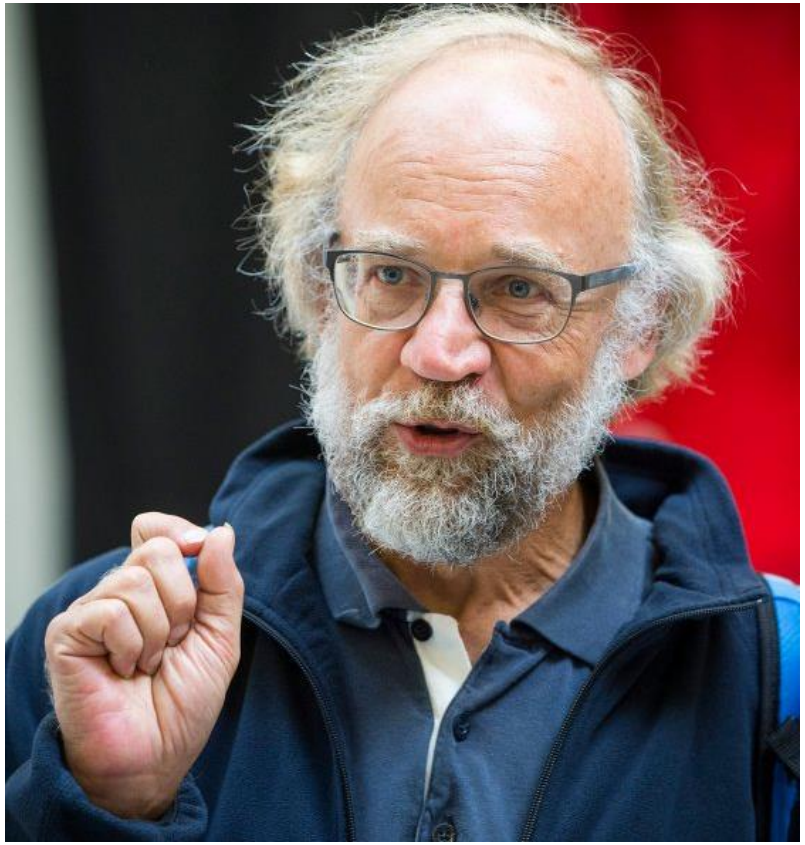
Aalto University

Industrial Use Cases of 5G

Martti Mäntylä
Aalto University

Martti Mäntylä

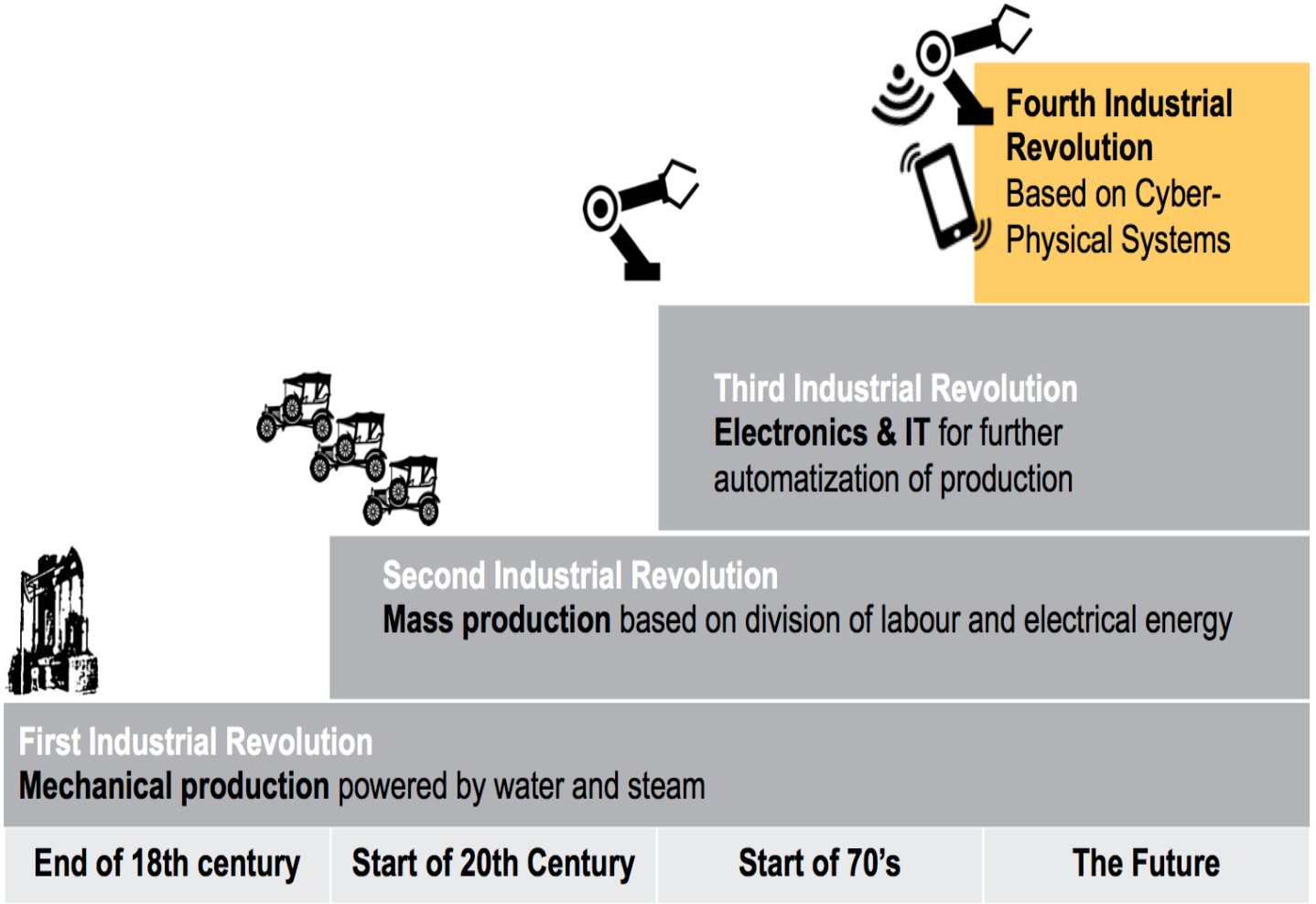
- Professor of Information Technology (Enterprise Systems), TKK & Aalto University 1987-
- Chief Strategy Officer, EIT ICT Labs 2009-2013
- Director, Helsinki Institute for Information Technology 1999-2008
- Since 2014, catalysing Aalto's activities in digitalisation of industry



The Next Industrial Revolution

Aalto University

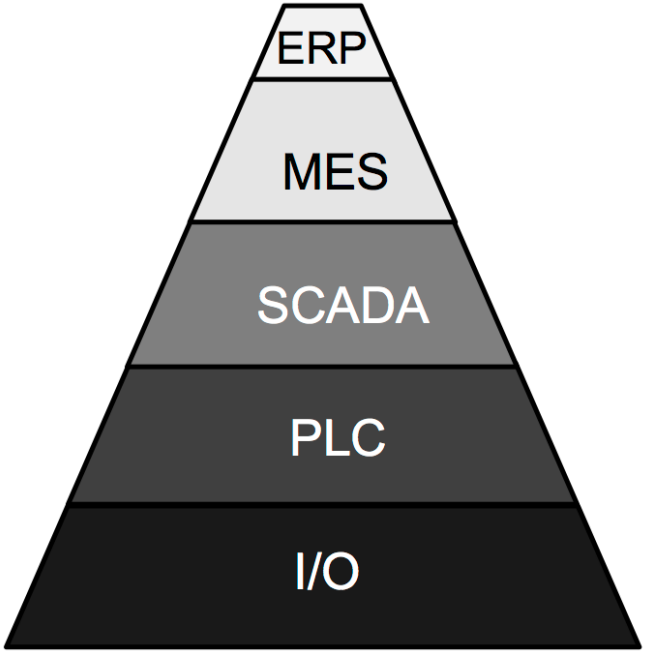
Industrie 4.0



From 5-layer architecture to autonomous cyber-physical systems

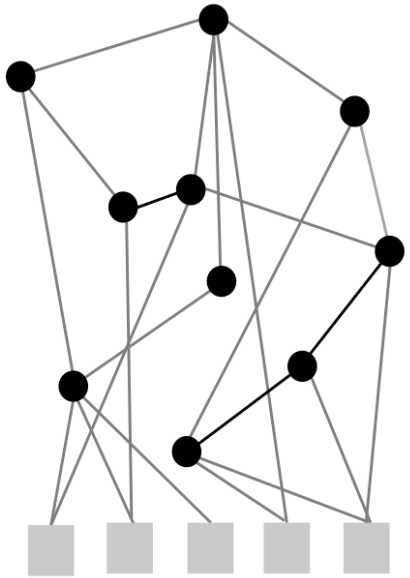
Today

5-layer architecture

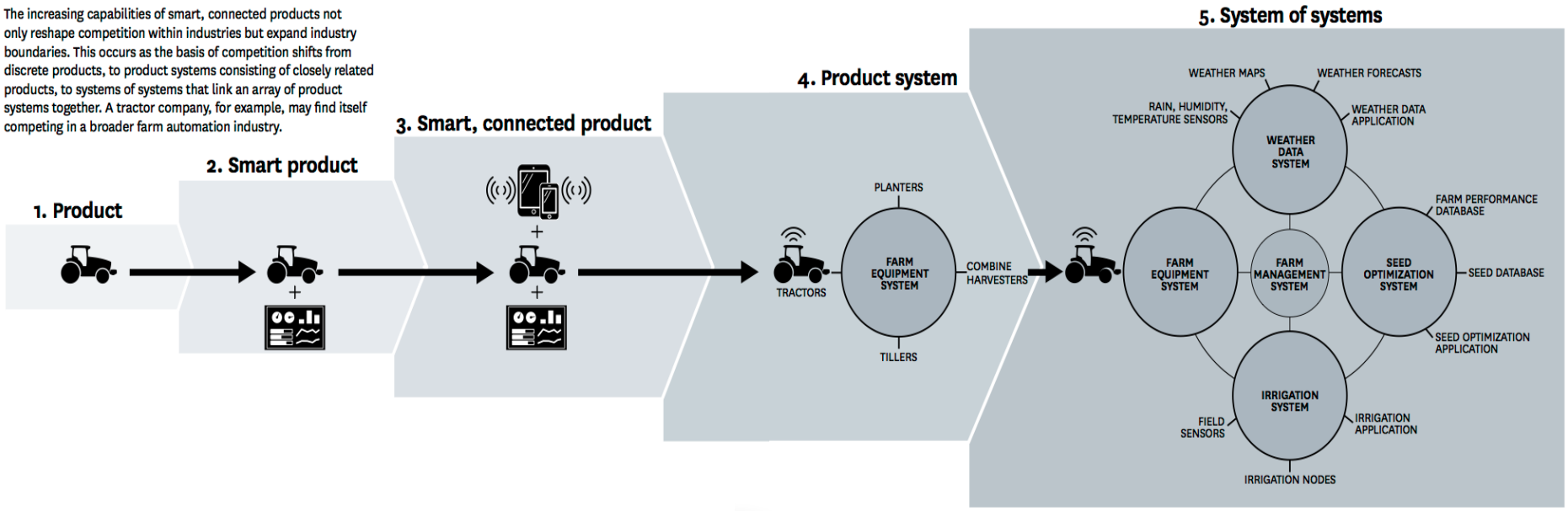


Future

CPS-based automation



Smart and connected products



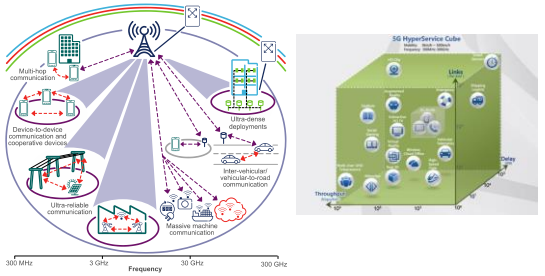
(Porter and Heppelman 2015)

The Potential Role of 5G

5G as an Industrial Internet platform?

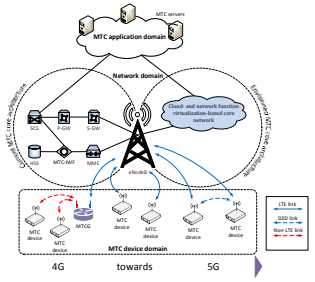
- Today, 4G/LTE architecture manages 3 billion mobile devices in a multiple actor environment, including sharing of business data across operators
- Can 5G provide a management and operational architecture for 20+ billion smart devices, providing the right mix of characteristics needed by next generation industrial use cases?

5G: Support for heterogeneous services



Aalto University

5G: Machine type communications



- Service and organization dependent virtualized EPC
- Edge computing
- Capillary networks
- Network controlled direct device-to-device

Aalto University

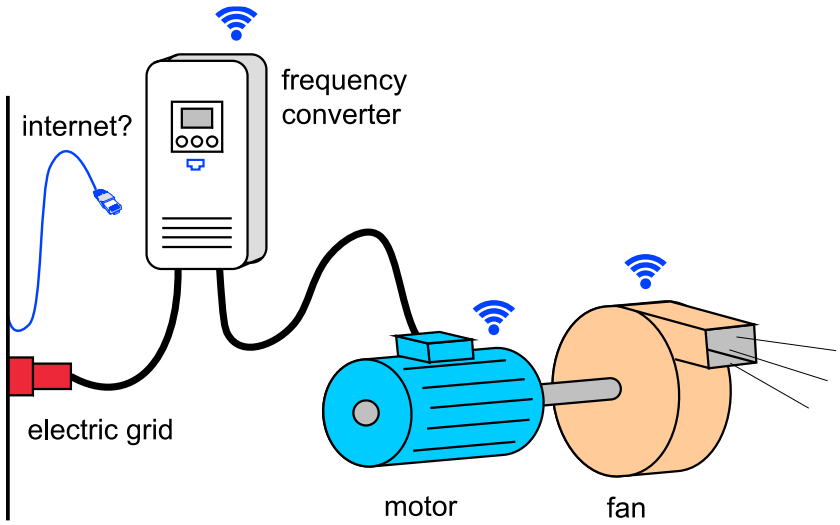
Aalto University

From operational benefits to new business value

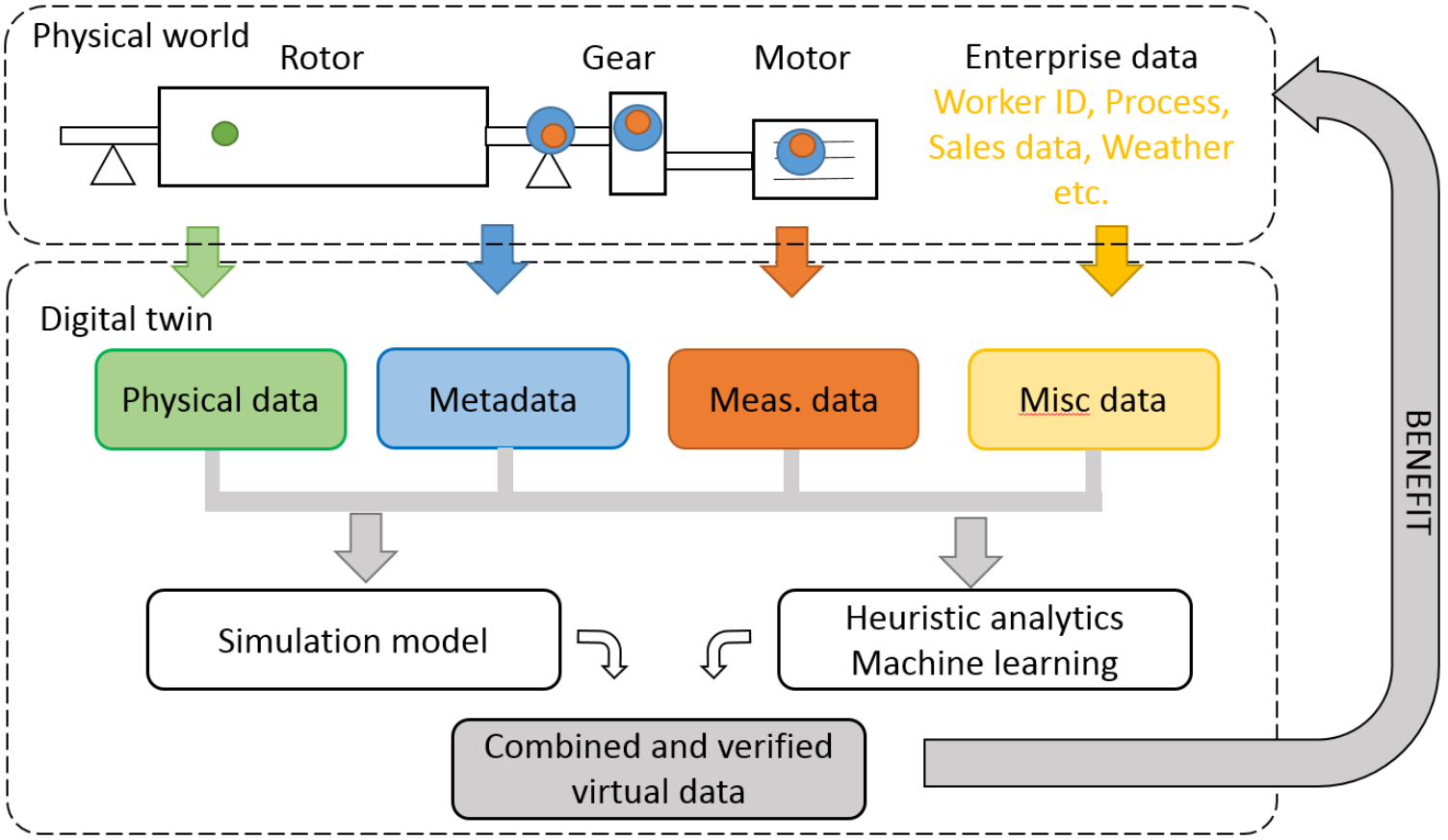
Cluster	Key Benefit	Key Asset	Typical Applications
Industrial Internet for operational benefits	Operational efficiency of in-house operations	Fleets of installed products equipped with sensors and connected to company network (“Industrial Intranet”)	Service and maintenance operations
Industrial Internet for new customer value	New digital services and service systems	Fleets of installed products and product systems, data from related systems, data from open Internet	Predictive maintenance, remote operations, optimisation of processes, systems optimisation, logistics
Industrial Internet for digital business	New business	Minimal physical assets, focus on data gathered via a digital platform	Innovative applications based on data and new business models

Case ABB

- Maintenance and diagnosis
  - failure prediction (converter, motor, load, ...)
- Start-up of a drive system
  - numerous motor and load parameters needed for control
  - some parameters are difficult to identify automatically using conventional methods only
- Resource-efficient control
  - self-optimization
  - fusion of information from various sources



Digital twin



Case Konecranes

Equipment in business processes	Data capture	Data integration and management	Data usage

Cranes/ trucks embedded with sensors

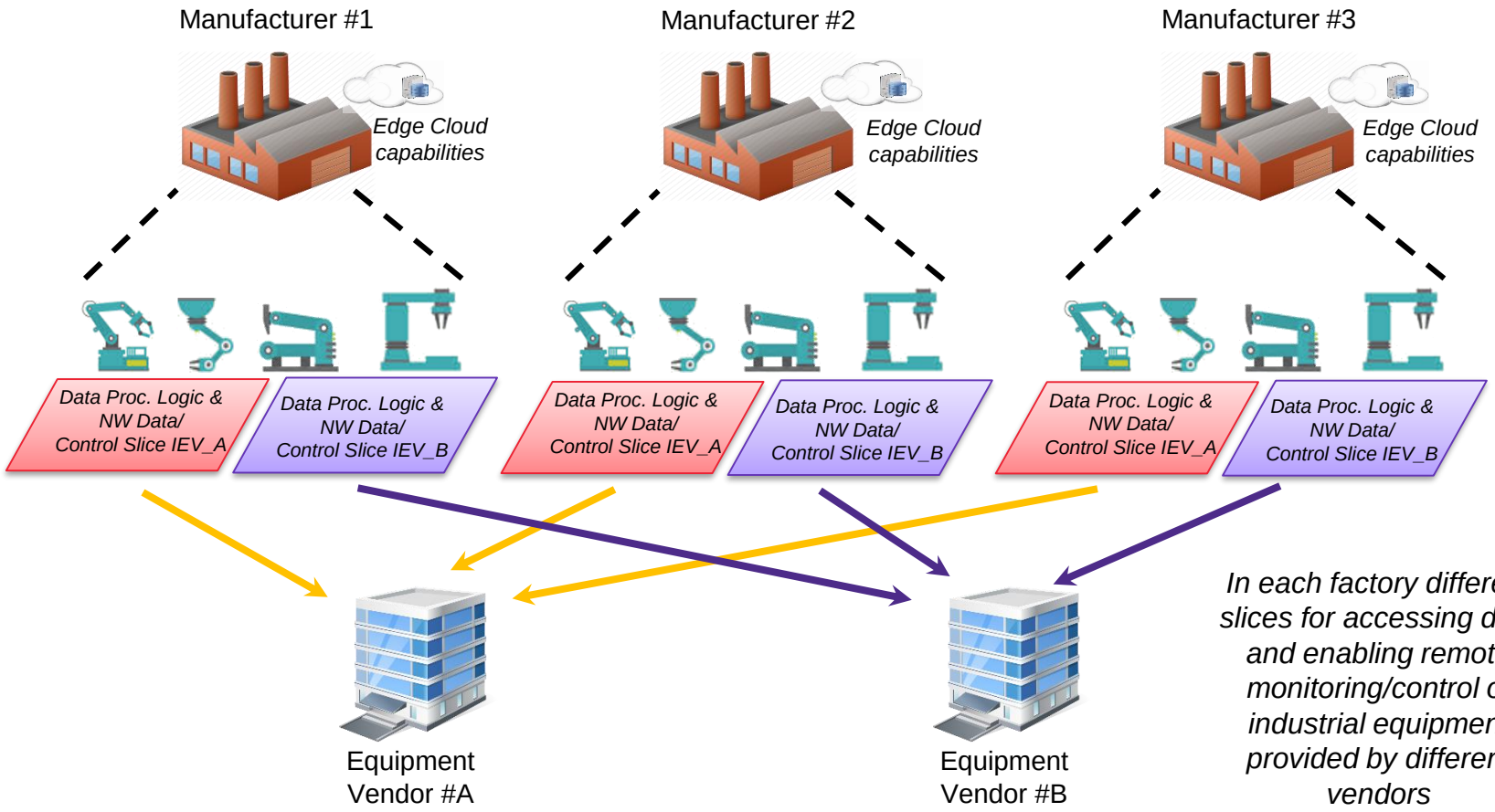
Diagnostic units/ sensors

Konecranes remote data center

Crane portal

World-class equipment in operation	Sensors capture various data	Analytics, predictive algorithms, automation and deep domain expertise	Improved safety, productivity, efficiencies, and maintenance

Remote monitoring / fleet management



In each factory different slices for accessing data and enabling remote monitoring/control of industrial equipment provided by different vendors

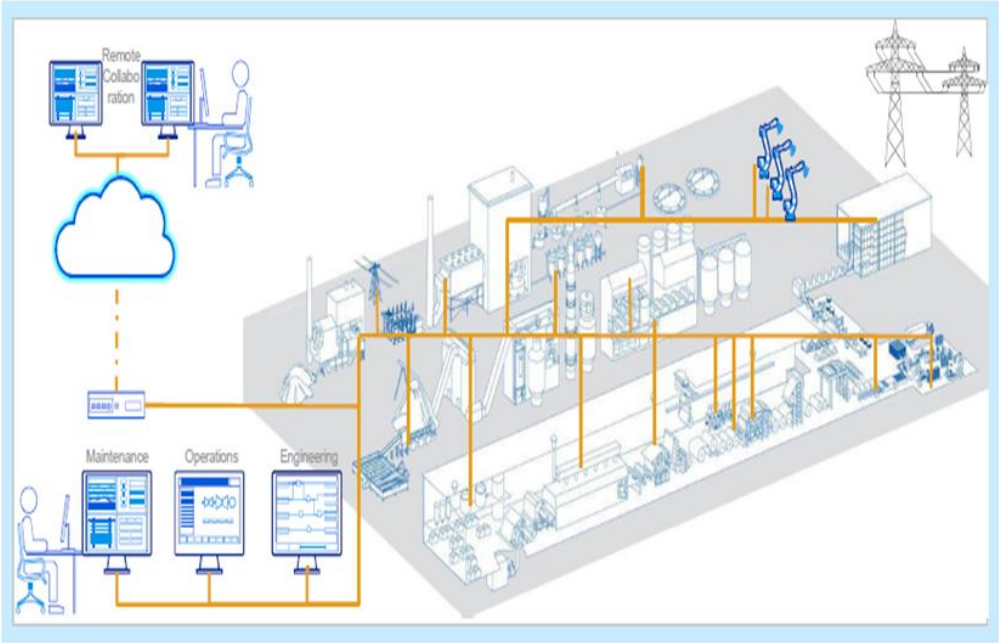
Picture credit: Ivan Ferris & Tarik Taleb

Fleet management

- Remote management of equipment by its provider
  - Diagnostics / predictive maintenance: Collect diagnostic data for fault prediction and assessment, guide maintenance operations
  - Life-cycle engineering: Collect diagnostic data to study how the operations can be improved, design and deploy updates
- Stakeholders:
  - Equipment providers: access to relevant data from installed base
  - Customers: need to grant access to relevant data
- 5G issues
  - How to provide access to all installed equipment on the field while respecting the confidentiality requirements of the customers?

Case Forest Industry

- Shared benefits across production life-cycle in
  - Engineering
  - Operations
  - Maintenance
- Key characteristics of the solution
  1. Real-time data
  2. Mobile & remote operations
  3. Predictive actions
  4. Increased automation
- The scope covers all major functional units of the selected production line



Open the sensor data of machines from a selected production line to boost operational innovations for all stake holders.

Factory control

- Enable control of factory equipment for industrial process optimization
  - Local: E.g., private 5G network inside factory site
  - Remote: E.g., network slice for data transmission between different production sites and other parties
- 5G issues
  - Spectrum management
  - Latency (especially to enable remote control-by-cloud scenarios)
    - On-demand provisioning of control features at the edge of the network
  - Dynamic network and service chaining
  - Robustness and availability
  - Cyber security
  - Lifecycle management
    - Esp. scenarios where equipment from many vendors needs to be managed and controlled in a single system

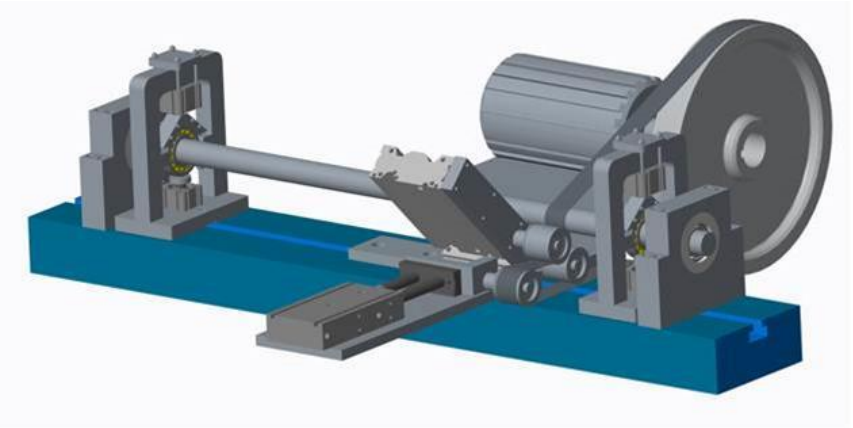
Work in progress @ Aalto

5G@II project

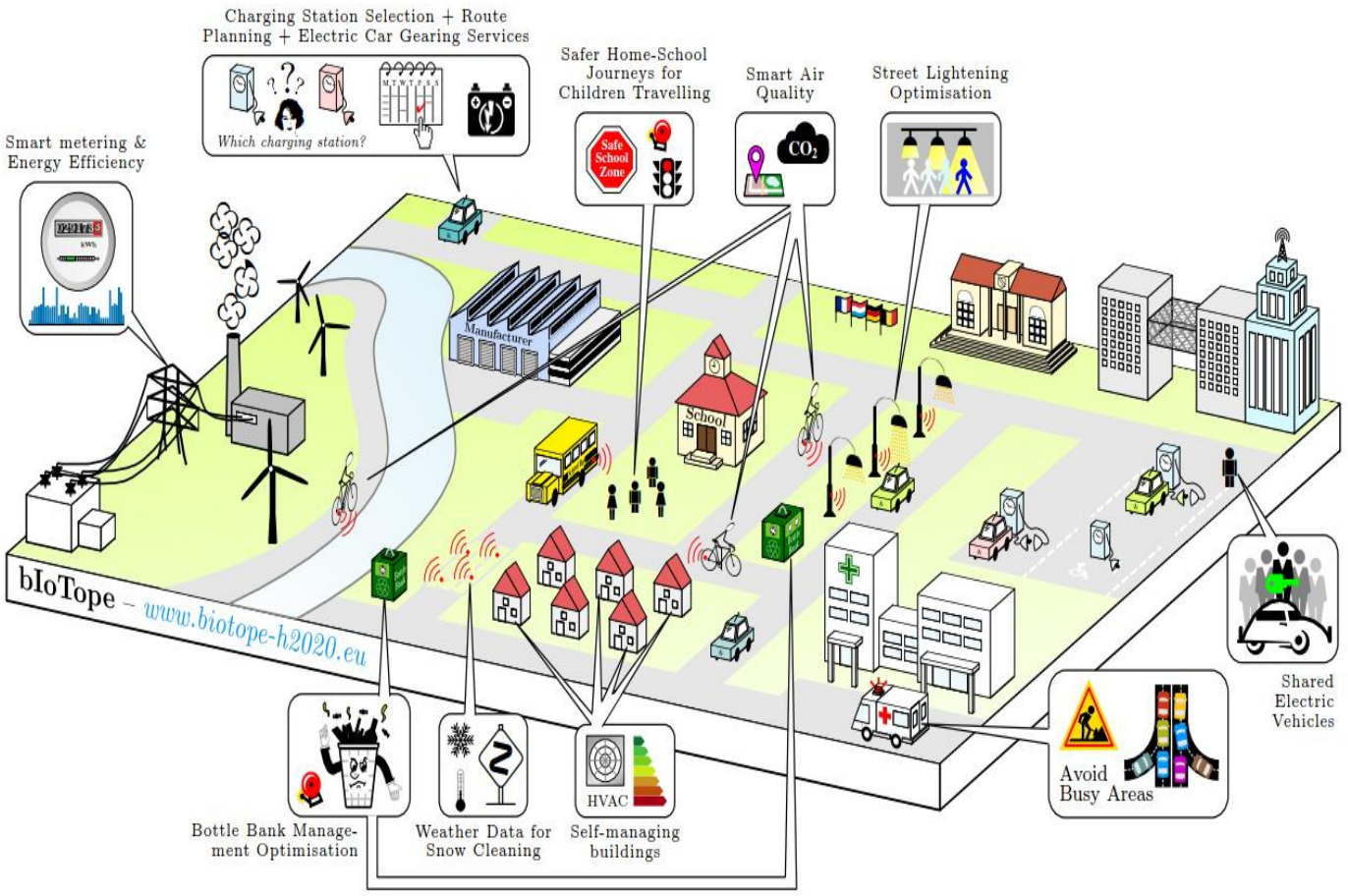
- Create a management system embedded in the 5G architecture that will support
  - secure management of the smart devices
  - scalable and secure data collection and storage on the basis of 5G network slicing
  - policy-based digital contracting, digital service creation and management
  - trustworthy data sharing using models rather than data itself.
- Pilot the system by combining the AIIC platform http://aiic.aalto.fi/en/ and TAKE-5 experimental 5G network (http://take-5g.org/) and running concrete experiments based on industrially relevant use cases.

AIIC experimental platforms

- ABB: IoT instrumentation for a research apparatus for studying magnetic bearings
- Konecranes: Smart crane with extensive PLM models and IoT interfaces enabling a digital twin
- ABB et al.: Process control lab covering several IoT-enabled unit processes for chemical industry
- ACRE: Digital campus



Digital campus: bIoTope project



Aalto University

Use cases vs. AIIC platforms

	Smart crane	Process plant	Digital campus
Factory control	M2M scenarios with strict latency requirements Operator interfaces	Remote control scenarios with strict latency requirements	System-level control of devices from multiple vendors Equipment life-cycle management
Factory monitoring /fleet management	Managed access to relevant data to the equipment provider Partial access to relevant data to other stakeholders	Managed access to relevant data to the equipment providers	Managed access to relevant data to the equipment providers and other stakeholders
Digital twin	Data integration scenarios including sensor data	On-line simulation & control scenarios	On/off-line simulation and control scenarios

Comments and questions welcome!