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Artificial Intelligence and Industry 4.0 based Digital Transformation of Supply Chains: Opportunities and Challenges

Dr. Irina Neaga
Senior Lecturer
|University of Wales Trinity St David
Swansea, United Kingdom
Email: Irina.Neaga@uwtsd.ac.uk
LinkedIn Profile

Trawsnewid Addysg; Trawsnewid Bywydau
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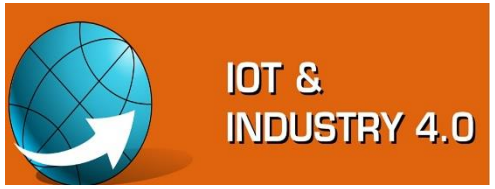
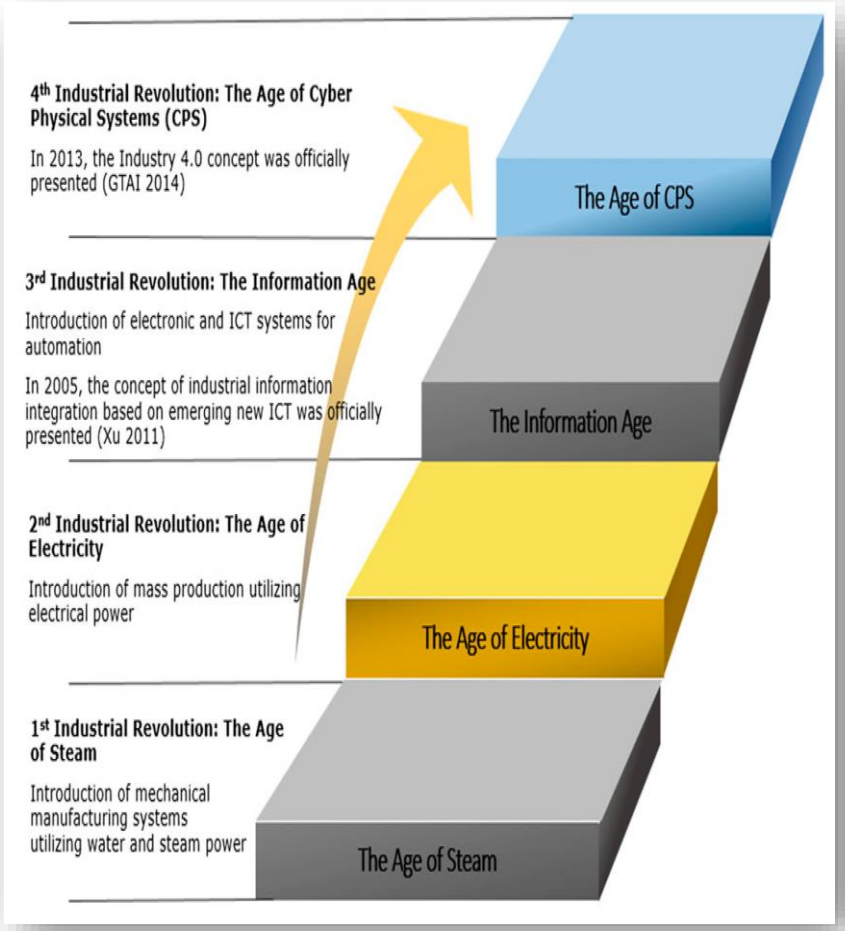
www.uwtsd.ac.uk

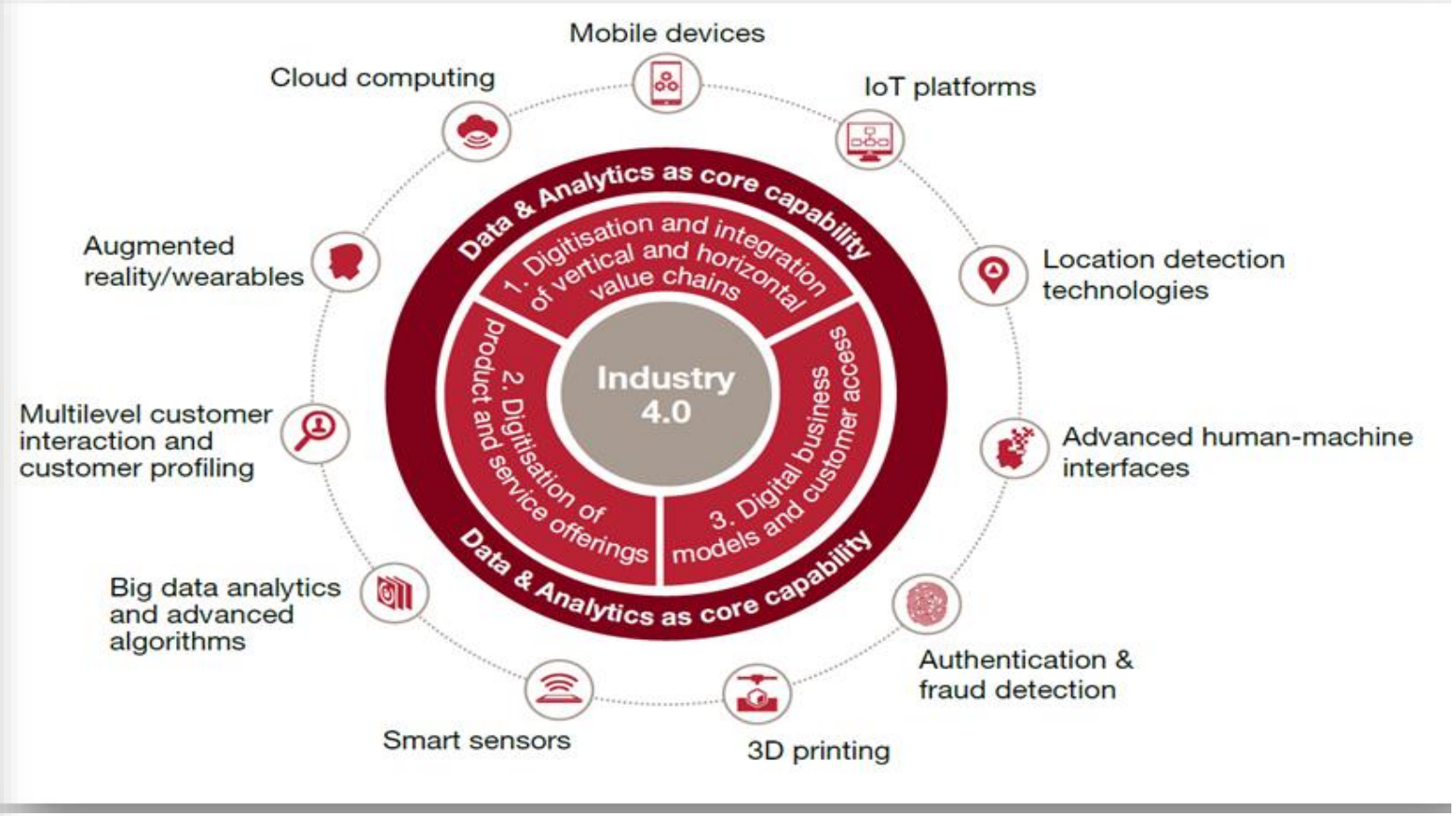
Content



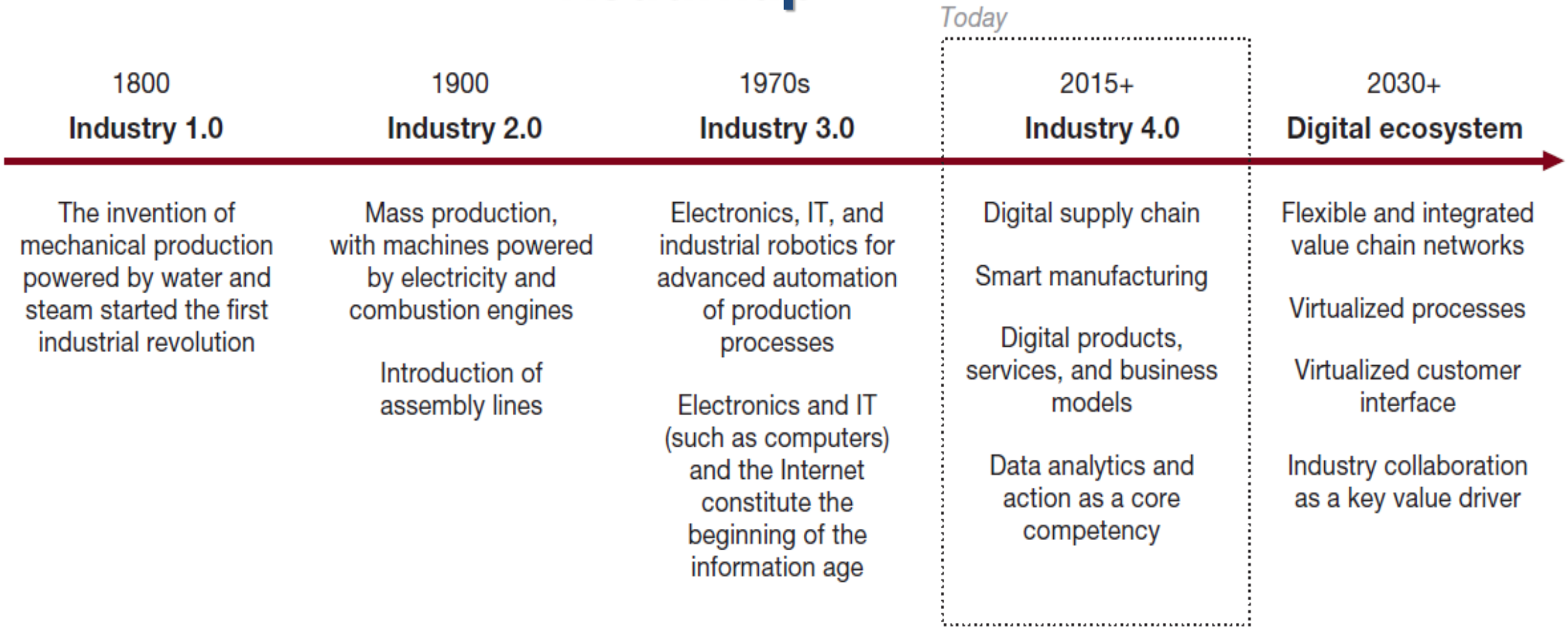
1. Industry 4.0 and Applications
2. Roadmap of Industry 4.0 to support Digital Transformation
3. Current Supporting Technologies
4. Environmental, Social and Governance Framework
5. Research and Technology driven STEM Courses Development and Implementation
6. Q&A Discussion

Industry 4.0


4th Industrial Revolution: The Age of Cyber Physical Systems (CPS)
In 2013, the Industry 4.0 concept was officially presented (GTAI 2014)
The Age of CPS
3rd Industrial Revolution: The Information Age
Introduction of electronic and ICT systems for automation
In 2005, the concept of industrial information integration based on emerging new ICT was officially presented (Xu 2011)
The Information Age
2nd Industrial Revolution: The Age of Electricity
Introduction of mass production utilizing electrical power
The Age of Electricity
1st Industrial Revolution: The Age of Steam
Introduction of mechanical manufacturing systems utilizing water and steam power
The Age of Steam


Mobile devices
Cloud computing
IoT platforms
Data & Analytics as core capability
1. Digitisation and integration of vertical and horizontal value chains
2. Digitisation of product and service offerings
3. Digital business models and customer access
Industry 4.0
Data & Analytics as core capability
Augmented reality/wearables
Location detection technologies
Multilevel customer interaction and customer profiling
Advanced human-machine interfaces
Big data analytics and advanced algorithms
Authentication & fraud detection
Smart sensors
3D printing

Roadmap



Source: Schrauf, S. and Berttram, P. Industry 4.0 How digitization makes the supply chain more efficient, agile, and customer-focused, PWC Strategy and Analysis Report , N.D.

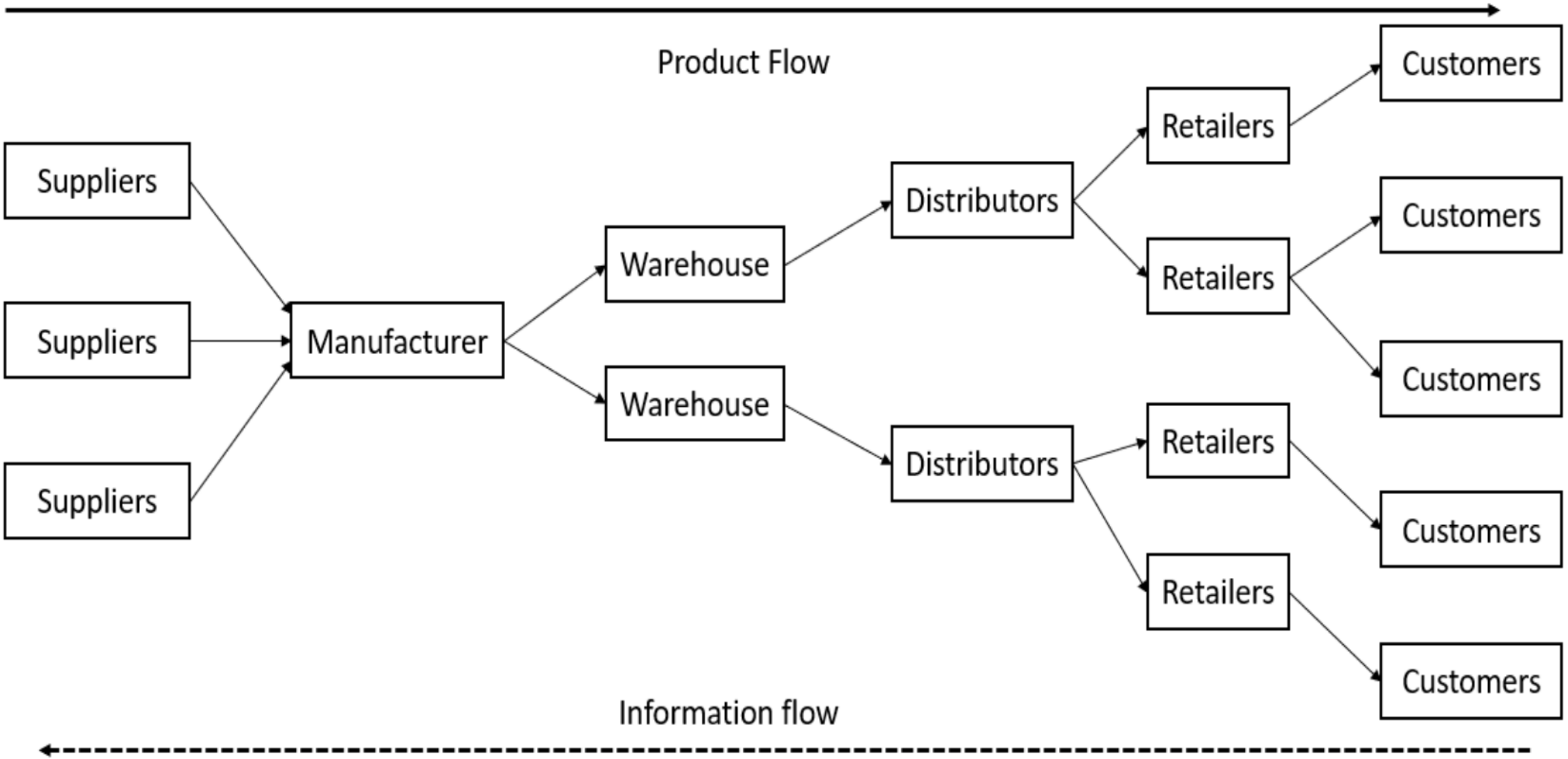


Figure 1.1 A typical Supply Chain

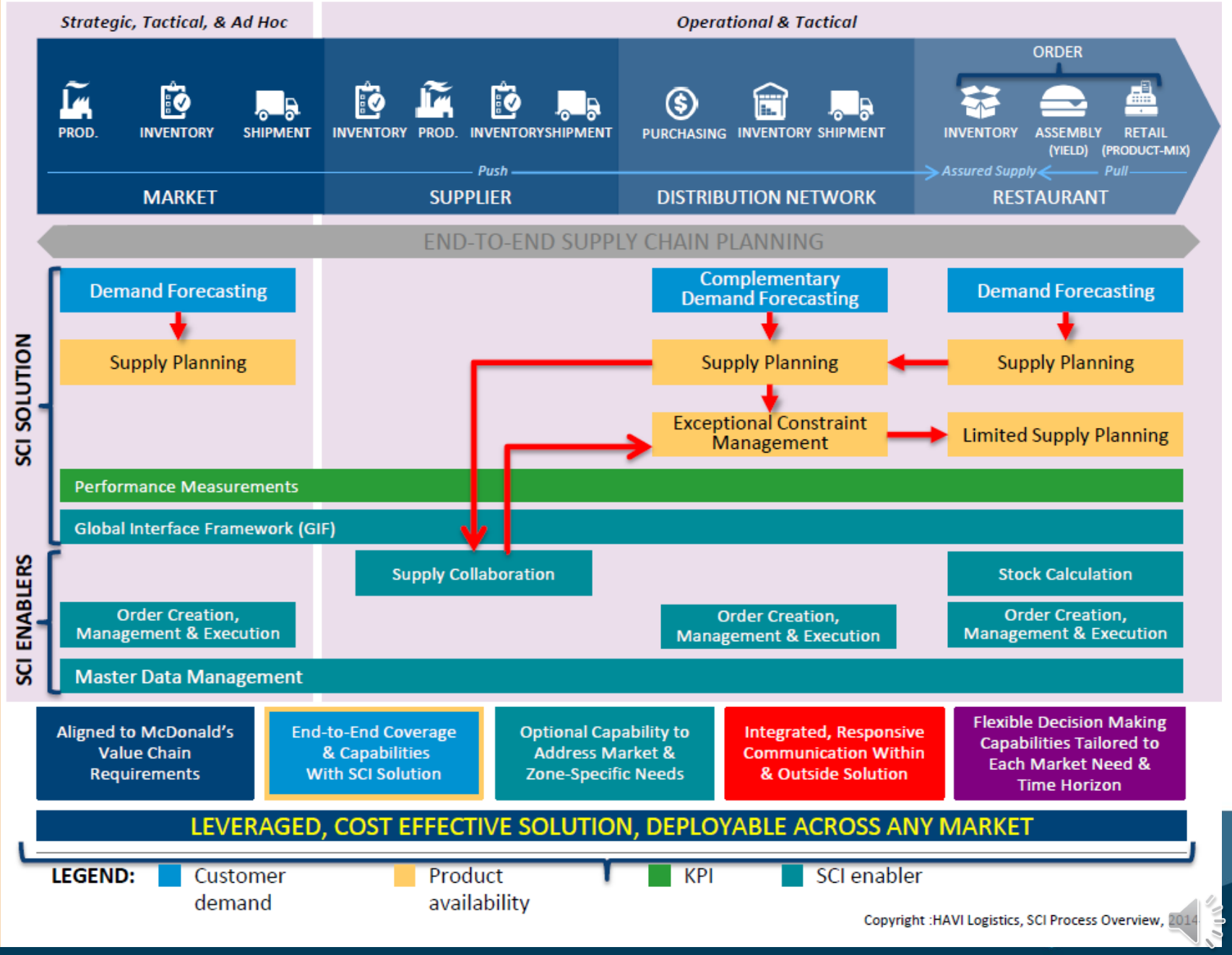
For Example: Forecasting and Big Data

Demand Modeling and Machine Learning based forecasting requires Big Data.

The result impacts the full supply chain, the way people interact and how processes are connected.

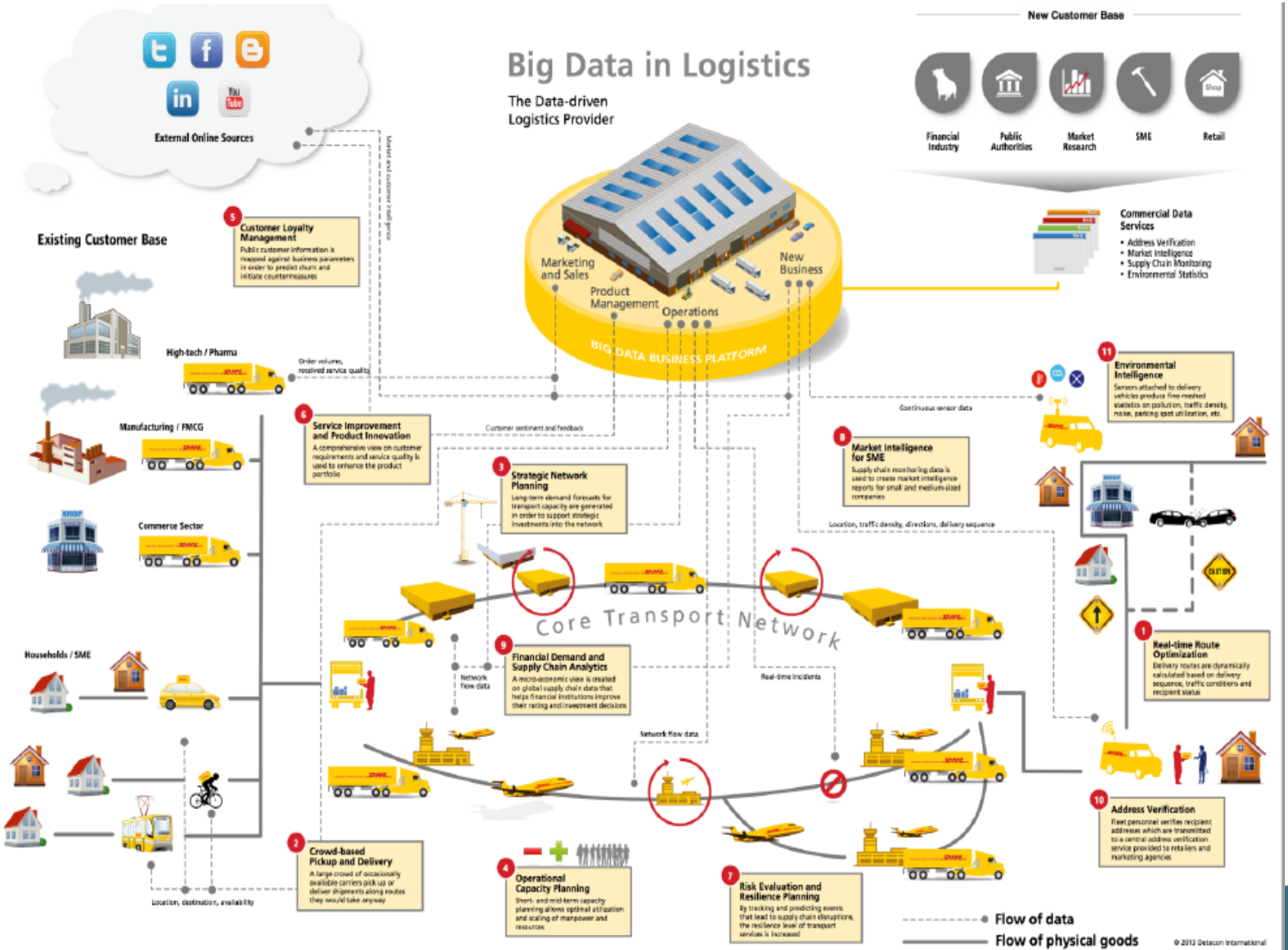
Each link of the chain is impacted and the implication of a change can be huge.

The data will come from all links and reversely influence how the whole supply chain operates and reduces the flexibility within a link.



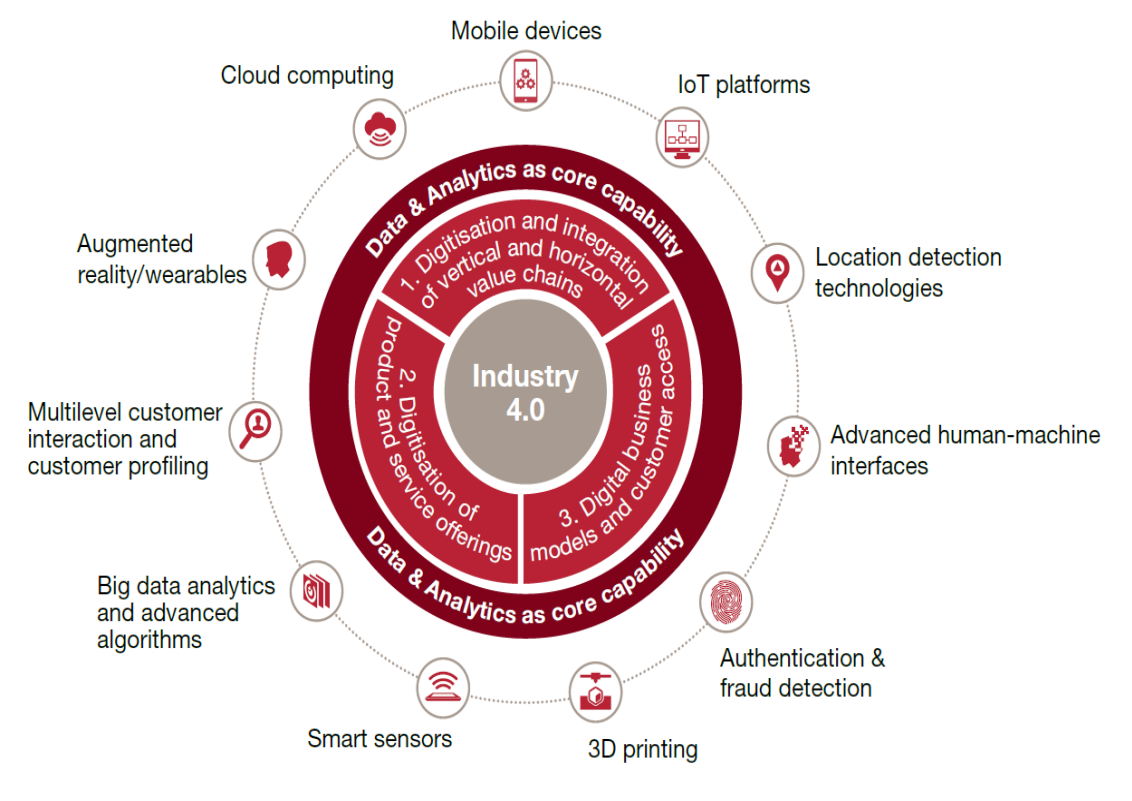
The usage of Big Data leads to an impact across most of the links of the chain.

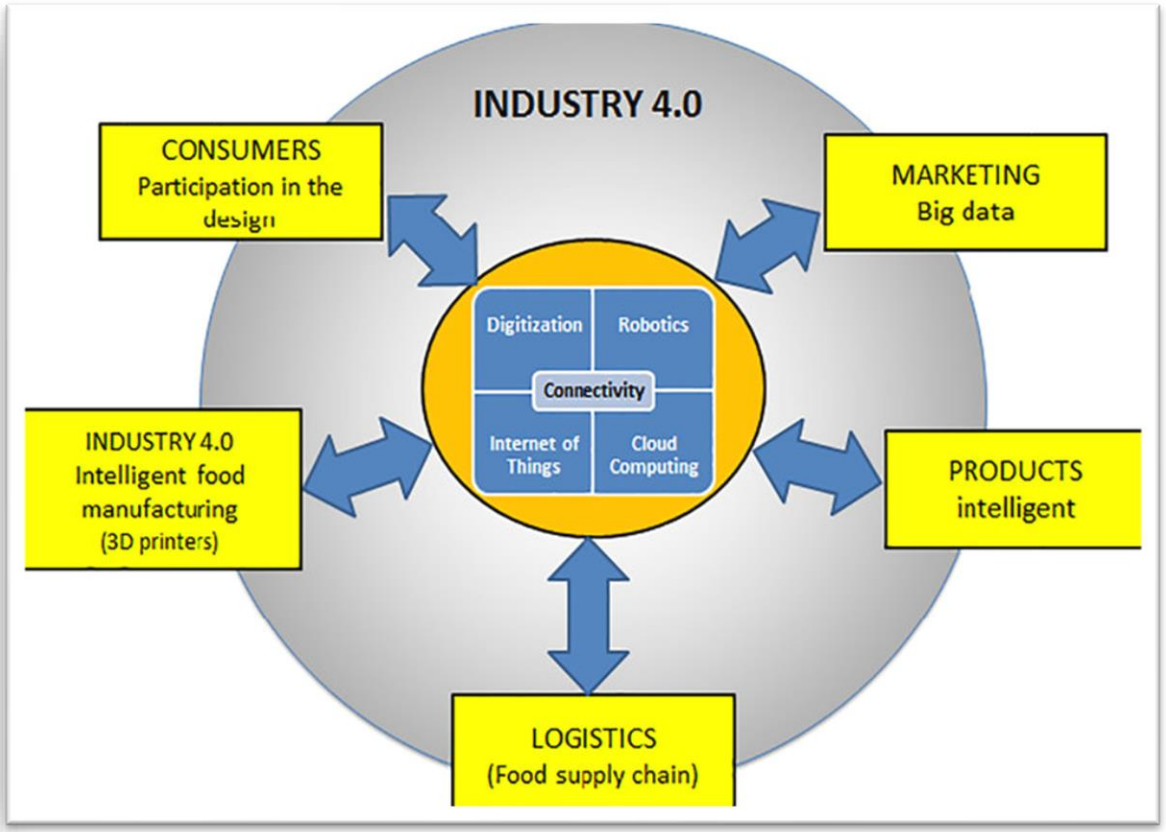
- New processes
- Data tells you more often what to do
- New services are possible
- The way of working (together) changes
- IT becomes the glue of the links
- It's becoming a real chain

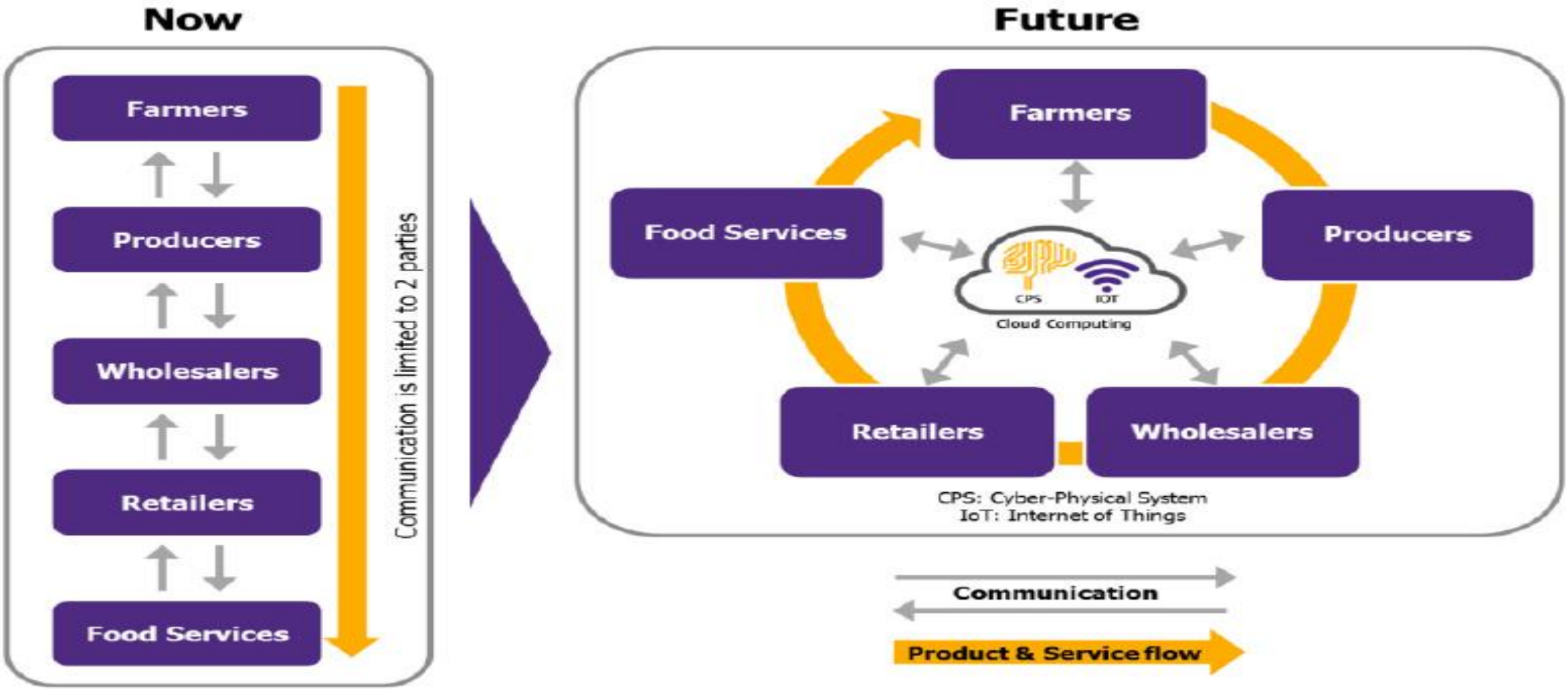


Copyright :BIG DATA IN LOGISTICS, A DHL perspective on how to move beyond the hype, 2013

Applying Industry 4.0 to Agri-Food SC4.0







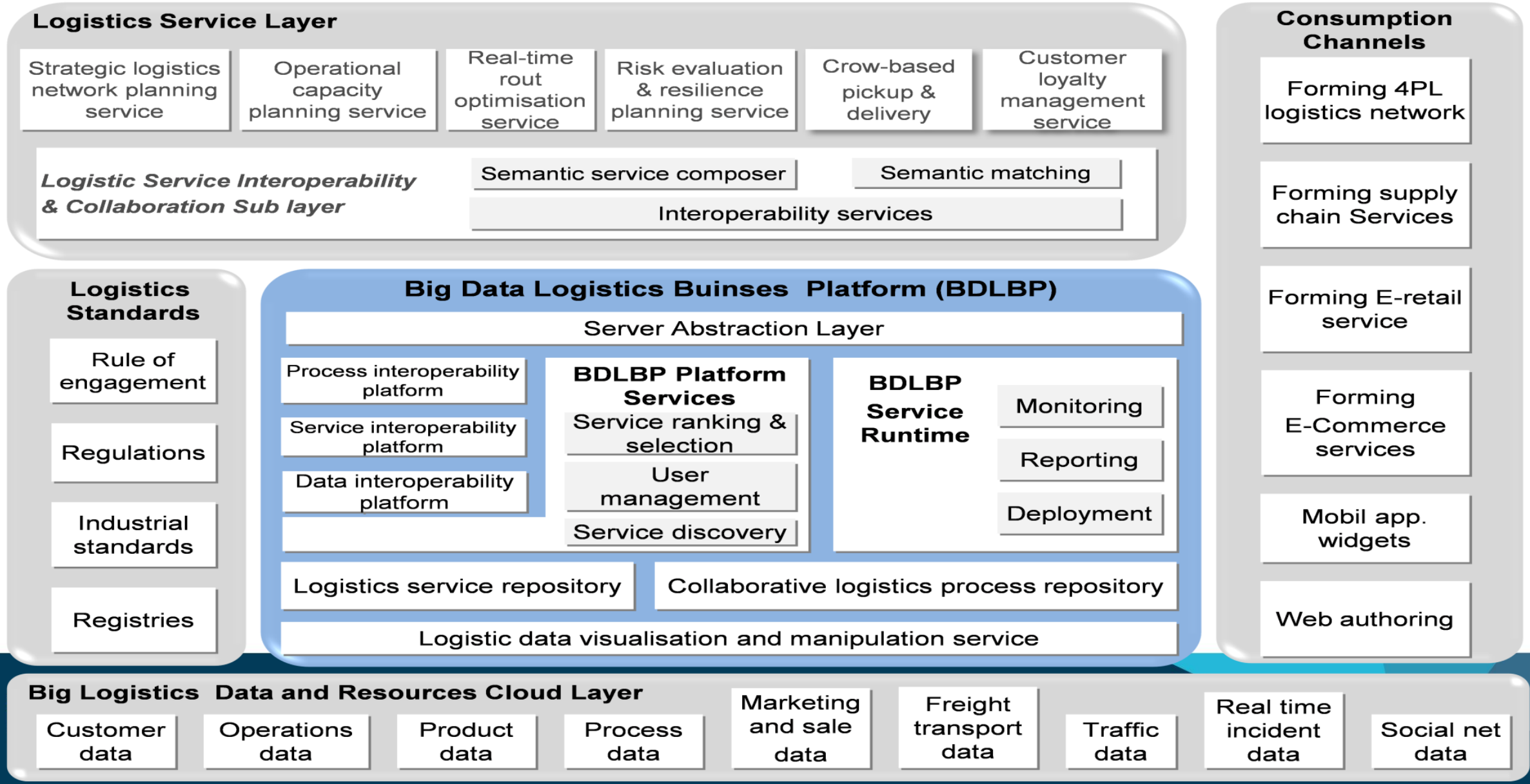
SOURCE:EIC Analysis

Expert Group Digital Platforms

Objective: To provide an overview of the variety of **digital platforms and solutions available globally**. The overview discusses the problems these platforms solve, the data sources they use, and the advantages and limitations of these platforms.
The planned outputs have been:

1. What are the stakeholder's needs from digital platforms**: A review of the available platforms based on websites, reports, surveys, and free available information.**
2. Map the current digital platforms against these needs and appraise the usefulness and limitation of each digital platform. Draw a strategy for future digital platform solutions by identifying the elements that are missing or need further refinement. Then, link this to the possibility of commercialization of the technology.
3. Further Opportunities to apply / obtain funding to support the digital transformation of Agri Food Sector

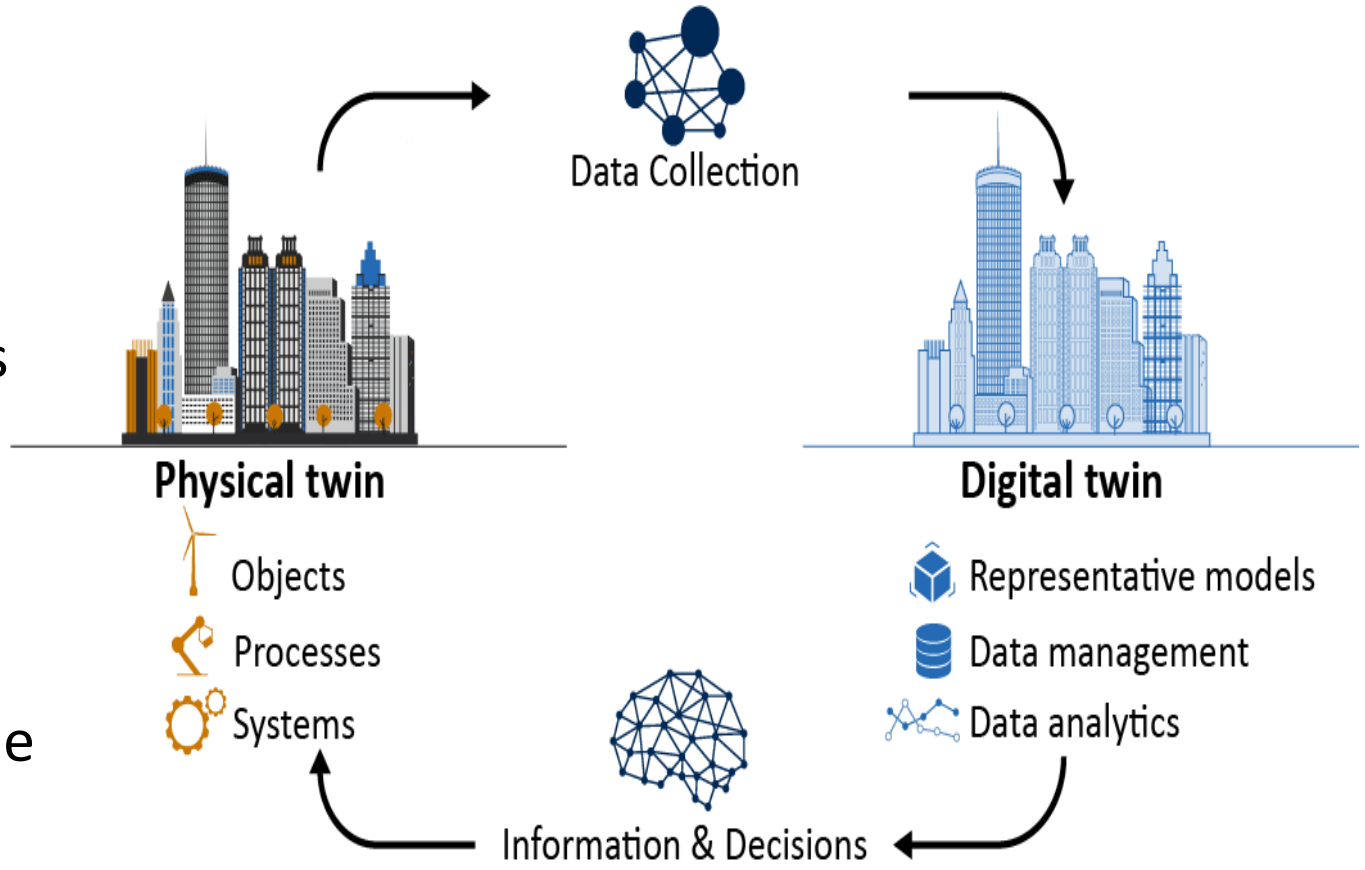
Big Data Driven Logistics Services



Digital twins

"A digital twin (DT) is a real time digital replica or model of a real physical device". The digital twins are characterised by

- Sharing data with multiple systems
- Real-time data analysis, and prediction or forecasting
- IoT, big data and cloud computing, Artificial Intelligence, machine learning, augmented reality provide intelligence to simulate and steer the behaviour of physical objects



PhD Project

Achieving Industry 4.0 goals based on the performance analysis of the application of digital twins in advanced manufacturing systems

By

PhD Student Mahesh Kannath

Supervisors

Dr. Irina Neaga

Dr. Carlene Campbell and Dr. Terry Walcott

Faculty of Applied Design and Engineering

School of Applied Computing

Supply chain digital twin

- Supply chain digital twin is a digital replica of a physical supply chain which shows the current state of entire supply chain in real time or near-real time.
- Digital twins are equipped with technologies to monitor supply chain and perform supply chain analytics in real-time (Ivanov, Dolgui, et al., 2018; Ivanov & Dolgui, 2020b).
- Digital twin of supply chains can be developed through combination of optimization and simulation tools, data analytics platform, and technologies required to capture the real-time supply chain data (Hosseini et al., 2019).
- Industry 4.0 technologies support processing of realtime data (high volume) in a short time and alert organization about potential disruptions.

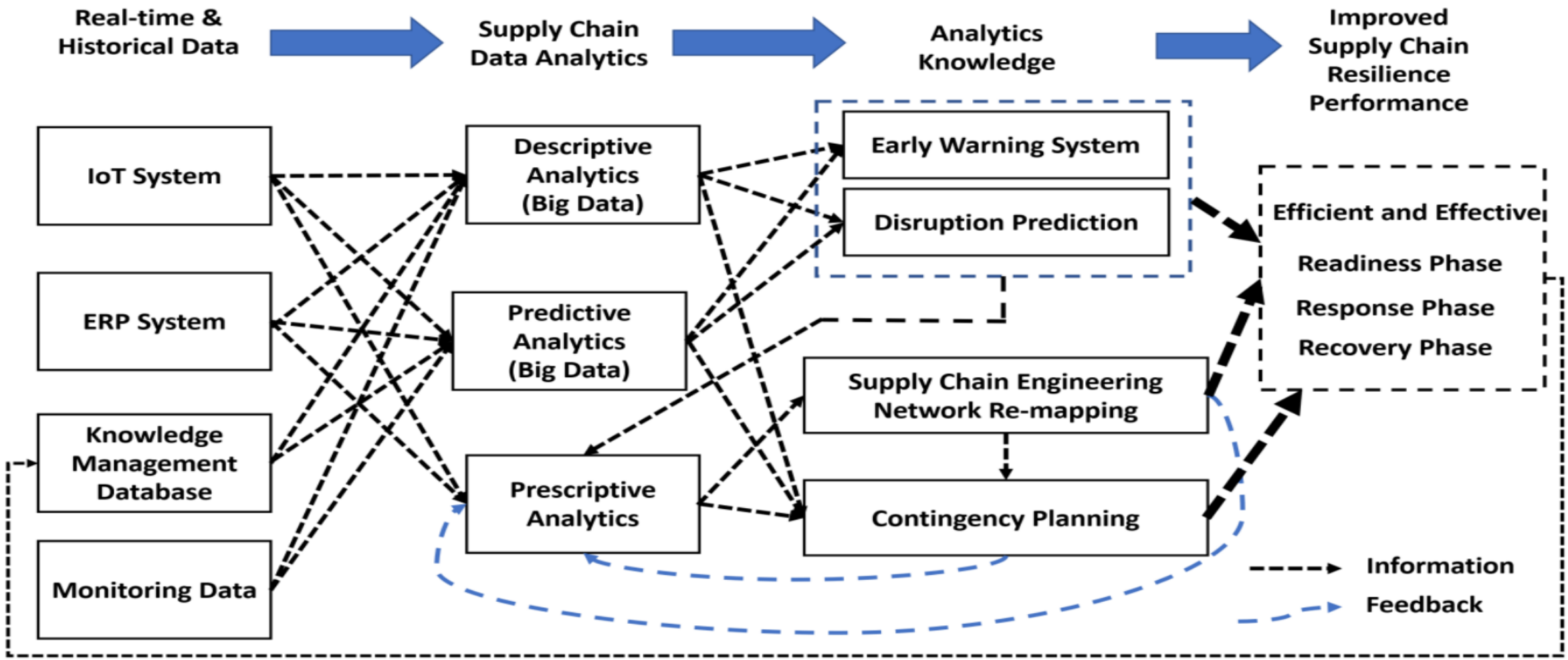
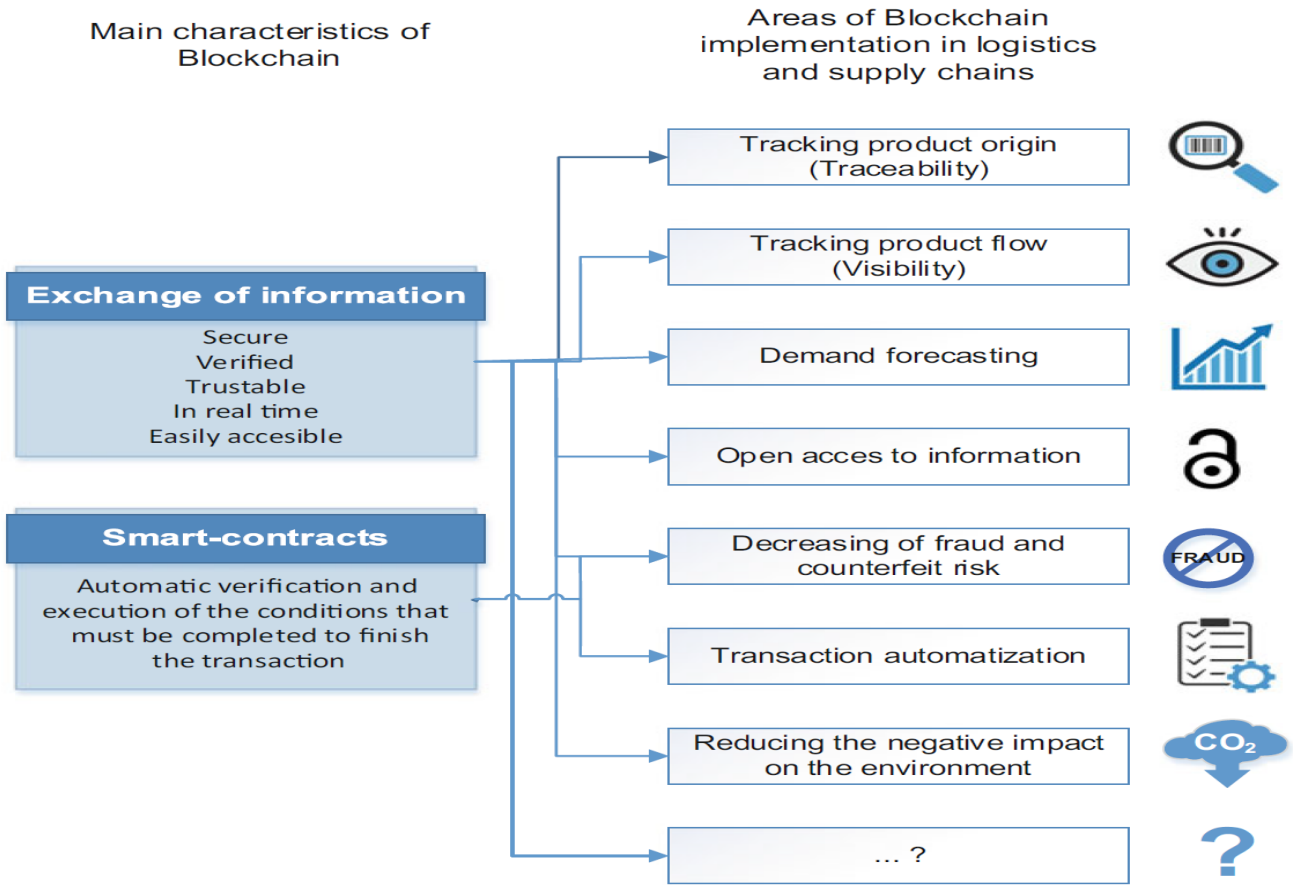


Figure 2.16 Data flow in Supply Chain Digital Twin

Adapted and modified from Ivanov and Dolgui (2020b)

Blockchain in Supply Chains



Blockchain technology can

- effectively manage workflows across the entire supply chain and through its distributed ledger approach, guarantee that data is accurate, transparent and immutable.
- support the digital transformation of supply chains
- Additional details at [Making sense of bitcoin and blockchain technology: PwC]

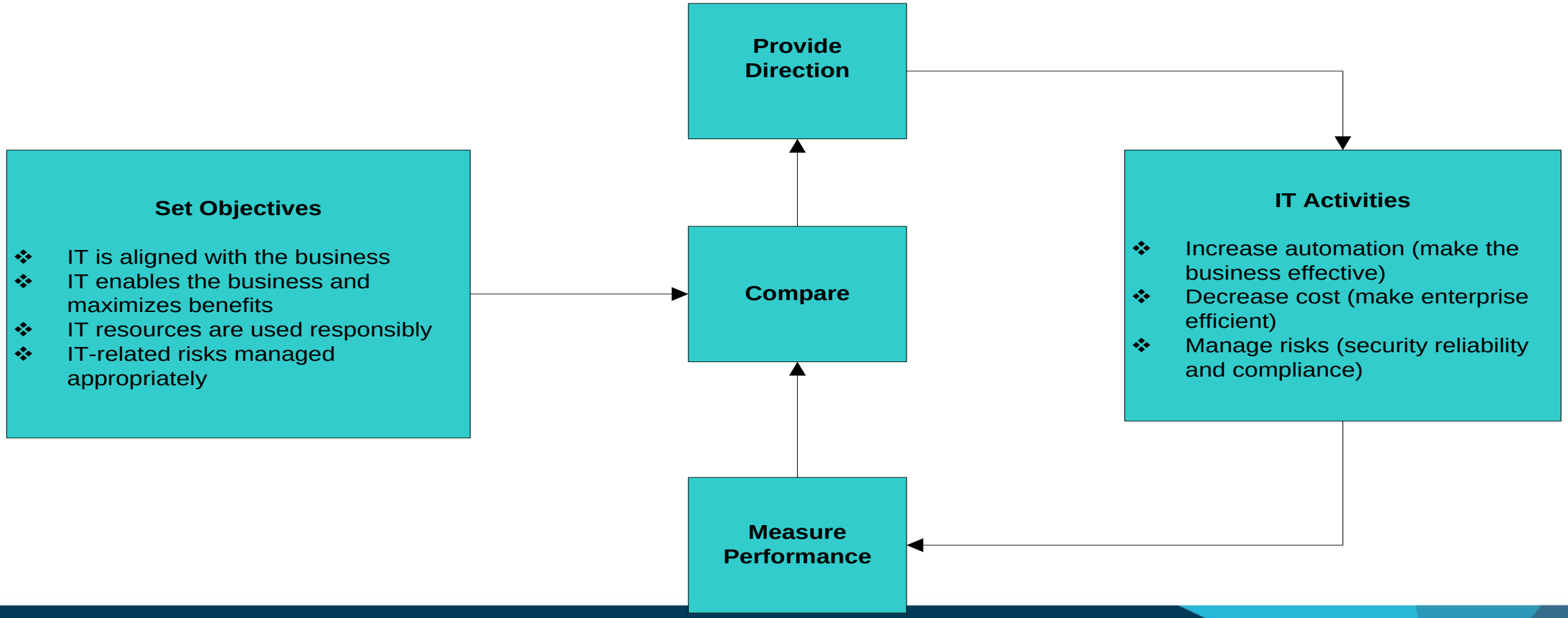
IT/Industry 4.0 Governance

- Competitive advantage
- Support of an organisation aims and objectives
- Growth and innovation
- Increase in intangible assets
- Reduction of risk

Compliance with regulations

Regulatory and Governance Framework

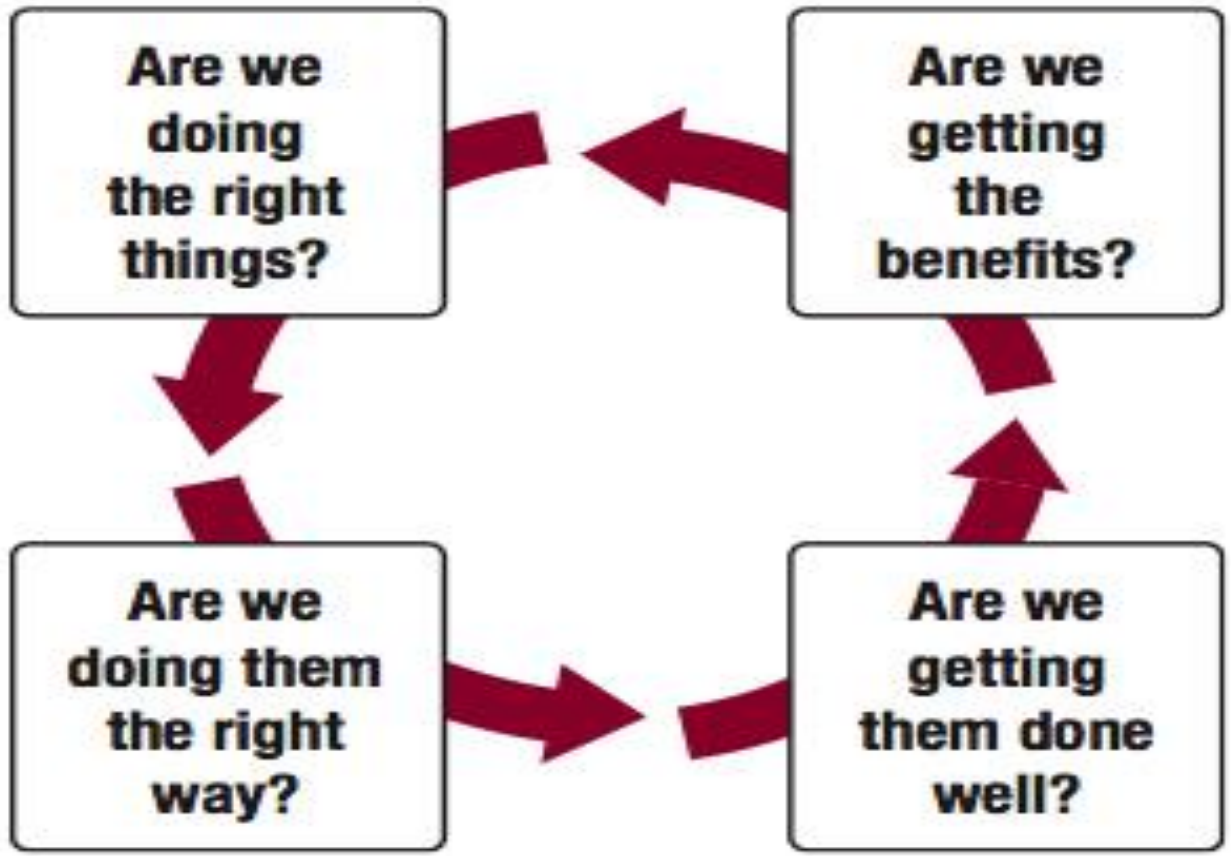
IT / Industry 4.0 Governance Framework



Aligning IT and Business Strategy

- Corporate Mission – Business Goals – IT Strategy
- Requires involvement from many levels and activities within the enterprise/organisation.
- Lack of alignment leads to adverse business issues.
- Strong IT Governance contributes toward proper alignment.

Figure 2—The IT Service Delivery Continuum[2]



Ensuring Value and Effectiveness

- IT issues are the least understood, despite increasing reliance placed on IT.
- Initiate IT governance structures with the right level of executive involvement.
- Board of Director requires essential IT related/digital skills

Measuring IT Governance Performance

- Measuring IT performance and benefits is a key concern as it demonstrates the effectiveness and added business value of IT.
- Commonly seen as the IT “Black Hole” – costs continually rise without clear evidence of value derived from the IT function.
- Traditional performance measurement methods require monetary values which are hard to apply to IT systems.

Industry 4.0 Governance

- Consists of leadership, organizational structures and processes that safeguard complex information structure and systems.
- Addressing Security and other issues related trusted information assets.
- Industry 4.0 Governance is a top-down process.

"The dark corners of industry 4.0 – Grounding economic governance 2.0"

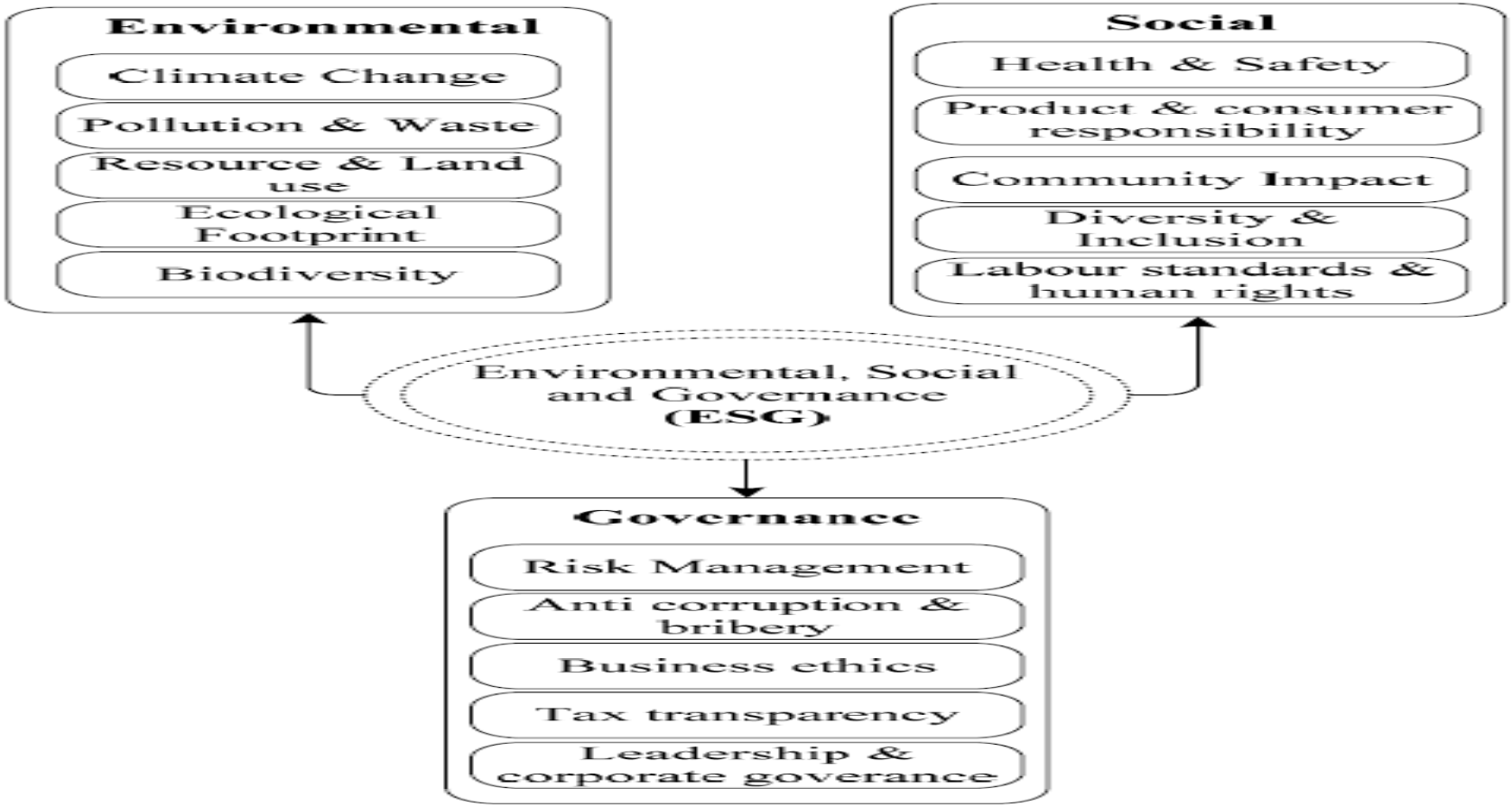
- Security related uncertainty;
- Data distortion and false data;
- Unintended consequences of neglecting contextual interactions;
- Increased level of systems complexity
- Human machine interaction

- Economic governance 2..0 is supporting a new economic systems thinking which is to marry economics / business with the approach of complexity science to draw a more realistic picture about the technologies phenomena (Industry 4.0) in favour of policies supporting structural change. Still, further research is needed not only to spark such complexity economics, but also to identify potential tradeoffs and synergies with respect to the policies–Industry 4.0 nexus.

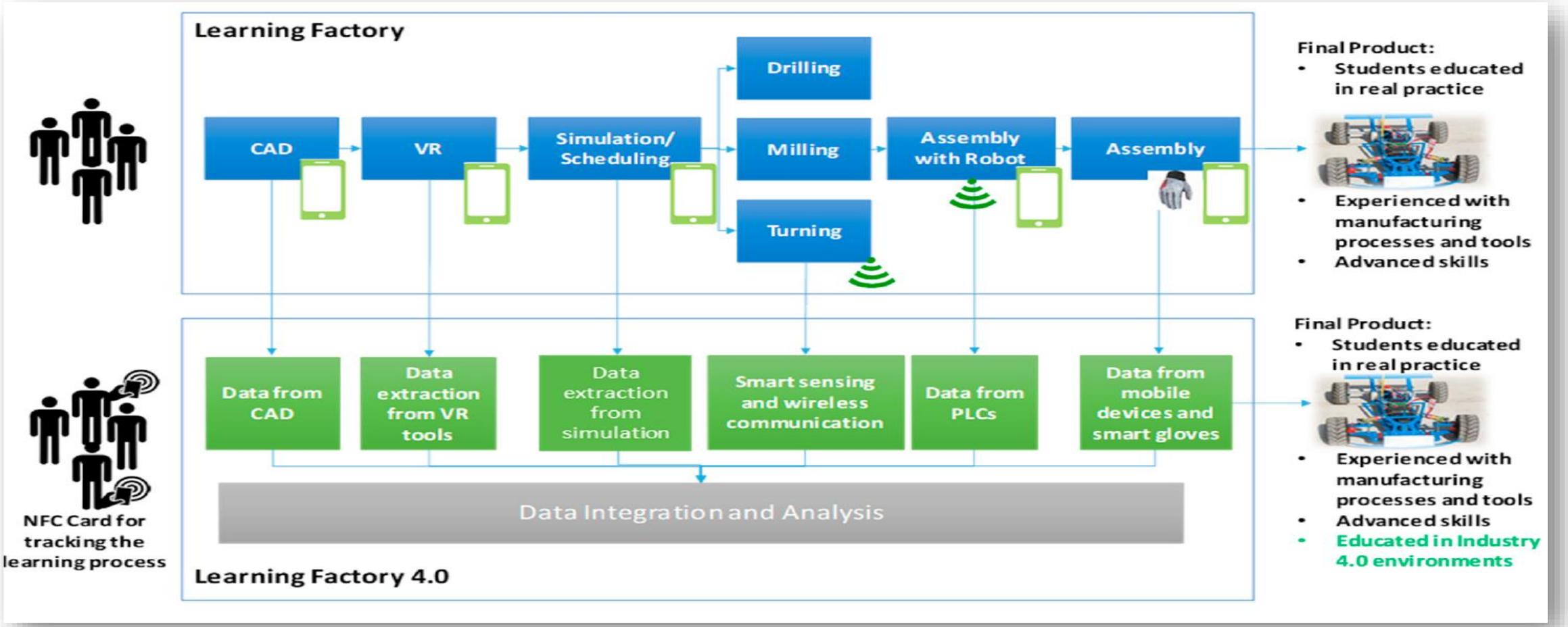
Towards Industry 5.0 / Society 5.0

- **Collaborative work between Humans and Robots:** by the contrast of Industry 4.0, humans and robots will collaboratively work together. For the successful of this interaction, the security aspects will be the key in order to keep the integrity of humans working together with robots. The aim of this collaborative work is to bring Artificial Intelligence aligned with Internet of Things and Big Data Analytics technologies
- **Mass Customization and Personalization to Customers:** The perfect harmony between Humans and Machines predicts to allow a more flexibility in terms of personalization of products demanded by customers.
- **Society 5.0** predicts the intensive use of technologies with human interaction going beyond the threshold of industrial and business perspective. The intensive use of disruptive technologies aligned with the creative and smarter job will provide higher capacity in delivering personalized products and services

Environmental, Social and Governance Framework



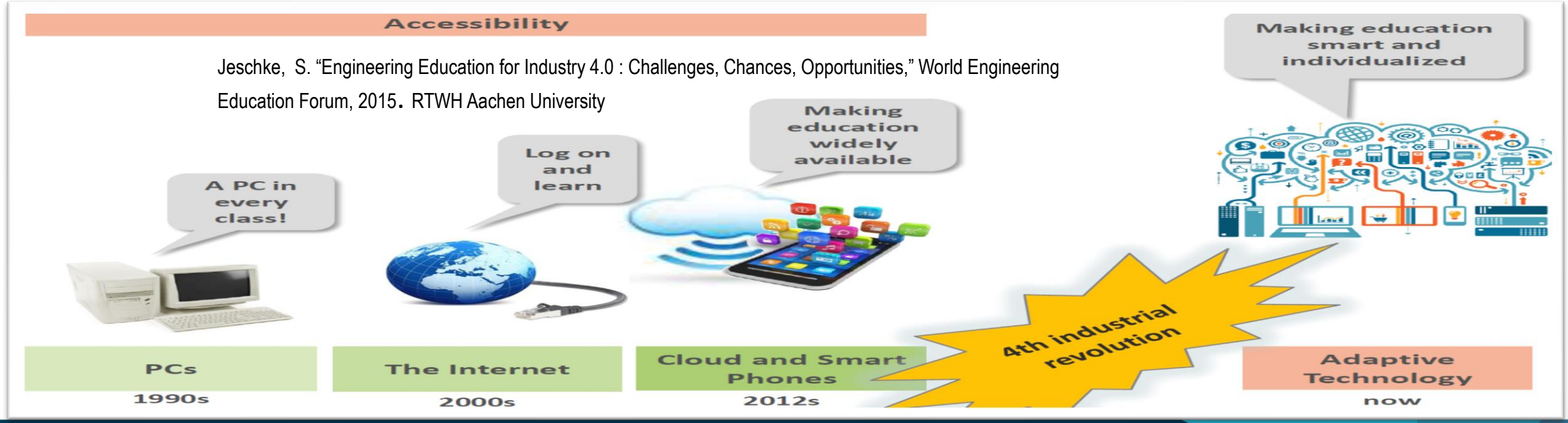
Education 4.0/5.0



Source:Mourtzis, D., Vlachou, E., Dimitrakopoulos, G., and Zogopoulos, V. Cyber- Physical Systems and Education 4.0 – The Teaching Factory 4.0 Concept, Procedia Manufacturing, Volume 23, pp. 129-134, 2018, Elsevier Publishers Ltd

Implications for Engineering Education

- Interdisciplinary engineering educational programmes holistically teaching science, engineering and business courses / modules
- Rapid / real-time innovation of the programmes, and modules in partnerships with industry requirements
- Developing adaptive learning environment and associated strategies.



Graduates' Knowledge, Skills and Competences

- Entrepreneurial, managerial, leadership knowledge and abilities
- Technology skills including advanced data analysis / big data and analytics
- Transition from developing skills and acquiring knowledge to **competences based education**
  - Creative and critical thinking
  - Socio-technical skills
  - Virtual collaboration
  - Resilience
  - Communication skills
  - Global citizenship features

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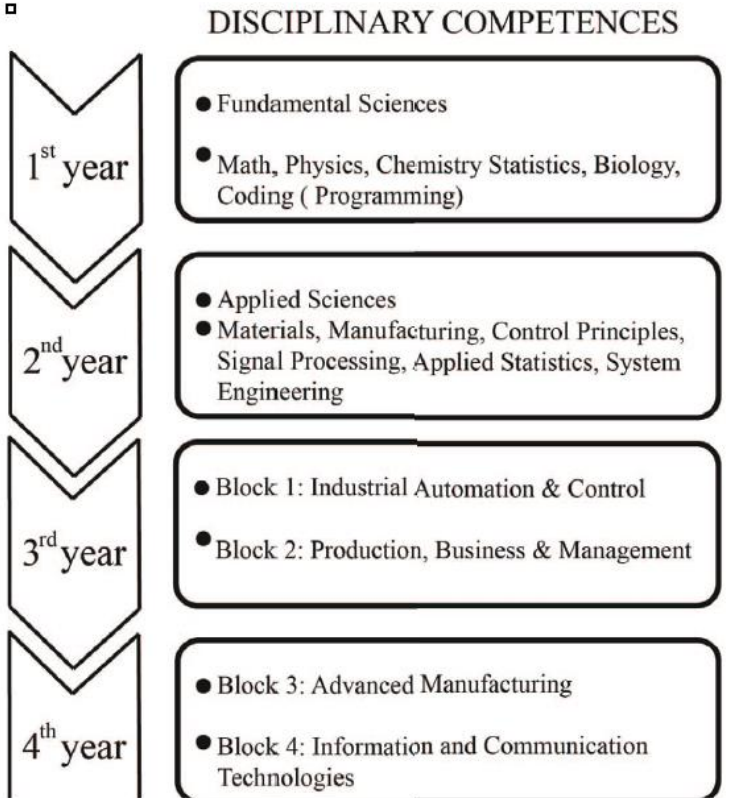
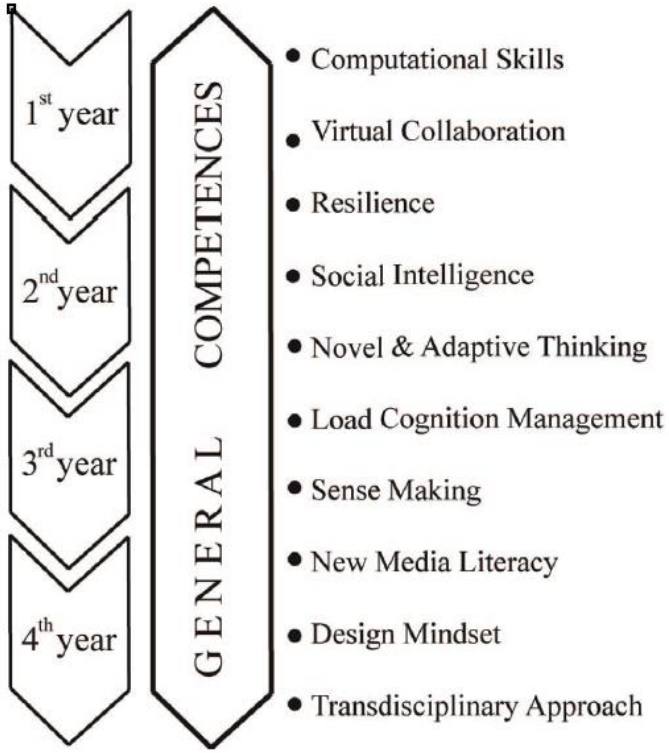
Competences based Education Framework





Source:Ramirez-Mendoza et al. (2018) - Engineering Education 4.0. IEEE Global Engineering Education Conference 2018, IEEE, pp. 1273-1282

STEM Education Development and Implementation

- Comparatively analysis the STEM education programme, teaching practices and curriculum development in HE institutions in UK - Ireland, and Canada.
- Developing a framework for Engineering Education 4.0/5.0 in the School of Engineering from University of Wales Trinity St David (UWTSD), Swansea, UK
- Engagement with relevant industry and research institutes in UK and abroad defining skills requirements of the graduates to better support the employment
- Identification of the required competencies of future engineers and managers professionals as well as the identification of the existing gaps in the educational programmes and in the related curriculum
- Definition of the requirements for a new curriculum for Industry 4.0 and Education 4.0 to leading to **apprenticeships programmes** from UWTSD such as Logistics and Supply Chain Management course.

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Thank you

Q&A

E-mail: Irina.Neaga@uwtsd.ac.uk