Industrie 4.0@Bosch
Dr. Thorsten Widmer
Connected Industry (Industrie 4.0)

Internet: driver of the connected world

Web 0
- Connected documents
- Connected companies
- Connected people
- Java, XML
- Browser, Webserver
- 1995

Web 1.0
- Connected companies
- Connected people
- Web-services
- 2000

Web 2.0
- Connected people
- Web-services
- 2005

Web 3.0
- Connected business models
- Internet of things and services
- Connection of the digital with the physical world
- 2020
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Megatrend: connected people

- **1995**
  - Of 5.7 billion people ...
  - 0.7 % are connected.

- **2005**
  - Of 6.5 billion people ...
  - 15 % are connected.

- **2015**
  - Of 7.3 billion people ...
  - 75 % are connected.

World population | People with internet access
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Internet of things and services
The world is changing – chances and challenges

- 80% of companies will have digital value streams
- 40 bn EUR/year additional investment in industrial assets
- 30 bn EUR/year additional value add by digital products & services
- 18% growth in efficiency and performance
- More than 50 billion devices will be connected by 2020

1) Source: Cisco IBSG April 2011, device per person
2) Source: PWC Study October 2014, Industry 4.0 – Chances and Opportunities of the 4th industrial revolution
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Revolution or evolution? At least with disruptive potential!

**Technology Trends**
- OPC UA
- Web-Services
- RFID
- Vertical Integration
- Horizontal Integration
- Decentralized Systems
- Augmented Reality
- Gesture Control
- 3D-Printing
- Sensoric
- Miniaturization
- ...

**New Business Models**
- Web based services
- Pay per use; pay per outcome
- Long Tail
- Multi Sided Platforms
- Freemium
- Open Business Models
- ...

**New Dynamics**
- Market & Customer Behavior
- Social Networking
- “Generation Y”
- Law of Moore
- Shortened life cycles
- ...

Our criteria for Connected Industry

- Fast integration and flexible configuration
- Open standards
- Virtual real-time representation
- Distributed intelligence
- Secure value-creation network
- Digital life-cycle management

People as key players
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I4.0 to support people – a prerequisite for success

- Extended space for decisions and participation
- Opportunities for stress regulation
- New challenges and opportunities for engineer’s and skilled worker’s knowledge

Criterion for success:

I 4.0 ≠ „CIM 2.0“

- Physical assistance by amplify capability
- Innovative forms of learning mobile, personalized, situative
- Networked working by multi-modal interaction human-machine and human-human
- Maintenance and planning assistance location-based, context-adaptive
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I 4.0 it’s straight on the way & Bosch is part of shaping future

**2013**
04.2013 ✦ Final report & start Plattform I 4.0

**2014**
03.2014 ✦ Start Industrial Internet Consortium
10.2014 ✦ Reorganisation National IT-Gipfel
04.2015 ✦ Extension Plattform I 4.0

**Bosch**
05.2013 ✦ Bosch Dual Strategy for I 4.0
11.2013 ✦ Project I 4.0@Bosch
01.2015 ✦ Innovation Cluster Connected Industry @ Bosch

04.2013 ✦ Hermes Award Open Core Engineering
09.2013 ✦ VDA Logistic Award Supply Chain Homburg 1
11.2014 ✦ I 4.0 Award Multi Productline Homburg 2
04.2015 ✦ Extension Plattform I 4.0

09.2013 ✦ VDA Logistic Award Supply Chain Homburg 1
11.2014 ✦ I 4.0 Award Multi Productline Homburg 2
07.15 ✦ Awarded place of ideas Lean Production I4.0@Blaichach
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Bosch dual strategy Connected Industry (I 4.0)

Lead Provider
System manufacturer/Production resource view

- I 4.0 solution provider with external business
- enabler technology or internal I 4.0 solution provider

- Rexroth Drive and Control Technology
- Bosch Software Innovations
- Packaging Technology
- Assembly Systems and Special Machinery
- Bosch Connected Devices & Solutions
- ...

Lead Operator
Product manufacturer/Product view

- Manufacturer of products
- Machine operator
- Plant operator
- Interface to customers/suppliers

250+ Bosch plants world wide

Many practical pilot applications are bundled within the Innovation Cluster CI
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The Innovation Cluster Connected Industry

- Bosch-Divisions
- Steering Committee
- Innovation Cluster Connected Industry
- Corporate Functions
- Employee Representatives
- Publicly funded projects
- Customers
- Suppliers
- Universities
- Partners
- BITKOM
- VDA
- ZVEI
- VDMA
- IIC1
- DRC2
- ...
Implementation roadmap for Bosch plants

**Connected Industry (Industrie 4.0)**

**Systematic roll out for holistic approach driven by strategically focused pilots**

- **Starting Level** (bottom up)
  - Pilot applications

- **Migration Level 1** (bottom up, top down)
  - Pilot I 4.0 Value Stream

- **Migration Level 2** (top down, bottom up)
  - Pilot IPN I 4.0

**I 4.0 innovation level**

- **Starting Level**
  - Migration Level 1
  - Migration Level 2

**Pilot projects**

- RB „main stream“
- RB „pilot stream“

**2013**

- Pilot IPN I 4.0
- Pilot I 4.0 Value Stream
- IPN = International production network

- ERP, MES, Controls, Actuators, Sensors
- Logistics
- Field service, After Sales
- New machinery/equipment and solutions
- Existing machinery/equipment and solutions modernized
- Today existing machinery/equipment and solutions

**IPN = International production network**

- Migration Level 1 (bottom up, top down)
  - Pilot I 4.0 Value Stream

- Migration Level 2 (top down, bottom up)
  - Pilot IPN I 4.0

**Systematic roll out for holistic approach driven by strategically focused pilots**

- the systematic and fast I 4.0 transfer and roll out to be ensured by Project I 4.0 @ Bosch

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I 4.0 feature: distributed intelligence

**Example: autonomous rollers**
- Parts transport from the supermarket to the production line
- Autonomous navigation of the rollers on the shop floor
- Collecting, processing and communicating data
- Independent work of logistics tasks through swarm

**Example: flexible manufacturing modules with own controls**
- Module knows its technical skills and autonomously organizes its work steps in the process
- Module detects different parts and processes them
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I 4.0 feature: open standards

Compatible equipment, machinery, components and services
- Easy integration of machines and components from different manufacturers
- Harmonized interfaces: e.g. of semantics, protocols, connectors
- Platform-independent and universal interfaces
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I 4.0 feature: people as key players

People play the decisive role in the connected plant
- Decisions based on contextual digital information
- Mastering complexity through new ways of visualization and operation

New ways of learning
- Individual integration of the employee in the work process
- Assistance functions and ability amplifier for people
- Health and well-being through adaptive workplace ergonomics
I 4.0 feature: fast integration and flexible configuration

Value-added network based on comprehensive broadband infrastructure
- Guaranteed latency, reliability and quality
- Ad hoc connection of people, processes and machines

Flexible integration and (re)configuration of machines
- Quick setup of process modules for new tasks
- Modules are strung together ad hoc to form a large-scale production line
- "Plug and Produce" - modules can be interchanged quickly
**I 4.0 feature: secure value-creation network**

**Secure cross-company value-creation networks**
- Secure infrastructure for people, processes, and data
- Protection of the means of production and the company’s IT systems from attacks and disturbances (data security)

- Unique tamper-proof digital identity for each intelligent component, machine, and product
- Tight and secure collaboration between people and machines (safety)
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Bosch with numerous examples straight on the way
Connected Industry (Industrie 4.0)

Bosch with numerous examples straight on the way

Robots share the load:
Handling of dangerous, strenuous, or monotonous tasks so associates don’t have to.

The APAS Family:
The mobile production assistants of the APAS family already work hand in hand with their human colleagues.

Round or angular?:
Components tell machines how they need to be shaped. The system then adjusts itself accordingly.

Bosch Rexroth in Homburg:
A manufacturing system with batch size of one already is in place producing many products on one line.

APAS: Automated production assistant
Pilot value stream HoP2 – step one was successful

**Use Case**

Assembly of hydraulic valves for mobile applications in HoP2

**I 4.0 Approach**

- Unique product identification by RFID, flexible work sequence
- Exchangeable autonomous stations, user-specific work place configuration
- Line-/product status via “active Cockpit”

**Results**

- Stock reduction ~ 50 %
- Output increase ~ 20 %, no setup time
- Savings up to 0,5 Mio. EUR (year / line)

**Adaptive assembly line to control high product variance**
Flows of Goods, digitally recorded: Due to automatic data capture the supply chain is virtually mapped and logistics are optimized.

RFID technology: In pilot projects the plant is already aware of the condition of products and containers via RFID technology.

Faster Work with technical aids: Warehouse associates receive their orders and operating instructions directly on displays.

Smart glasses: Technical aids like smart glasses make work easier. Initial tests are being conducted in Bosch plants.

Bosch with numerous examples straight on the way
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**Transparent Supply Chain**

**Use Case**
- Logistic enhancements in the entire value chain (common rail: injector, rail; pump), enabled by RFID

**I4.0 Approach**
- Explicit identification of products as enabler of the internet of things
- Product memory e.g. quality data
- Decentralized self monitoring (Kanban, …)
- Automatic order processing throughout the entire value chain

**Result / Targets**
- Reduction of internal transport ~ 10%
- Stock reduction ~ 30%
- Efficiency increase in processes ~ 10%

*Real time transparency increases process efficiency*
Shopfloor Suite

Use Case

Comprehensive solution package
“Shopfloor Service Suite” with Active Cockpit and Shopfloor Management Cycle

I 4.0 Approach

- Role specific information is mobile available
- Digital support for PDCA, f. e. KPIs
- Management of deviations, shift book
- Connection of shopfloor, SAP and office

Result / Targets

- Current status in real time available
- Higher transparency of production data
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Bosch with numerous examples straight on the way

Models at top speed:
A component is drafted on the computer, sent to the device, and produced there from a base material.

Rapid prototyping:
3D-printers have a place in the smart production. One application at Bosch is prototype production.

Predictive quality:
Close examination of questionable parts based on millions of data points.

Data mining for quality:
At the Anderson plant in the U.S. “data mining” already gets used to improve quality.
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Bosch with numerous examples straight on the way

Facilities predict problems:
Smart lines analyze data and report problems directly to the service department.

Predictive Maintenance:
A pilot is up and running at Bosch. Bosch Software innovations offers this type of solution.

Data from Tools
Tools are networked and send important data to server for quality proof.

“Nexo” Smart Tightening:
Screwdriver is able to measure and submit the tightening torque and screwing angle for quality prove.
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Lead Operator – Pilot: Energy management (NuP1)

Use Case
- Network charge discount through peak reduction management

I 4.0 Approach
- Peak reduction due to dynamic management of bulk consumers
- Sensors are checking the energy consumption and bulk consumers get shut down if possible during peaks
- Load cold storage at night (discharge of chillers at daytime, use of cheap energy)

Result / Targets
- Grading of peaks in consumption
- Reduction of energy consumption

Evenly energy consumption 24/7/12
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NEXO – Smart Tightening

NEXO – Tightening System
Cordless, tightening system for safety / functional relevant applications. Fully integrated process controller. Wireless communication capabilities.

Use Case
- Intelligent use of tightening process data of all tools in a production environment

I 4.0 Approach
- Communication between tightening system and data base; automated data analysis; configured visualization (cockpit view)
- Real time information of experts about process anomalies based on statistics and expert rules

Result / Targets
- Reduction downtime ~ 10 %
- Reduction failure cost ~ 10%
- Reaction time in case of failure occurrence

Intelligent devices as enabler for intelligent process data analytics
Enabler Connected Industry – some examples ...

- Manufacturing Execution: e.g. OpCon MES
- Sensor Solutions: e.g. MEMS
- Software Solutions: e.g. Bosch IoT Suite
- Assembly Technologies: e.g. Smart Workstation
- Human & Machine: e.g. APAS
- Automation: e.g. cabinet free drive technology
Our People are our key players for Connected Industry

- Tasks
- Organization
- Safety & Security
- Workplace
- Qualification
- Communication

Collaboration, Change, Leadership, Enabling
Connected Industry @ Bosch (I 4.0)

Chance & challenge: from individual actor to orchestra

We are just at the very beginning with many steps to go...

- Alignment activities to common interests
- Explorative approach & implementation speed
- Long term viable IT architecture
- Synergies & standards
- Trust & security
- Legal framework
Thank you for your attention!