated, virtual, full-life-cycle engineering, high-confidence CPS, validation, verification, risk analysis and risk management

Integration, interoperability, flexibility, and reconfiguration including semantic interoperability and models, openness and open standards, automatic (reconfiguration and plug-and-play

Agile, open plug and play platforms, vertical and horizontal digital technology platforms, federation of platforms, open interfaces, interoperability, reference architectures, standards

Edgification/Security/Safety

Cybersecurity, privacy, trust including block-chain, distributed ledgers digital identities, trusted and adaptive security architecture, co-engineered safety and security

Connectivity, computing and storage seamless connectivity, hyper convergence and wireless intelligence, edge computing and edge cloud interactions, intelligent edge devices, new disruptive technologies including quantum technologies, cognitive computing, neuromorphic computing, brain inspired computing

Safety, robustness, resilience, and dependability including fault detection and mitigation for secure real-time and mixed-criticality systems, risk based testing of autonomous / intelligent systems, fail-safe operation of intelligent / autonomous systems

AI/Decision Making/Humans

Trustable AI enabled autonomous systems, cognitive systems and situation awareness, diagnostics, prognostics and large-scale data analytics / decision support and explainable AI

Human-in-the-loop, human as part of the system and HMI including intuitive systems, wearable and implantable systems, virtual and augmented reality as well as human machine collaboration and collaborative decision making

Application of intelligent systems for SW and Systems Engineering processes including automated decision making in all lifecycle phases, and AI based analysis of development and runtime artefacts

ECSEL SRA

- Transport and Smart Mobility
- Health and Wellbeing
- Energy
- Digital Industry
- Digital Life

EFFRA Vision - Manufacturing

	Excellent, responsive and smat factories	Low-environmental footprint, customer- driven value networks	Parallel product manufacturing engineering	Human-driven Innovation
Each of the technologies are important for adversing the key priorities. Note: The darker colour indicates a higher conduction of technology and enabler to address the priorities listed along the vertical dimension of the matrix.	Scalable fart-time right manufacturing Aglie and robust Aglie and robust	Demand and costumer- driven manufacturing networks Circular economy (symbiotic manufacturing networks)	Virtual end-to-end life- poduct to proving from product to proving from networks networks contractives and contractives and contractives products service engineering. Menufacturing smart and complex products	Co-creation in European Innowlegin retenoios Managing constant change a technology Haman & technology complementarity
Advanced and smart marerial and product processin technologies and process chains				
Smart mechatronic systems, devices and components				
Intelligent and autonomous handling and robotics, assembly and logistic technologies				
De-manufacturing and recycling technologies, life- cycle analysis approaches				
Energy and power supply technologies				
Simulation and modelling (digital twins) covering the material processing level up to manufacturing system, factory and value network level				
Robust and secure industrial real time communication technologies, distributed contral architectures				
Data analytics, artificial intelligence and deployment of digital platforms for data management and sharing				
New business and new organisational approaches, including links with regulatory aspects such as safety, data ownership and liability				

AI for Manufacturing

Report from the Workshop on Artificial Intelligence for Manufacturing

held on 2nd July 2019, Bluepoint Building, Auguste Reyers 80, Brussels, Belgium

July 2019

Organised by the European Commission DG CONNECT Unit "Technologies and Systems for Digitising Industry", the European Factories of the Future Research Association (EFFRA), the Big Data Value Association (BDVA), and euRobotics <u>http://bit.lv/DigindEU</u> <u>www.effra.eu</u> <u>www.effra.eu</u> <u>www.eu-robotics.net</u>

Disclaimer: The views expressed here are those of the workshop participants and do not necessarily represent the official view of the European Commission on the subject.

European Data Strategy

Green Deal

Funding for Green Deal

Twin Green and Digital Transformation

Emphasis on Digital Transformation while meeting Green goals

Concluding Remarks

- There is still a lot more to achieve with digitalisation
- Industry 5.0 ushers in a new era of working alongside machines and smart products which will change our lives
- There are great opportunities for Europe in edge computing but we need to move quickly and develop trustable systems
- EC strategy based on technological autonomy and key value chains
- Horizon Europe and Digital Europe designed to promote edge computing, IIoT, 5G and AI as well as green technologies.
- Hopefully we will benefit and celebrate success over the coming years - Skål!

