BOSCH IOT SUITE –
WE CONNECT EVERYTHING

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Research and Development Manager,
Bosch Software Innovations EOOD
THE INTERNET OF THINGS
What is the Internet of Things?
At the heart of a new wave of innovation

- The IoT is about connecting things and machines.
- Connecting devices results in more data intelligence.
- Data insights and analytics give rise to new solutions and services.

<table>
<thead>
<tr>
<th>Generate value through new business models and revenue streams</th>
<th>Complement conventional product business</th>
<th>Improve the way of running a business</th>
<th>Streamline and automate processes</th>
<th>Make lives of customers, citizens, or employees safer, easier, or more comfortable</th>
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The Internet of Things
Enabling new business with digital services

Sources: Prof. Elgar Fleisch, 2011, 2016
Bosch in the Internet of Things
From Physical Products to Digital Services

Example: EV Charging

Physical product 
EV

Digital product
Charging app

Digital service
IoT platform

Physical product
EV

Physical service
Charging

Product

Service
From Physical Products to Digital Services: Mobility

Example: Community based parking

- **Physical product**: Car with park pilot system
- **Digital product**: “Smart Parking” app
- **Physical service**: Finding a parking space
- **Digital service**: Community Based Parking Cloud Platform

Hybrid Product Scheme: Prof. Elgar Fleisch, 2016
Bosch in the Internet of Things
From Physical Products to Digital Services: Smart Heating

Example:
Junkers Gas Boiler

Physical product
Gas Boiler (100 years ago)

Digital product
"HomeCom" app

Digital service
Web-based control

Physical service
Hot Water & Warm Air

Physical

Product

Smart Gas Boiler

Digital

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Bosch in the Internet of Things
From Physical Products to Digital Services: Powertools

Example: “TrackMyTools”

- **Digital product**
  - “Track my tools” app
- **Digital service**
  - Inventory Management

- **Physical product**
  - Electric Drill + module
- **Physical service**
  - “Drilling a hole”
Bosch Software Innovations

Global presence

Market presence

6.2m
connected devices using
Bosch IoT Suite

Know-how

800+
IoT experts around the world (Germany, Bulgaria, Singapore, China, Japan, USA)

Projects in many business areas

250+
IoT international projects in the areas of manufacturing, mobility, energy, home & building, city, agriculture ...

Bosch early IoT visionary

2008
Bosch Software Innovations emerged out of the two earliest acquisitions in the IoT space
Our vision for the Internet of Things: The Connected World

- Industry
- Mobility
- Energy
- Home & Building
- Smart City
Bosch Software Innovations
Our product groups and areas of activity

Mobility
Solutions for electromobility, intermodal transportation, and connected vehicles

Industry
Solutions for connected manufacturing

IoT General Projects
Tailored solutions for agriculture, cities, homes & buildings and new domains

Energy
Solutions for smart and simple energy management

PaaS
Core development of the Bosch IoT Suite

ProSyst
Gateway software and middleware for the IoT

Enterprise
Software for process management and business rules

Customer Success Services
Comprehensive IoT service and consulting portfolio

Bosch IoT Suite
Spearheading the Internet of Things
IoT innovator, enabler, incubator & catalyst

Global IoT market
We develop, market, and sell
- IoT solutions for the manufacturing, energy, building, and mobility sectors.
- platform technology for customized IoT projects.

Bosch Group
We are an agile unit supporting the Bosch business units in a partnership approach for IoT competencies and technology.

We develop outstanding software solutions and products that take our internal and external customers to the next level of the Internet of Things.
# The Bosch IoT Suite

## Technology for the connected world

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<tr>
<th>Trusted &amp; secure</th>
<th>Open &amp; flexible</th>
<th>Innovative</th>
<th>Ready-to-Use</th>
<th>Cost effective</th>
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</thead>
<tbody>
<tr>
<td>Highest standards of data privacy</td>
<td>Connectivity to other platforms</td>
<td>Supporting innovative business models</td>
<td>Tailor-made for IoT</td>
<td>Shared platform – shared costs</td>
</tr>
<tr>
<td>State-of-the-art security technology</td>
<td>Supporting different deployment models</td>
<td>Opening up cross-domain use cases</td>
<td>Fast and easy subscription to services</td>
<td>Easy entry pricing (service plans)</td>
</tr>
<tr>
<td>Own data centers</td>
<td>Actively engaged in open source communities and standardization bodies</td>
<td>Consistent and systematic access to Bosch and 3rd party devices</td>
<td>Deployment in a minute</td>
<td>Usage-based pricing</td>
</tr>
</tbody>
</table>

### Key pillar for Bosch’s IoT strategy

- Full service provider for connectivity and IoT (software, services, sensors)
- Domain knowledge from all divisions
- Lead supplier and lead user in IoT
- Ecosystem player
The Bosch IoT Suite
One open IoT software platform for all domains

Services & applications

Software platform

Connected things

Building
City
Energy
Manufacturing
Mobility
The Bosch IoT Suite
Toolbox in the cloud for IoT developers

Bosch IoT Hub
Bosch IoT Things
Bosch IoT Rollouts
Bosch IoT Remote Manager
Bosch IoT Analytics
Bosch IoT Permissions

Software services available on developer marketplace

Successfully commercialize prototype applications
The Bosch IoT Suite services
Tailor-made for Internet of Things scenarios

Bosch IoT Hub
Secure and reliable messaging for device-related communication between services in the cloud

Bosch IoT Things
Managed inventory of IoT device assets

Bosch IoT Rollouts
Rollout software and firmware updates to devices

Bosch IoT Remote Manager
Remote IoT gateway and device management service

Bosch IoT Analytics
Leverage the data of IoT connected devices

Bosch IoT Permissions
Authorization management for IoT applications
The Bosch IoT Suite
Developer building blocks for creating IoT solutions

Scalable IoT solution

IaaS
Compute, Storage, Network, Security

PaaS

SaaS

Marketplace
Bosch IoT Cloud
Strategic completion of our sensor, software, and service portfolio

Foundation for IoT solutions delivered by Bosch and our partners

Strong focus on privacy and security

Important milestone in our transformation into a product company with advanced IT capabilities
Software components
Strategic impact on IoT applications

- **ProSyst Gateway Software**
  - Running on local gateways bundling and connecting also non-IP-ready devices

- **Gateway software**
  - The brain of an intelligent device or machine

- **Embedded software**
  - Bosch is excelling in intelligent products of superior quality

- **Cloud & enterprise software**
  - Connecting users, devices, and business partners

- **Bosch IoT Cloud & Bosch IoT Suite**
  - Users experience services on mobile devices, TV sets, ...

- **End-user apps**

Technological, commercial, and user angles covered through Bosch
ProSyst Gateway Software
Overview device protocols

ProSyst OSGi middleware stack

<table>
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<tr>
<th>Local logic (OSGi apps)</th>
<th>Android / iOS apps</th>
<th>Web apps (HTML5)</th>
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<tbody>
<tr>
<td><strong>Automation Engine</strong></td>
<td><strong>History &amp; Statistics</strong></td>
<td><strong>APIs (Java, JSON-RPC, RESTful and JavaScript)</strong></td>
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<tr>
<td><strong>Device &amp; Protocol Abstraction</strong></td>
<td></td>
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</table>

- EnOcean
- EEBus SHIP
- KNX
- ZigBee
- Z-Wave
- DECT ULE
- wMBus
- modBus
- BACnet
- BT LE

Discovery
Security
Remote management
Software update
Logging

Bosch Software Innovations GmbH | INST-PSY/QMM | 18/10/2017
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The Bosch IoT Suite

Target architecture
The Bosch IoT Remote Manager

Managing diverse IoT deployments

Sensors

- LoRa
- Bluetooth
- ZigBee
- enOcean
- OPC UA
- Modbus

Sensor protocols

Gateways

Management protocols

(Cloud) backend

Bosch IoT Remote Manager

Bosch IoT Suite

Bosch IoT Cloud

Amazon Web Services

SAP Leonardo

On-premise
End-to-end IoT solutions
The components needed ...

Devices

- Gateways (if needed)

- Backend (Cloud or on-premise)

Out of the box support of most common communication protocols

Bosch IoT Connectors

Remote Manager

Bosch IoT Suite

ProSyst mPRM
Demo architecture – modular approach

Data collector processing
Data analysis
Custom dashboard

Bosch IoT Analytics

Web / app server (e.g. Tomcat) Customer GUI

Bosch IoT Remote Manager – host 1
Bosch IoT Remote Manager – host 2
Bosch IoT Remote Manager – host n

Remote Manager cluster

Remote Manager provides full remote access over: REST and Messaging (TCP/IP) protocols

Load balancer

HTTP Server (OSGi) CustomerGUI

ProSyst Gateway Software

e.g. ZWave e.g. ZigBee e.g. BLE

Gateway

End user

Mobile app / Web browser (remote access)
Web browser (local access)

HTTP + REST

ProSyst Compact Gateway Software
Controller

Sensors / actuators 1 - n

FW Update, Config, Restore

Administrator / operator

USB

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The Bosch IoT Suite services

Pricing principles

- Pay-per-use
- Performance-based
- Monthly subscription
- Transparent and predictable
- No software license

Plans: free, starter, and standard
- Parameter definition depends on each service, e.g. transactions
- Support categories: bronze, silver, and gold
NO ONE CAN DO I(O)T ALONE.
Leading companies and organizations build an open IoT

| GE and Bosch: Industrial IoT leaders work towards interoperability and open source collaboration |
| Industry 4.0: Bosch and SAP combine expertise |
| Eclipse project proposal: Bosch initiates new machine language for Industry 4.0 |
| Bosch and IBM: Collaboration for Industrial IoT; Bosch IoT Rollouts on IBM Bluemix |
| Bosch and Amazon Web Services: Making Bosch IoT Suite available on AWS cloud |
| Bosch and Software AG: Joint Bosch IoT Analytics cloud service |
| Bosch, through ProSyst, is active member of the OSGi Alliance since 1999 |
| Bosch joins Industrial Internet Consortium |
| Industrial partners Bosch, Tech Mahindra, Cisco, and National Instruments form IIC testbed |
The Bosch IoT Suite
Now also available on Amazon Web Services (AWS)
Bosch IoT Rollouts cloud service via IBM Bluemix
Reduce customers’ IoT software provisioning risks and costs

Bosch IoT Rollouts available in IBM marketplace via Bluemix
Available in EU as (free of charge) experimental service for evaluation purposes by Q2/2017

Next steps:
- Watson IoT Integration for device connectivity
- Make it available as (paid) service for productive use, also for NA and AP
IoT and partner ecosystem

Working together for innovative applications

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<th>Consortial Engagement</th>
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<td>eclipse</td>
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<td>HUEJect</td>
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<td>Industrial Solutions</td>
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<td>HOS software</td>
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<td>OSIsoft</td>
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<td>Project 4.0</td>
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<td>PTTB</td>
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<td>OSIsoft</td>
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<th>Implementation Partners</th>
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<td>Ancud</td>
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<td>B-K Solutions</td>
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<td>LMM lab</td>
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<td>ROCKET home</td>
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<td>Tata Consultancy Services</td>
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<td>tech lab</td>
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<td>STMicroelectronics</td>
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<td>Texas Instruments</td>
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<th>Cloud Strategy Partners</th>
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<td>EBM BlueMics</td>
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<td>FOGHORN</td>
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<td>MongoDB</td>
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<td>Oracle</td>
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<td>PTC</td>
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<td>Vodafone</td>
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<td>Cloud Connected Services</td>
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<td>IoT Consulting</td>
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The Bosch IoT Suite
Open source basis

- Focus on device/user attach/control points.
- Drive forward cloud/docker capability.
- Observe and leverage momentum around Kapua.

Custom IoT solutions

Hub Integration

Bosch IoT Permissions

hawkBit
Bosch IoT Rollouts

Bosch IoT Remote Manager

Bosch IoT Things

Bosch IoT Analytics

Bosch IoT Integrations

Visual Rules

Developer Console

Integration Gateway

(Non-Bosch) enterprise systems

3rd party cloud services

3rd party IoT hub

IoT devices

(IP ready)

Custom gateway

ProSyst Gateway Software

IoT gateways

(IP/ non-IP ready)
The Eclipse Open Source Community has become a major technology enabler for multiple Bosch businesses impacting more than 10,000 Bosch software developers.

**Goals**

- Promote and establish an open platform as de-facto standard for IoT in IWG* IoT
- Establish worldwide common SW-Tool-Chains for automotive development in IWG Automotive
- Provide long term support over 12 years for critical development tools in IWG Long Term Support (LTS)
- Get early developer feedback in case of contributions
- Promote open technology
Eclipse Foundation: strategic membership
Actively engaged within the Eclipse IoT Working Group

Eclipse Ditto
... where IoT devices and the state of their digital twins get together

Eclipse Leshan
A Java library for implementing Lightweight M2M servers and clients

Eclipse hawkBit
A domain-independent, back-end solution for managing software rollouts in IoT

Eclipse Vorto
A smart, open approach to the interoperability of IoT products

Eclipse Hono
Enabling device-related communication between connected devices and IoT applications in the cloud
Open standardization
Adopted rapidly by growing industrial community

- Founded in 1999
- Common software platform for distributed devices and multi-device-vendors with complex software requirements
- Providing modular, dynamic architecture for multiple industries
- Software framework targeting all device classes
- Worldwide accepted standard
- ProSyst software is built on OSGi technology
SECURITY
The Internet of Things

Security challenges

Enterprise Systems

Permanently changing and developing security threats

Application layer attacks (e.g. Buffer overflow, cross site scripting)

Bosch IoT Suite

Backend and cloud runtime

Bosch IoT Cloud

Local gateway

Password theft or cracking
Protocol and network layer attacks (e.g. sniffing, ...)
DNS hacking man-in-the middle (e.g. spoofing)

Devices

Hardware hacking or theft, application layer attacks, identity theft

Denial of Service attacks (DoS) (e.g. using botnets)

Ports and apps

Password theft or cracking

Protocol and network layer attacks (e.g. sniffing, ...)

DNS hacking man-in-the middle (e.g. spoofing)
The Bosch IoT Suite
Security concepts

Security architecture and concepts (design time and runtime)

Enterprise Systems

Authentication, authorization, and accounting (AAA) management

Bosch IoT Suite

Bosch IoT Cloud

Backend and cloud runtime

Denial of Service (DoS) attack detection

Demilitarized Zone (DMZ), firewall, packet filtering, reverse proxy

Local gateway

Trusted Platform Module (TPM), firewall, port filtering and blocking, identity assurance

Data encryption, key management
Bosch IoT Permissions (authentication)
Client & server certificates, certificate management

Portals and apps

Devices

Portals and apps

Devices

…

…”

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The Bosch IoT Suite
Identification and encrypted communication

Automated deployment essential for initial and regular rollout of certificates
Recommendations and best practices

Holistic IoT security – white paper

Bosch-si.com/iot-security
We connect every thing

Bosch IoT Suite in practice

- Device management for connected filters
- Smart heating: intelligent networking of heating systems
- IoT Gateway: easy connection to Industry 4.0 environments
- ‘Internet of Oysters’: monitor the health of the water system
- TrackMyTools: a smart inventory management system
- Indego Connect: intelligent device management
- Connected asset intelligence system for rail freight
- Firmware and software updates over the air
Leading vendor: Bosch Software Innovations

PAC Report Bosch IoT Suite “Best in Class Device Management”

The PAC analysts rated Bosch Software Innovations as above average in several categories, noting in particular the company’s strong strategic focus on the Internet of Things (IoT).

In addition, they designated the Bosch IoT Suite’s device management the leader in the European market and awarded it the “Best in Class” seal, thanks in part to the company’s strong references.
Vendor benchmark: Industry 4.0 Platforms
Leader position: Bosch Software Innovations
Importance of business models for the IoT
Solid foundation for highly complex projects

The Business Strategy and Innovation Framework is the most in-depth Industrial IoT-focused business strategy framework comprising expert vision, experience and business strategy best practices from IIC members, including Bosch Software Innovations, InterDigital, Hewlett Packard Enterprise, and Machina Research.
IOT PROJECTS
Together with FivePoint, Bosch is creating more livable, healthier and connected communities in San Francisco.
Reliably connecting motor vehicles: Already connecting more than 1.5 million vehicles
Bosch’s **ProSyst** software is deployed in more than **1,000,000 smart homes** providing home automation, higher security, energy management and savings.
Making life more convenient

Thanks to intelligent technology, your home can now adjust many things in the background without you having to lift a finger, making your life more convenient, secure, and sustainable.

This intelligent home control is based on interconnected devices that communicate with one another via the Bosch IoT Suite and automatically adapt to the changing circumstances of your day-to-day life.
Cross Domain Development Kit (XDK) connected to the Bosch IoT Suite

Get started:
http://www.xdk.io/cloud

Prototyping IoT applications: the XDK enables professional users and software developers to immediately start an IoT demo or PoC.
Bosch Software Innovations has connected over 80 different machines, some older than others, for the lighting manufacturer Osram in Berlin. The company’s plant for xenon lamps in Berlin now has an Osram Ticket Manager. In this way, Osram is helping its workforce put digital, flexible manufacturing into practice.
Filtration leader MANN+HUMMEL deploys IoT solution on AWS with Bosch IoT Suite services and uses the Bosch IoT Remote Manager to securely connect and manage their filtration systems in the field.
Customer case: Mann+Hummel
Managing 3G-enabled M2M devices

Managing 3G-enabled M2M devices

- Bosch IoT Remote Manager
- AWS IoT
- Amazon EC2
- Amazon RDS
- ProSyst Gateway Agent
- Software Repository
- Software Management
- Telemetry
- 2G/3G
- Gateway w/Gemalto M2M Module
Bosch IoT Gateway for Industry 4.0

Apps for data collection, data processing and data publishing

The IoT Gateway provides

- **Dashboard App** for system administration, configuration and parameterization
- **Devices App for integration** of I/O-modules and sensors
- **Processing App for processing** of signal values and forwarding of information to MES systems, database and cloud application

Sensors and software take Robert Bosch’s from 1887 into the age of Industry 4.0
Bosch IoT Gateway for Industry 4.0
Pilot Project

**Rexroth Bosch Group**

**IoT Gateway**

- **Technology:**
  - ✓ Linux with Java/OSGi
  - ✓ Web-based configuration
  - ✓ Connection of sensors via LowEnergy and I/O Link
  - ✓ Integrations-Interface for I4.0 Platform or Bosch IoT Cloud
  - ✓ Security

**Production Performance Manager and Production Rules Configurator**

- Maintenance notification/tickets
- Maintenance completion

**Maintenance Support System**

- Reduces manual testing by 20%
- OEE Increased by up to 5%
- Reduction Maintenance costs about 25%
- ROI < 1.5 years
How can machine manufacturers benefit from the IoT?

**Predictive maintenance**

- **Prevention of production downtimes**
  thanks to continuous remote monitoring of machine data

- **Improved SLA management**
  Improved KPI monitoring, enables new service-based business models instead of traditional product sales

- **New Aftersales offerings**
  new services can be offered based on data analytics

- **Future-proof investment**
  Sustainable technology for future applications and economical invest both for low- and high-wage countries

*Machines at customer’s premises are distributed globally*
Agile IoT software development

Asparagus field 2.0

Conventional asparagus cultivation

Best growth at 20°C
Best profit from asparagus season
Consider weather forecast
Control via cover sheet

In 3 weeks from scratch to solution

The Bosch innovation project

Sensor kit
Temperature tracking with connected sensors

Asparagus farmer

▼ BETTER YIELD ▼ BETTER QUALITY ▼ BETTER DECISIONS ▼

FUTURE
- Foil placement recommendation
- Temperature prediction
- Yield prediction
- Dashboard for consultants
- Other crops
“Internet of Oysters”: The Yield, an Australian AgTech business, helps oyster farmers reduce the risk of unnecessary harvest closures caused by weather.
Conventional oyster harvesting

If harvested at the wrong time, oysters can be dangerous to eat.

Regulators conservatively control harvesting via coarse rainfall data.

**BETTER DECISIONS**  **BETTER HARVESTING**  **BETTER YIELD**

The Yield & Bosch innovation project

- Measure Water Salinity
- ProSyst IoT
- Harvesting Regulator & Growers

**BENEFITS**
- Improve scheduling of harvesting operations by predicting closures
- Extended harvest periods so more oysters make it to the market.
Connected Building
Intelligent solutions for commercial buildings

LifeCycle Tower One in Dornbirn
Bosch IoT Suite integrates sensors, lighting infrastructure, users, and existing IT systems.
Improving quality of life by simplifying parking

**Active parking lot management**

- Bosch simplifies parking for drivers, parking lot operators and car manufacturers

-30% **traffic volume** possible through reduced search for parking space

-**CO₂** through shortened search for parking space
Asset monitoring for railway applications (AMRA)

Fleet operators and goods recipients can review the status of railway cars at any time.
**Connected forklift trucks enabling digital intralogistics solutions:**
Zeno Track creates an intralogistics hub running in the Bosch IoT Cloud. By connecting forklift trucks via the Bosch IoT Suite the operational data generated allows to create new digital solutions.
Connected Products

B2C and B2B heating portal

- Cloud-based solution for consumers and installers to get access to heating systems – at any time, from anywhere.

- Remote monitoring reduces service costs while increasing service effectiveness
WE ARE BOSCH
Our past

Efficiency = Control

Fast = Central

Bigger = Better

Hierarchy = Fast
Agility at Bosch
Success factor in the connected age

Becoming more agile

- Start-up platform / innovation clusters as incubators for new business ideas
- Scrum as anchor of agile IoT development for products, software, and service

“We can draw on the strengths of the Bosch Group: we take the steadfastness, power, and range of an ocean-going tanker and combine it with the speed and agility of a speedboat.”

Dr. Volkmar Denner, chairman of the Bosch board of management
The essentials: IoT@Bosch
Intro: how Bosch sees the connected world
The essentials: IoT@Bosch

When it comes to the IoT, what are Bosch’s business goals?

- To consecutively make its products web-enabled, also with the help of cloud computing
- To use connected products and solutions to take its traditional business forward
- To open up new business opportunities, especially in services
- Main aim: to be a globally leading IoT company
The essentials: IoT@Bosch

What is the motivation behind Bosch’s IoT activities?

In various areas, Bosch is extending its acknowledged expertise as a manufacturer and provider of solutions in order to make everyday life easier. **Invented for life**
The essentials: IoT@Bosch

How does Bosch intend to become a leading IoT player?

Bosch plans to...

- ...make all its electronic products web-enabled by 2020
- ...offer new, connected services with its web-enabled products
- ...in this way expand its product and services business with connected solutions, and generate additional sales as a result
Why are sensors so important?

Sensors are indispensable for the IoT

- Bosch uses sensors to teach things how to feel.
- Bosch is the world’s leading supplier of MEMS sensors (4 million a day).
- Sensors and software are the basis for a multitude of new services, such as connected parking in the mobility sector.
- This is why we at Bosch often speak about the 3 S’s of the IoT.
The essentials: IoT@Bosch

What role does the Bosch IoT Cloud play?
Why does Bosch need artificial intelligence?

Products and systems have to become capable of learning

- Mobility (e.g. automated driving)
- Industry (e.g. condition monitoring of machinery)
- Homes (e.g. controlling central heating systems, voice recognition in home assistants)
- Artificial intelligence will increasingly allow machines to become personal assistants
The essentials: IoT@Bosch

Who is partnering with Bosch on this journey?
What role will people play?

In the IoT age, people will...

- ...contribute their flexibility.
- ...form intelligent teams together with connected objects.
- ...experience everyday convenience and a reduced workload, and expand their job profiles.
- ...also benefit from technology that is “Invented for life.”
The essentials: IoT@Bosch

Where can I get more information and concrete examples?

www.iot.bosch.com
THANK YOU FOR YOUR ATTENTION!