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Industry 4.0: Overview, Drivers and Implications

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"Strategic Value Networks for Industry 4.0", IoT Week, Aarhus, Denmark, June 19th, 2019

Drivers of Future Manufacturing

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From Capacity to Capability

- Manufacturing Flexibility
- Respond to variable market demand and achieve high levels of customer fulfillment
- Moving Production Tasks closer to the Innovation (Re-Shoring)

New production models

- Moving away from mass production
- From make-to-stock (MTS) to make-to-order (MTO), configure-to-order (CTO) and engineer-to-order (ETO) production
- Becoming more demand driven
- Mass Customization
- Lot Size 1 Manufacturing

Profitable proximity sourcing and production

- Modular products based on common platforms and configurable options
- Adopt hybrid production and sourcing strategies
- Produce modular platforms centrally, while leveraging suppliers, distributors, or retailers to tailor final products locally to better serve local customer demands

Workforce engagement

- People will remain at the center of the factory of the future
- People will provide the degree of flexibility and decision-making capabilities required to deal with increasing operational complexity
- Higher levels of collaboration

Fourth Industrial Revolution (Industrie 4.0) – Role of IoT & Cyber-Physical Systems (CPS)

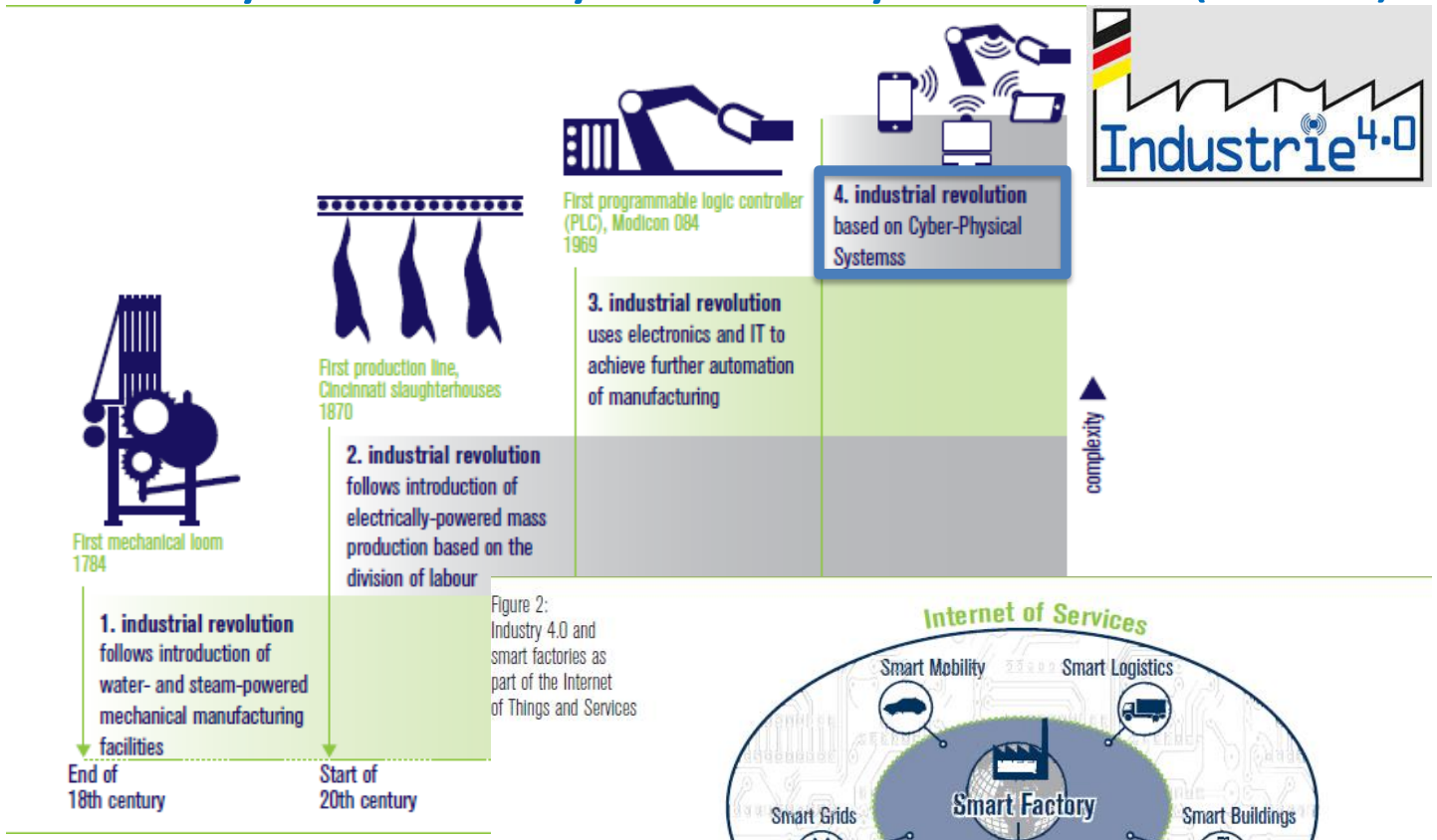
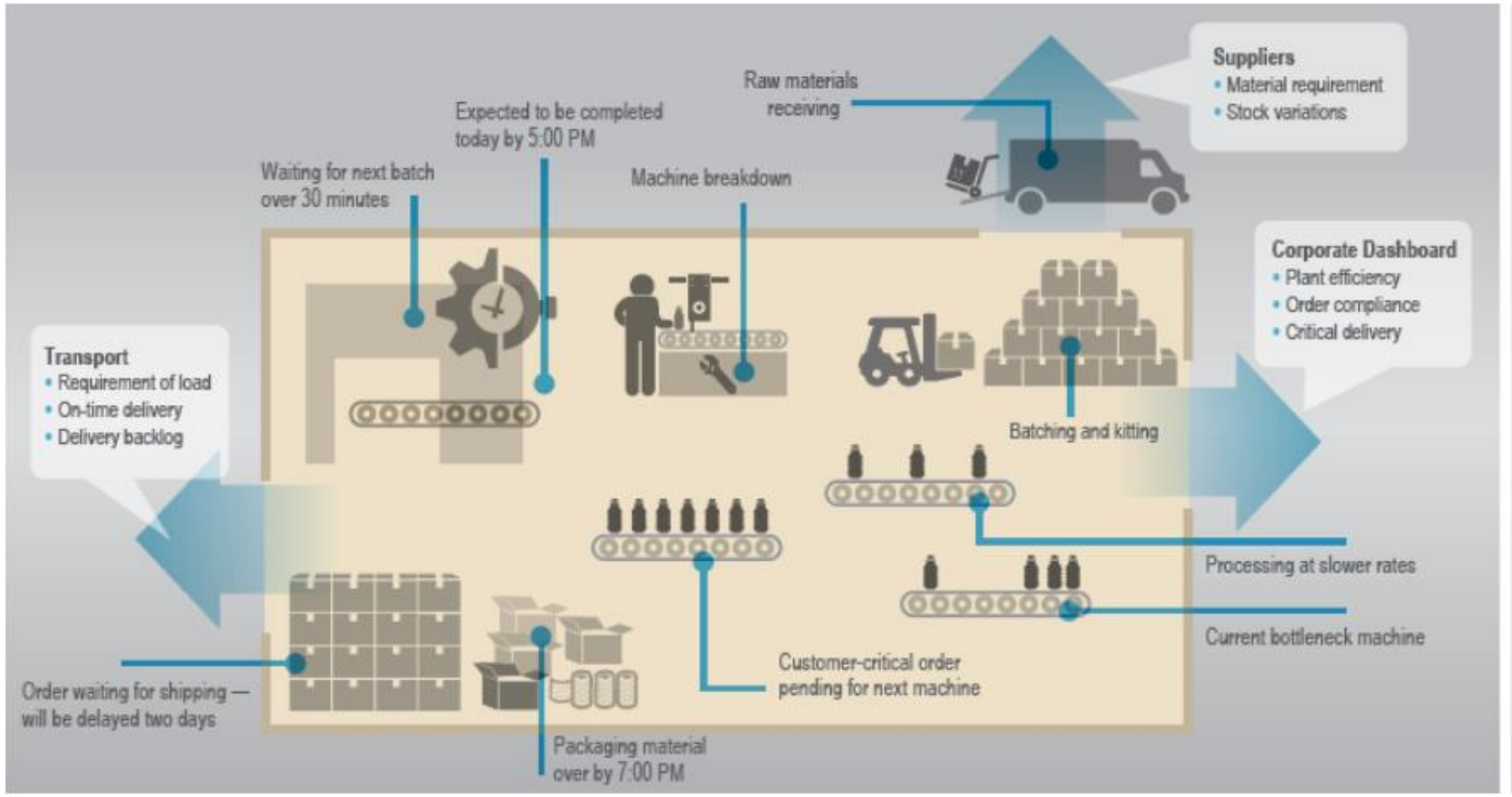
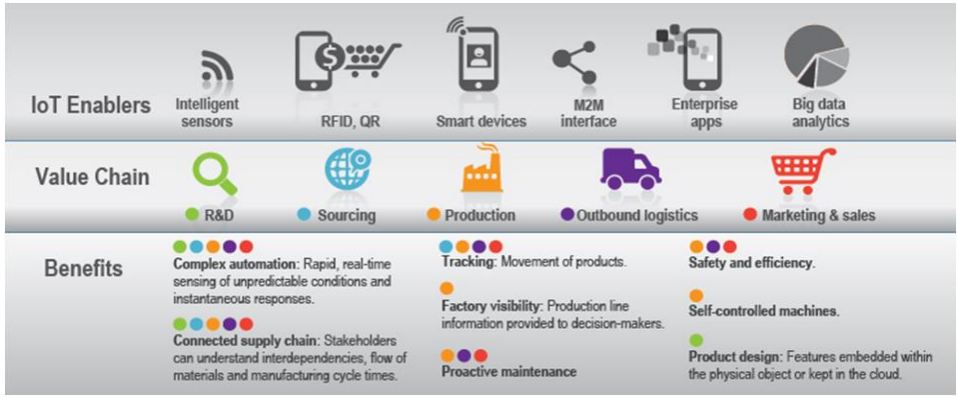


Figure 2: Industry 4.0 and smart factories as part of the Internet of Things and Services

Source: *Recommendations for implementing the strategic initiative INDUSTRIE 4.0 by The Industry-Science Research Alliance & Sponsored by the German Federal Ministry of Education and Research*

The Vision: Connected & Informed Plants

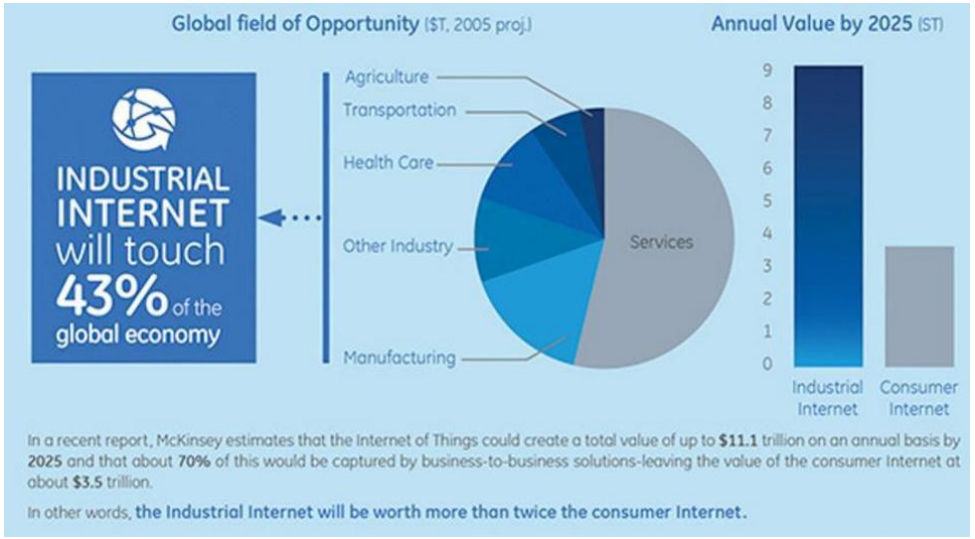


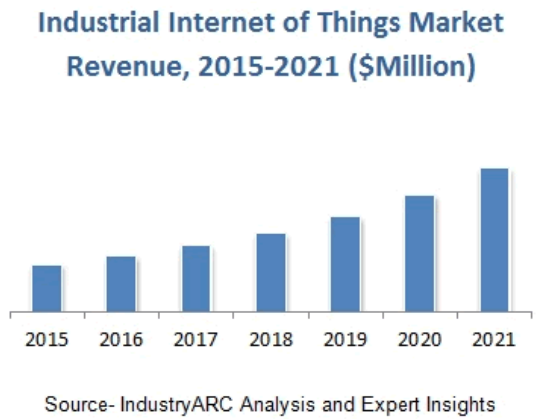


Source: Cognizant.com

Industry 4.0 & Industrial Internet-of-Things (IIoT)

- IIoT Market Momentum
  - The lion's share of IoT's business value & market potential
- Application Sectors
  - **Manufacturing**
  - Energy
  - Oil & Gas
  - Mining
  - Supply Chain Management
- Main Use Cases
  - Flexible Automation
  - Predictive Maintenance
  - Quality Management
  - Zero Defect Production
  - Simulation & Digital Twins
  - Worker Safety





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Main IIoT Use Cases in Manufacturing

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Flexibility in Automation

- Flexibly Configurable Production Lines
- Configuration at IT rather than OT (Operational Technology) timescales

Predictive Maintenance

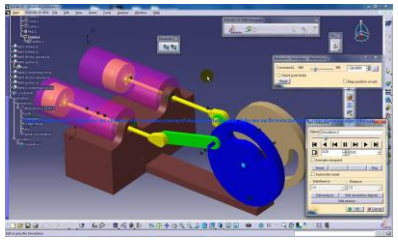
- Schedule Maintenance at the best point in time – Optimal Overall Equipment Efficiency (OEE)
- Reduce Unplanned Downtime – Optimize OEE & Worker Safety

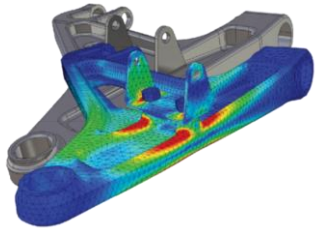
ZERO DEFECTS

Zero Defect Manufacturing

- Collect data from the line and proactively mitigate any sources of defects
- Holistic approach to Zero Defects combining knowledge about the process, maintenance, supply chain management

Main IIoT Use Cases in Manufacturing





Digital Simulation & Digital Twins

- Simulate industrial process in terms of what-if scenarios using their digital (twin) model
- Optimize operations & decisions – Test without disrupting the production

Supply Chain Optimization

- Created Interconnected and Informed Plants
- Rapidly exchange timely & accurate information across all stakeholders

Worker Safety

- Interact with cyber-representations instead of with harsh environments
- Track workers' status with wearables and boost their collaboration

Industry 4.0: Digital Enablers

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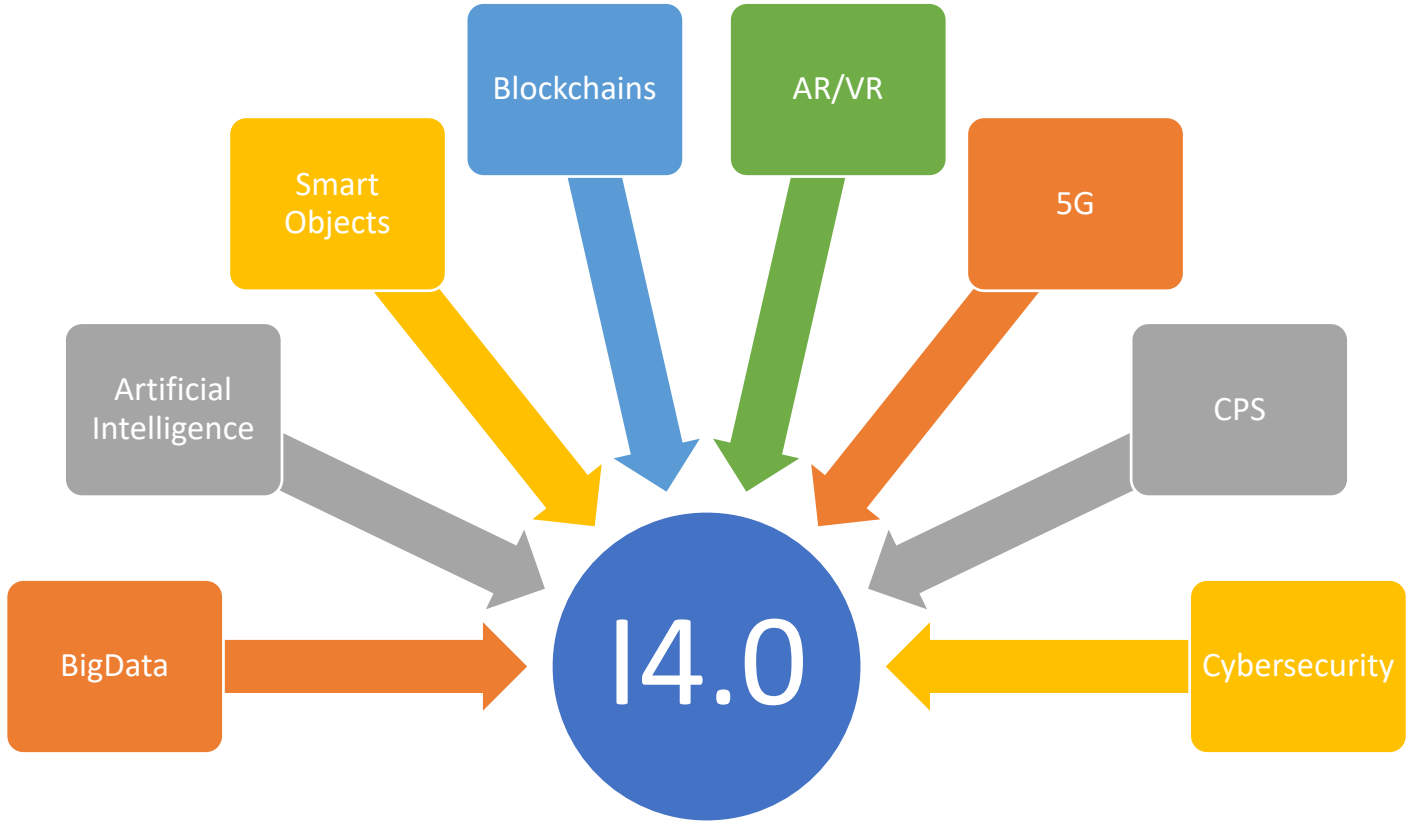

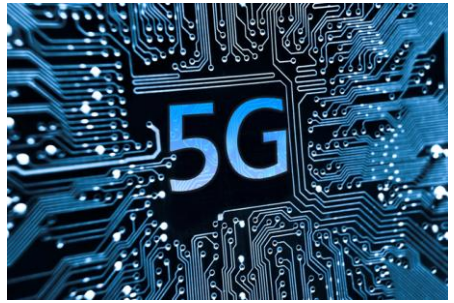

Prerequisites & Preparatory Steps

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Cyber-Physical Systems

- Enabling Machinery for I4.0
- Especially for legacy Machines

Digital Skills

- Strong digital team required
- Workers, but also technical and R&D partners

Testing Facilities

- Lab or Pilot Line
- Simulation & Testing Infrastructure

Strategy & Roadmap

- Specification of Business goals
- Use Cases to be implemented

Implementation Steps

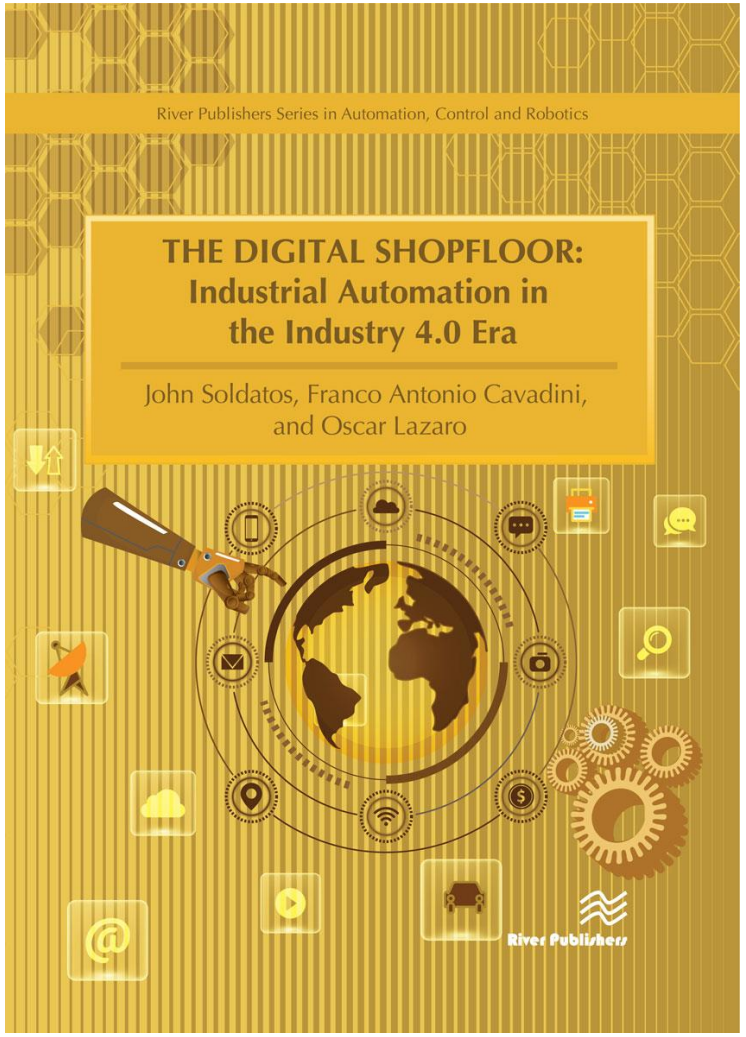
Process Reengineering	• As-is → To-Be
Solution Architecture	• RAMI4.0, Industrial Internet Consortium RA, OpenFog RA
Digital Modeling	• AutomationML, COLLADA, B2MML..
Field Connectivity	• OPC-UA, MQTT, DDS..
Data Analytics	• Data Mining & Machine Learning, Deep Neural Networks & Deep Learning
Cybersecurity	• Industrial Internet Security Framework, IT & OT Security Convergence
Pilot Testing & Deployment	• Pilot Lines, Testbeds, Simulation…

Industry 4.0 Activities in Europe

	Launch date	Target audience	Budget	Funding approach
	2015	Industry & production base, SMEs & mid-caps	Approx. €10 billion	Mixed
	2011	Manufacturers / producers, SMEs & policy-makers	€200 million	Mixed
	2012	Large companies, SMEs, universities, research centres	€45 million	Public
	2014	General business community	€25 million	Mixed
	2016	Industry, above all SMEs & micro-enterprises	€97.5 million	Public
	2013	Research, academia & industrial & service SMEs	€50 million	Mixed
	2012	Business, industry & research organisations	€164 million	Mixed
	2016	Industry & service sector companies, trade unions	Not yet defined	Public

Source: *European Commission, Key lessons from national industry 4.0 policy initiatives in Europe*

Open Access Book on Industry 4.0



The Digital Shopfloor: Industrial Automation in the Industry 4.0 Era

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