Industry 4.0 – Technology for the Fourth Industrial Revolution
Dr. Stefan Ferber
First Joint German-Indian Workshop „Big Data in Engineering Applications“
Berlin, 15.03.2013
Industry 4.0

Agenda

1. Company Overview: Bosch and Bosch Software Innovations
2. Technology Trend: Internet of Things & Services
3. Example Applications of Internet of Things & Services
4. Industrie 4.0: acatech Study
5. Industrie 4.0 in Practice: Predictive Maintenance
6. Conclusion
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## Bosch 2011 key figures

### Bosch Group total

- 51.4 billion EUR in sales
- 303,200 associates including 38,750 in research and development

### Automotive Technology

- 59% share of sales
- World's largest supplier of cutting-edge automotive technology

### Industrial Technology

- 14% share of sales
- World's leading manufacturer of large gearboxes and of powertrain, packaging, and process technology

### Consumer Goods and Building Technology

- 27% share of sales
- World's largest power tool manufacturer, leading the field in household appliances, heating and cooling, and security systems

1 Including other segments
Bosch Software and Systems House

Overview Bosch Software Innovations

Industry Solutions
- Automotive/OEM, Energy, Finance, Health, Insurance, Manufacturing, Public, Retail, Telco

Technologies
- M2M (Device Management)
- BPM (inubit)
- BRM (Visual Rules)

Professional Services
- Planning, Implementation and Operation of Solutions, based on our Software Products

Locations:
- Immenstaad, Stuttgart, Berlin, Chicago, Palo Alto, Washington D.C., Singapore, Shanghai and Melbourne

Personnel:
- ~ 535 worldwide
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Internet – The Driver of Change

- **Web 0**
  - Year: 1995
  - Browsers, Web servers
  - Connected documents

- **Web 1.0**
  - Year: 2000
  - Connected companies
  - Java, XML

- **Web 2.0**
  - Year: 2005
  - Connected people
  - Web services

**Internet of Things & Services**

- Linking the virtual to the physical world
- Connected business models
- Business services

**Year**

- 1995
- 2000
- 2005
- 2020

**Number of devices**

- 1,000
- 1,000,000
- 1,000,000,000
- 1,000,000,000,000

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Massive Distributed System of Systems

Internet of People

10^9 - 10^{10}

Internet of Things

10^9 - 10^{12}

Internet of Services

10^5 - 10^7

Social Web

Business Data & B2B Network

System and Service Platforms

Smart Mobility

Device

Smart Grid

Aggregation

Smart Home

Smart Building

Industry 4.0
Reference Model Internet of Things & Services

Industry 4.0

Application Fields
Customer Access
Business Intelligence
Domain Know How
Software Technology
Internet of Things
(Wired/Wireless) IP-capable Components

Layer

Mobility
Energy
City
Enterprise
Industry
Life

Service
Service
Service
Service
Service
Business Models
Business Models
Business Models

Applications Solutions
Linking of functions and services
Integration of business partners

Aggregation, analysis, and enhancement of data

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Changing IT Environment

Systems

Enterprise
- Business Processes
- Business Rules

Mobile Networks
- Machine-to-Machine

System of Systems

Internet of Services
- Connected Enterprises
- Connected Processes
- Connected Rules
- Cloud & Data Services

Internet of Things
- Semantic Machine-to-Machine
- Aggregation
- Big Data

(R)Evolution Towards IoT

Our response

Application
- M2M
- BRM
- BPM

Business-to-Model-to-Execution
Bosch Software Innovations Offering

Solutions

Suite

BPM+
Design, optimize and automate business processes and rules

IoTS
Enable business models and processes in the IoTS

Software-Suite

Editions

Core Products

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Process Modeling & Simulation

Model-to-Implementation

Visual Debugging

Build, Test, Deploy

Execution & Monitoring

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Visual Rules Modeling

Test & Simulation
Dependency Management
Build, Test, Deploy
Execution & Monitoring

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M2M

Device Data Management

Information Models
Logical abstraction of device

Device Parametrization

Device Trend Analysis

Map-based Visualization

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Positioned as “Visionary” in Gartner Magic Quadrant for iBPMS

- Strong in application integration
- Model-driven development environment is rich in features
- Good business rule processing capability (Visual Rules)
- Domain knowledge and product features for operational technology (OT) application

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The Ecosystem as open Business Environment

- User Portals
- Other Platforms
- Internet of Things
- Industry 4.0

Multiplication

- City
- Mobility
- Life
- Industry
- Enterprise
- Energy

Networked Business Models

Integration of Things

Use

Cooperation

System as a Service Integration

Leveraging

Partner & Ecosystem
- Sales Partners
- Technology Partners
- Strategic Partner
- Ecosystem Partner

Integration of Things

Use

Partner

City

Mobility

Life

Industry

Enterprise

Energy

Other Platforms

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Internet of Things & Services (IoTS) in a Nutshell

**Business Innovations**
Weaving smart things, enterprises, and people leads to innovation in services and business models.

**Market Disruptions**
Players of different industries compete and cooperate in new market segments leading to business ecosystems linked to communities.

**People Competences**
Software and system competencies linked to deep domain knowledge and enlightened with creativity are the core for innovation in technology and business.

**Technology Advances**
Internet technologies offer a platform to interconnect billions of things. Open Source communities accelerate the development and implementation of standards.
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Enabling business success in a connected world

Connected Mobility
Connected City
Connected Energy
Connected Industry
Connected Life
Connected Enterprise
eMobility “pioneering technology in Singapore”

Project figures

- **2011**: Launch of Charging Service
- **2012**: 60 Electric Vehicles, 63 charging stations
- **2014**: break-even 1,500-3000 EV (ca. 2% of vehicles)
- **By 2016**: Develop business model, partners & drivers

eMobility Solution

*Technology and service provider*

- Openness to 3rd party vendors
- Integration of new business models
- Local operation of infrastructure

- Second highest population density
- Top ranked on Innovation Index
- Living city lab and talent hub (AP)
E.ON Ruhrgas: Central Platform for Market Communication

Benefits

- Implementation of requirements of the cooperation agreement “Gas” as well as the new standards of the “European Committee EASEE-Gas”
- Reduction of servers from 11 to 5, decreased operating costs

inubit Suite

Implementation of national & international requirements

- Consolidation of the IT landscape with only minor project specific modifications
- Connection of internal systems
- Highly productive monitoring of business relevant processes
- Turnover >700 billion kWh petroleum gas p.a.
- One of the leading gas companies in Europe, one of the major private importers of petroleum gas worldwide

Industry 4.0
**Bosch Healthcare: “Closer to the patient”**

**Benefits**

- Improved **adherence to therapy**, reduced **mortality**, improved **quality of life**
- **Increased efficiency** of medical service providers
- Very good **acceptance** among patients & attendants

**Platform for the Internet of Things**

*Bosch Telehealth Plus*

- Constant IP-based exchange of vital & behavioral parameters between doctors & patients
- Rule-based analysis of health
- Regular refinement of detection parameters by trained medical staff

- Internationally Successfully implemented
- Germany: Projects with Charité, RB Hospitals, Asklepios
REWE: “No customer need goes unanswered”

Transaction-oriented inventory control system

- Systematic mapping of all processes along the value-added chain
- Connection of all data suppliers, from back office to the store shelf, including external suppliers
- **Shortening** of delivery times from the point of order to **less than 1 day** in some cases
- **Updating** of products and inventories from checkout or shelf in **less than 5 minutes**
- Leading position in Europe
- 2010 sales: EUR 51 billion
- > 15,000 stores worldwide

**Project figures**
Fannie Mae „Handle risk with care“

Project
- Implementation of a robust, flexible and extensible Risk Rating Platform
- Traceable, accurate, and complete portfolio rating in one system for the first time
- Lighthouse Project with Bosch-Technology

Customer benefits
- Batch-Rating: **41,000 credits/h**, defect rate from 15% to 0%
- Counterparty assessment, obligor and facility rating models
- Simulation with more than 20 individual scorecards
- Speedup form 1 to **9** Scorecards in 6 months

World’s biggest mortgage bank
- Customer Assets: 869 bn. USD
- More than 6,000 employees
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John Deere “Machine health revolution”

Project figures

- Minimization of downtime
- Price reduction for servicing contracts
- Competitive advantage:
  “Move More Dirt for Less Money” (quote, John Deere)

Rules Technology

- Machine diagnosis with telemetrics
- Range of services for John Deere customers
- Intelligent monitoring of machine KPIs and fluid analysis
- Optimum servicing intervals
- Global market leader
- 2010 sales: USD 26 billion
- > 50,000 employees worldwide

Bosch Software Innovations
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Industry 4.0 – The next industrial revolution

- From the 1\textsuperscript{st} to the 4\textsuperscript{th} industrial revolution

- Connecting systems and machines
- Increasing variance with maximum productivity (batch size = 1)
- Decentralization

Source: DFKI / Forschungsunion Wirtschaft & Wissenschaft
Production: International Comparison

Anteil des Produzierenden Gewerbes (einschließlich Energie) an der gesamtwirtschaftlichen Bruttowertschöpfung

Quelle: OECD; IW Köln / Forschungsunion Wirtschaft & Wissenschaft
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BITKOM, VDMA, ZVEI Plattform Industrie 4.0

Industrieller Lenkungskreis (LK)
maximal 17 Mitglieder
- 12 Industrievertreter (je 4 pro Verband) daraus ein Sprecher
- 1 Vertreter Wissenschaftlicher Beirat
- 3 Verbandsvertreter
- Gäste: AG Leiter nach Einladung

Vorstände

Wissenschaftlicher Beirat (WB)
organisiert sich selbst, entsendet 1 Sprecher in LK

Lenkung Monitoring Außenvertretung

Geschäftsstelle (GS)
4,5 Mitarbeiter (Leiter, Mitarbeiter, Assistenz, je 1,5 aus ZSG und VFI und BITKOM)
Organisation – Koordination - Information

Industrie 4.0

AG1  AG2  ...  AGn
weitere Verbände u.a. BDI, VDI, IGM

Fachcommunity

Quelle: BITKOM, VDMA, ZVEI
Industry 4.0

Perspektive der IKT-Automatisierungstechnik heute

Quelle: Festo / Forschungsunion Wirtschaft & Wissenschaft
Smart Factory

- **New business models** through the convergence of IT & production

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**Predictive Maintenance**

- **Networked Production**
- **Resilient Factory**
- **Customer Integrated Engineering**
- **Adaptive Logistics**
- **Up-Cycling**
- **Technology Marketplace**

Source: Forschungsunion Wirtschaft & Wissenschaft
Industrie 4.0: Impact for Bosch

Bosch Rexroth

Bosch Werke

Verpackungstechnik

Software & Systemhaus
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Intelligent Maintenance based on Remote Service Portals

Customer benefit

- Planning of optimal maintenance effort
- Reduction of repair, resources and energy costs
- Increase of productivity by preventing unplanned down-times

Predictive Maintenance

Increase Overall Equipment Effectiveness (OEE)

- Service Portal for customers and employees
- Integration of machines and systems
- Real-Time data acquisition of machine conditions
- Tool supported data analysis for malfunction prognosis
Remote Service Portal – Stages and features

**Predictive Maintenance**
- Tool supported data analysis for malfunction prognosis
- Automated maintenance process
- Integration of 3rd party process (logistic, purchasing etc.)

**Central Service Management**
- Monitoring and reporting of maintenance processes
- Service Ticketing Management
- Integrating business processes (e.g. ERP System, CRM System)

**Central Machine Health**
- Capturing machine sensor data
- Monitoring of machine health and production status
- Data analysis using predefined algorithms

**Remote Service Portal Basic**
- Central access to machines and systems via Web-UI
- Remote Software Updates
- Transparent and centralized documentation

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Industry 4.0

Solution Architecture

Applications
- BPM
- BRM
- Data Analysis
- CRM
- ERP
- Field Force
- Logistic

Device Management
- M2M
- Device Abstraction
- Device Data
- Device Access
- Event Management
- Big Data

Agents
- Edge Controller

Device & Machine Level
- Direct Nodes
- Indirect Nodes

CRM = Customer Relationship Management, ERP = Enterprise Resource Planning, M2M = Machine to Machine
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Conclusion

- The Internet of Things & Services stands for the progressive linking of the physical and virtual world.
- Model driven approach and Open Platforms are key: Process to Device & Device to Process.
- Technology itself is not the key factor - much more the development of applications and business models.
- Quick wins in Industrie 4.0 e.g. Service Portals
- Bosch will consequently utilize the chances and possibilities of the Internet of Things & Services.
Q & A

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