INDUSTRY 4.0

Overview
The Fourth Industrial Revolution: Industry 4.0

Industry 1.0
“Mechanization”
Mechanical production equipment with water and steam power

Industry 2.0
“Electrification”
Mass production with division of labor and electrical energy

Industry 3.0
“Automation”
Automation of production with electronics and IT

Industry 4.0
“Autonomization”
Cyber physical production based on the internet of things & services

1784 first mechanical loom
1800
1870 first conveyor belt
1900
1969 first programmable logic controller (PLC)
1970
... today

based on [Wahlster 2014; Bosch 2015]
Definition of Key Terms

**Internet of Things**
A global infrastructure enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. [ITU 2012]

**Industrial Internet**
An internet of things, machines, computers, and people, enabling intelligent industrial operations using advanced data analytics for transformational business outcomes. [IIC 2015]
Definition of Key Terms

Cyber Physical Systems

Embedded Systems with a range of multi-modal and interconnected human-machine interfaces that collect and process data through sensors and manipulate physical operations through actors. [acatech 2011]

Embedded Systems

A microprocessor-based system that is built to control a (range of) function and is not designed to be programmed by the end user. [Heath 2003]
Industry 4.0

The technical integration of CPS in production and logistics as well as the application of the internet of things and services in industrial processes – including the resulting consequences for the value creation, business models, and the subsequent services and industrial engineering. [AKI 2013]

Smart Factory

Factories with decentralized production logic based on intelligent products in horizontally and vertically embedded production systems for a consistent engineering along the value chain. [AKI 2013]
Relationship Between Key Terms

Internet of Things
  Industrial Internet

Cyber Physical Systems
  Embedded Systems

Infrastructural requirement

Technical requirement

Industry 4.0

Result

Smart Factory

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Types of Integration in Industry 4.0

**Vertical Integration**
Integration of different IT systems on different hierarchy levels (e.g. actors and sensors level, control level, manufacturing management level, manufacturing execution level, corporate planning level) to a consistent solution. [AKI 2013]

**Horizontal Integration**
Integration of different IT systems for different process steps of manufacturing and corporate planning which are connected through material, energy, or information flows both company-wide (e.g. inbound logistics, manufacturing, outbound logistics) and across several companies to get a consistent solution. [AKI 2013]
Facets of horizontal Integration

- Innovate
- Design
- Plan
- Make
- Service

1. **Customer as designer**
   - Connected customer
   - Design collaboration
   - Predictive maintenance

2. **Design Supplier**
   - Supplier collaboration

3. **Manufacturing supplier** (design & manufacturing)

4. **Manufacturer**
   - Performance monitoring
   - Factory visibility
   - Distributed manufacturing
   - Embedded compliance
   - Local factory

5. **Sales** (manufacturing & service)
6. **3rd Party Service Provider** (services)

- Customer
  - Customer-centric service

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Challenges in Industry 4.0

- Managing complex systems
- Resource efficiency
- Standardization and reference architecture
- Security
- Comprehensive broadband infrastructure
- Legal framework
- Vocational training
- Work organization and design
- Managing complex systems
- Human
- Technology
- Socio-technical system

Based on [AKI 2013] [Spath et al. 2013]
What are the Opportunities in Industry 4.0?

**Product**
- Digital product memory
- Integrated compliance
- Service-enabled products

**Process**
- One-piece flow
- Asset information management
- Predictive maintenance
- Adaptive & transparent logistics
- Anticipatory quality management

**After Sales Service**
- Fraud-secure warranty management
- Targeted recall management
- Service cross-selling

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**Smart Products**
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**Smart Processes**

**Smart Services**

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Based on [SAP 2013b]