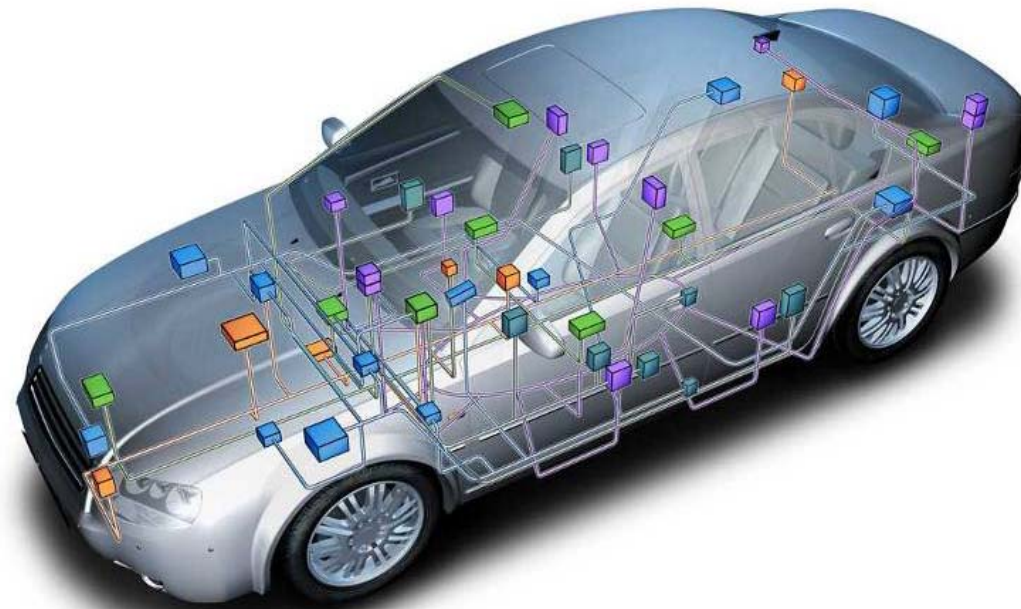


# Mastering the Challenges in Embedded Software Development

October 6<sup>th</sup>, 2008

Dr. Juergen Moessinger  
Vice President  
Automotive System Integration  
Robert Bosch GmbH



Automotive Technology

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C/AI - Mr | 9/08 | © Robert Bosch GmbH 2008. All rights reserved, also regarding any disposal, exploitation, reproduction, editing, distribution, as well as in the event of applications for industrial property rights.



**BOSCH**

# Agenda

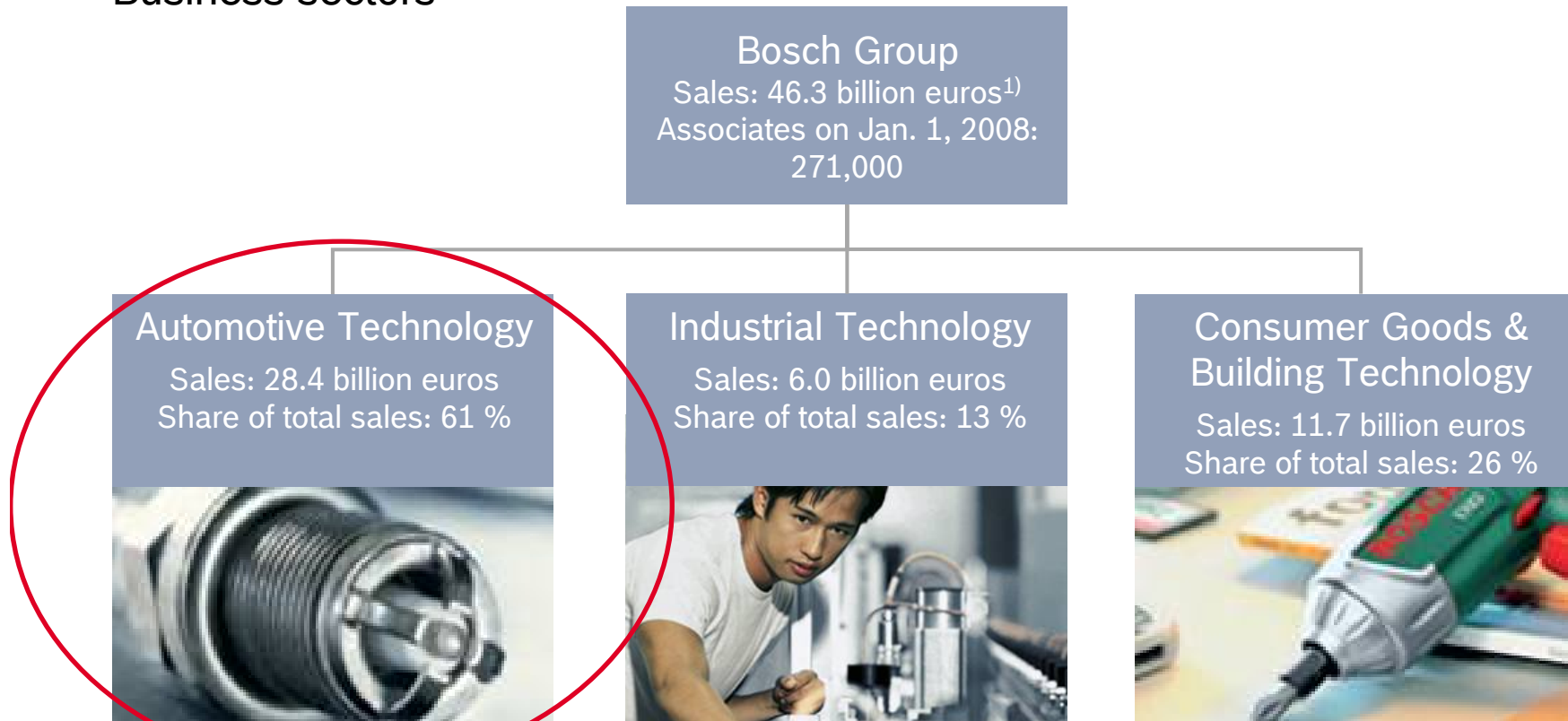
- Bosch Group
- Challenges in Automotive Development
- Solutions
  - Architecture Based Development – SW Reuse
  - Processes
- Conclusion – Implementation at Bosch
- Summary



# Bosch Group

## Structure of the Bosch Group

### Business sectors



<sup>1)</sup> Including other business areas

### Automotive Technology



# Bosch Group

## Key data

	2006	2007
Sales revenue*	43,684	46,320
Associates <sup>1)</sup>	261,291	271,265
located in Germany	110,480	112,300
located outside Germany	150,811	158,965
Capital expenditure*	2,670	2,634
Research and development cost*	3,348	3,583
Profit before tax*	3,081	3,801
Profit after tax*	2,170	2,850

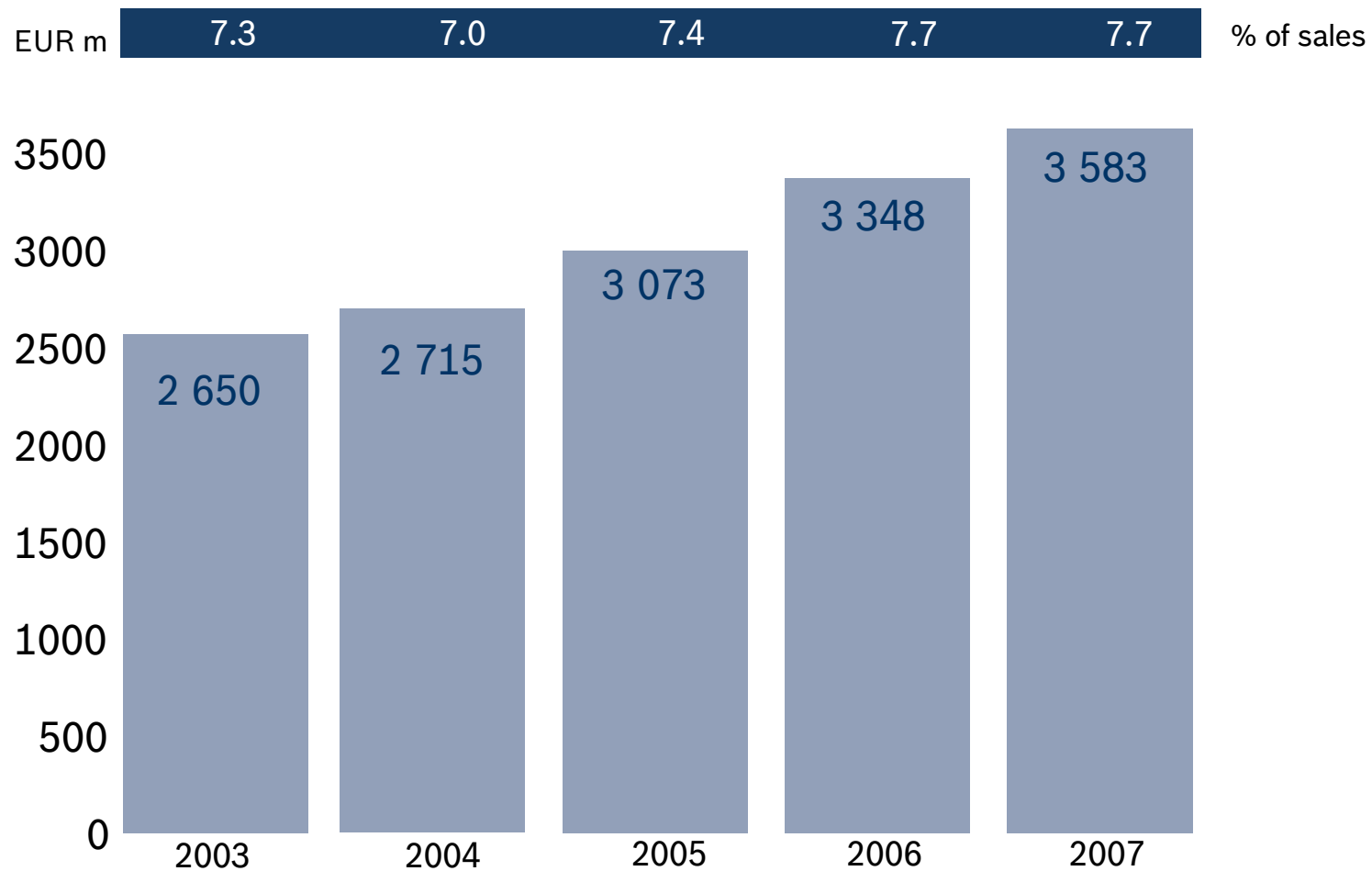
<sup>1)</sup> As per January 1, 2007/2008

\*Currency figures in millions of euros



# Bosch Group

## Research and Development Expenditure



Automotive Technology



## Patents

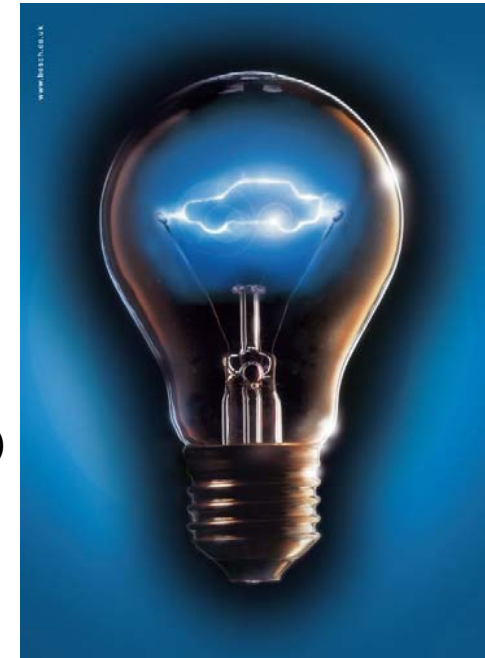
In 2007, Bosch applied for patents for a total of 3,281 new inventions (approx. 14 per day).

In April 2007, the Bosch researchers Andrea Urban and Franz Lärmer received the EU Commission's and European Patent Office's "European Inventor of the Year" award.

Bosch remains the global technology leader in the field of **automotive technology**, a fact which is also shown by its strong patent position in leading countries:

- **Germany:** **1st place** (German Patent and Trademark Office)
- **EP:** **1st place** (European Patent Office)
- **U.S.:** **3rd place** (United States Patent and Trademark Office)
- **WIPO (PCT):** **1st place** (World Intellectual Property Organization)

Germany, EP, WIPO: published applications for patents  
U.S.: patents granted



# Agenda

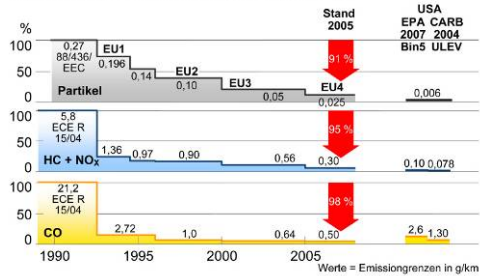
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# Challenges in Automotive Development

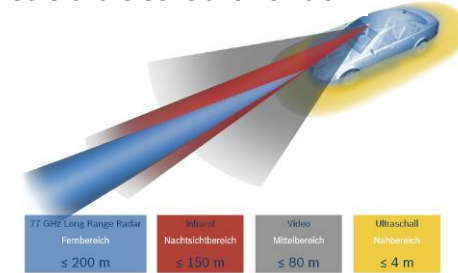
## Increasing Requirements

Diesel

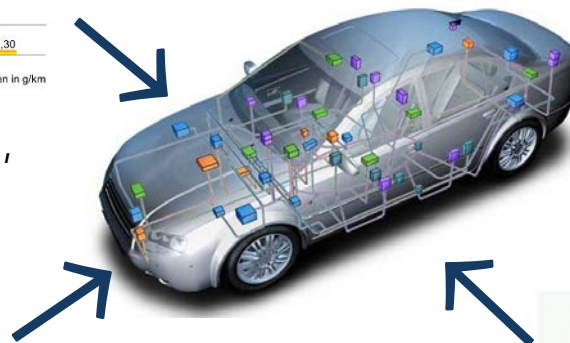


Reduction of emission,  
fuel consumption

Sensors of the sensitive vehicle

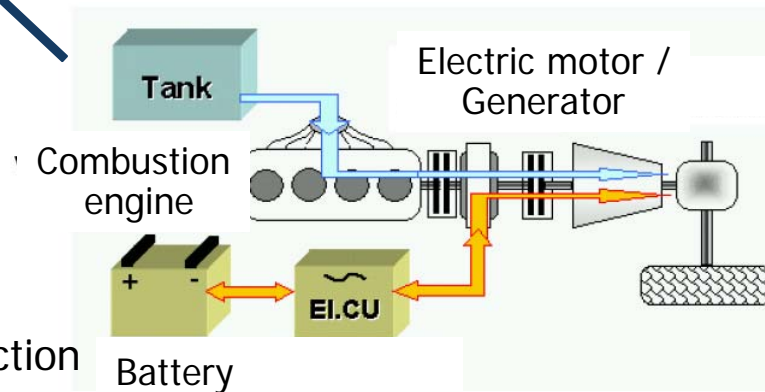


Safety



Comfort

CO<sub>2</sub> reduction



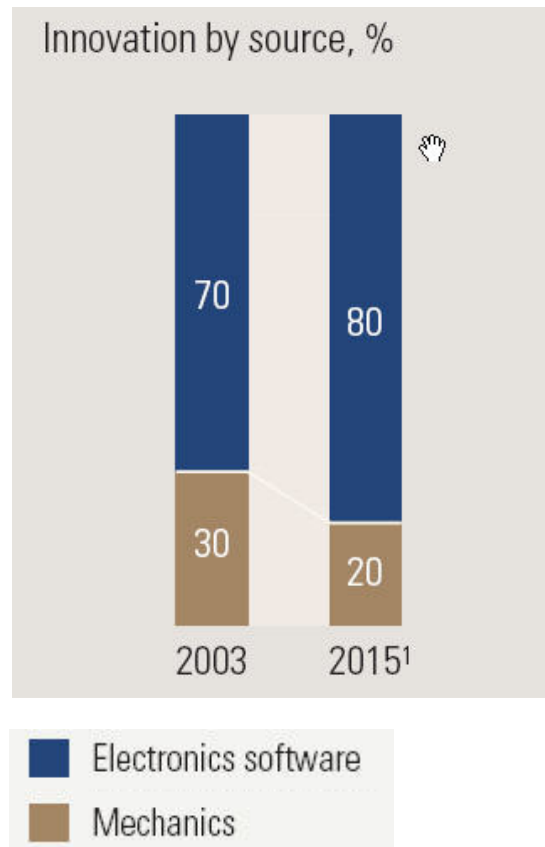
Automotive Technology





# Challenges in Automotive Development

## Drivers of Growth – Electronics / Software



- Share of electronics in vehicle value (in value)\*:  
2004: 20% → 2015: 40%
- Share of software in vehicle value (in value)\*\*:  
2000: 4,5% → 2010: 13%
- Number of ECU in vehicles strongly increases
  - mid size: e.g. Golf 50 ECU
  - high end: e.g. Lexus > 80 ECU
- SW in high end vehicles reaches 1 GB

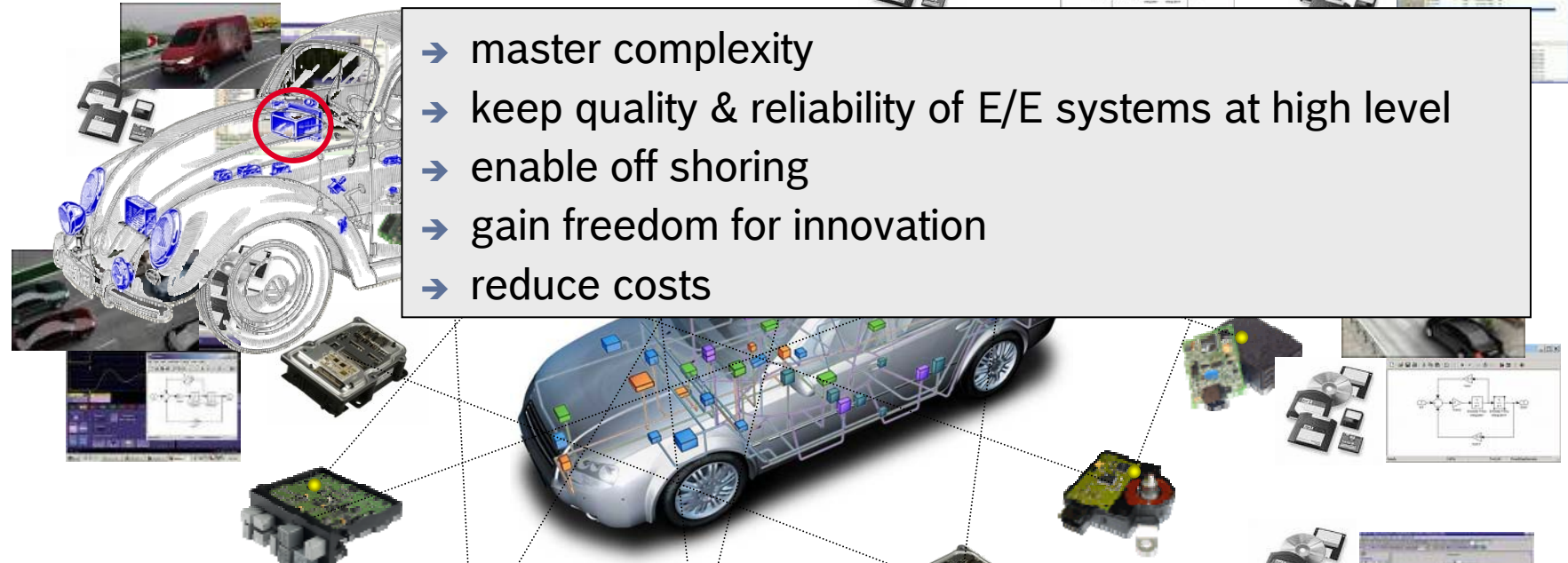
Source: \* McKinsey, Automotive Electronics - Managing innovations on the road)

\*\* Mercer Consulting, Automobile Technology 2010



# Challenges in Automotive Development

## The Challenge - Increase of Complexity

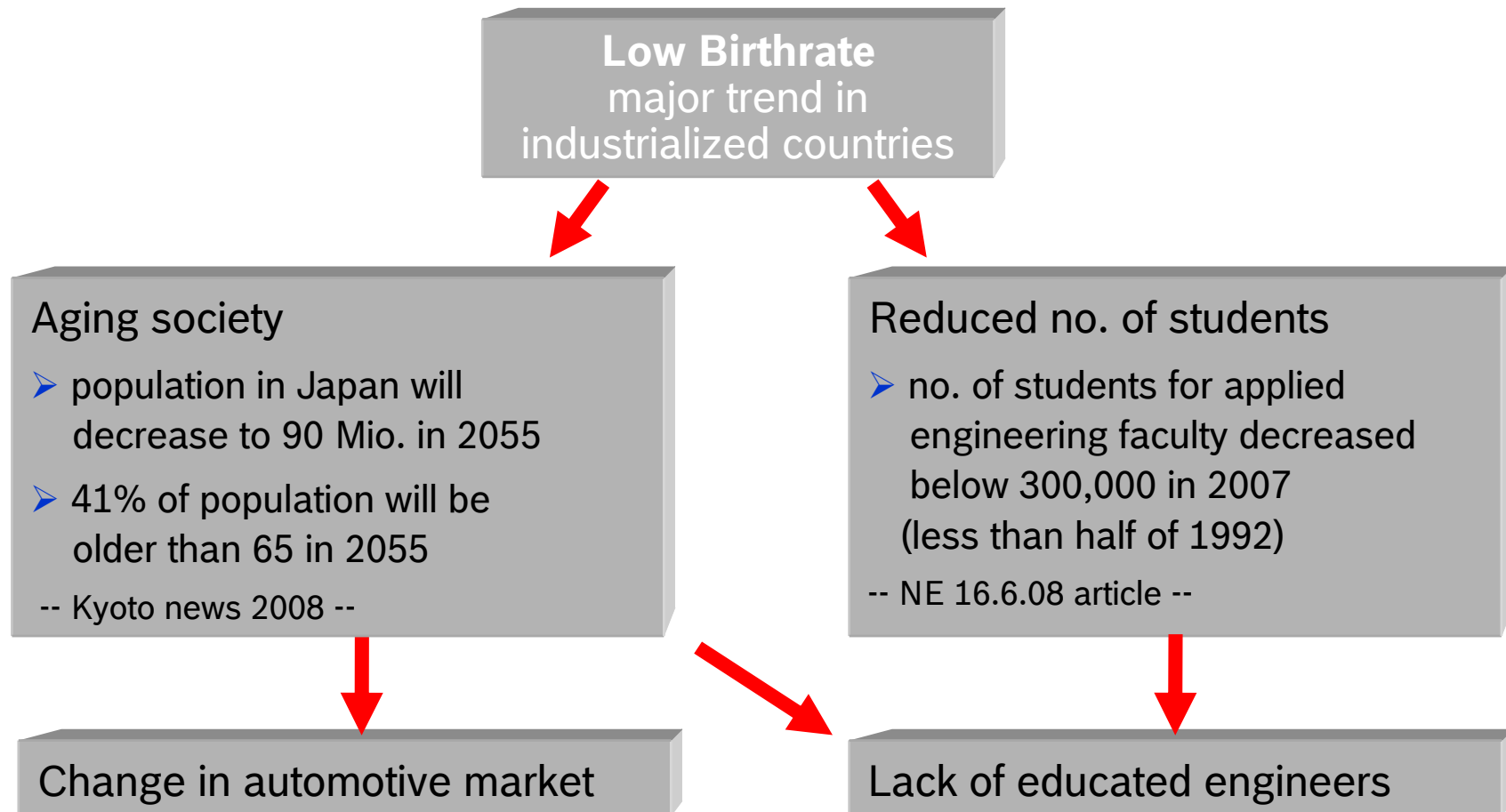


- master complexity
- keep quality & reliability of E/E systems at high level
- enable off shoring
- gain freedom for innovation
- reduce costs

- **Solution:** SW Reuse and Sharing
- **Strategy:** Standardization of SW architecture

# Challenges in Automotive Development

## Industrialized Countries - Shortage of Engineers



# Agenda

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# Architecture Based Development –SW Reuse

## AUTOSAR

- **Architecture - AUTOSAR Basis-SW**
  - ⇒ Uniform behavior of the ECU in the vehicle
  - ⇒ Easier integration of ECU in the vehicle

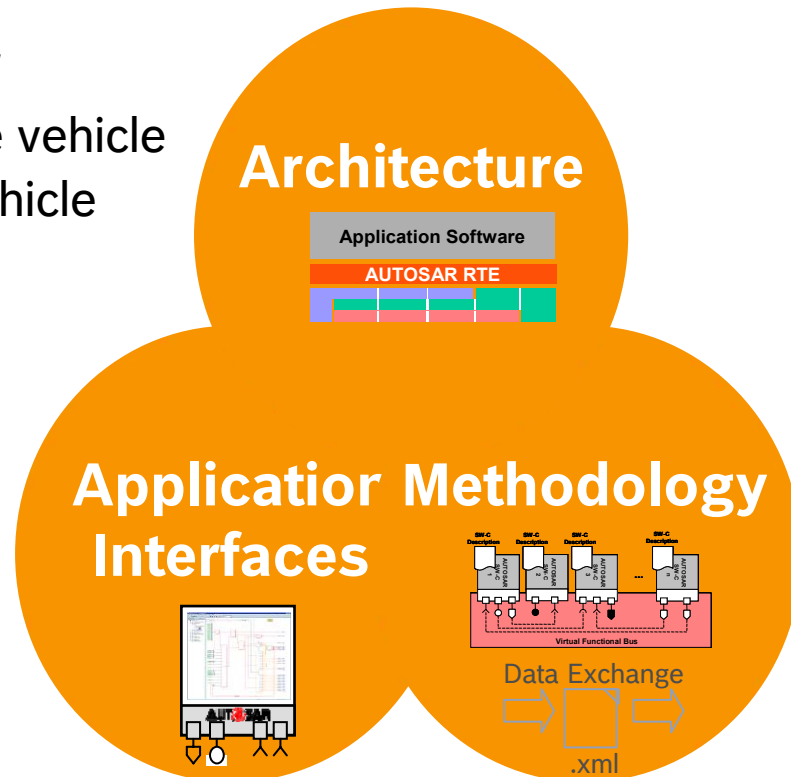
(Mastering complexity)

- **Methodology**

- ⇒ Shift from ECU based to function based SW development

- **Application Interfaces**

- ⇒ Support of SW re-use and SW Sharing between vehicle platforms, OEM and Tier x



Increase of quality and reduced time to market, cost reduction by SW re-use

# Architecture Based Development –SW Reuse

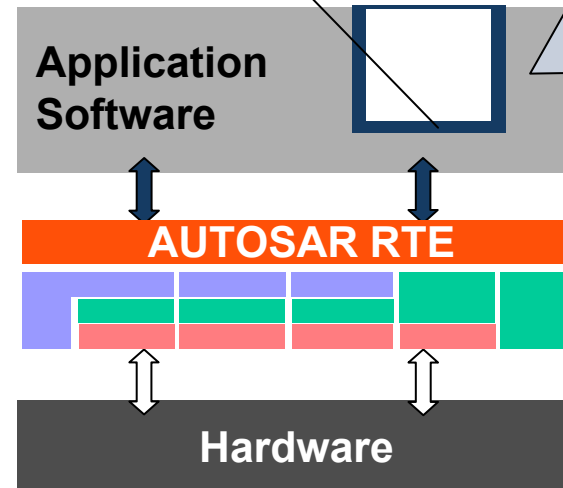
## SW Reuse

→ Pre-condition for integration of application software

- Standardized BSW
  - ▶ AUTOSAR
- Standardized ASW interfaces
  - ▶ AUTOSAR
- Well structured and modular application architecture
  - ▶ e.g. Bosch



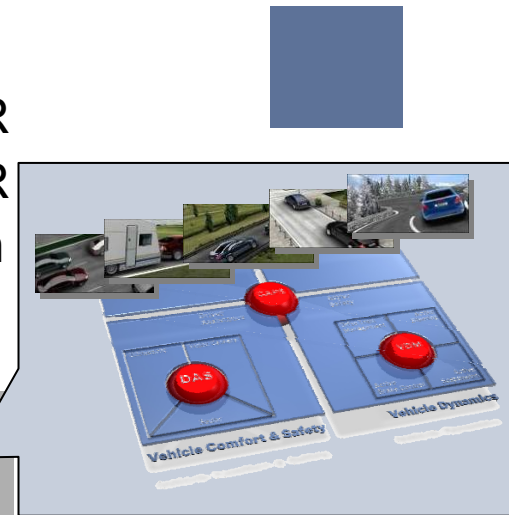
**Conventional**



standardized

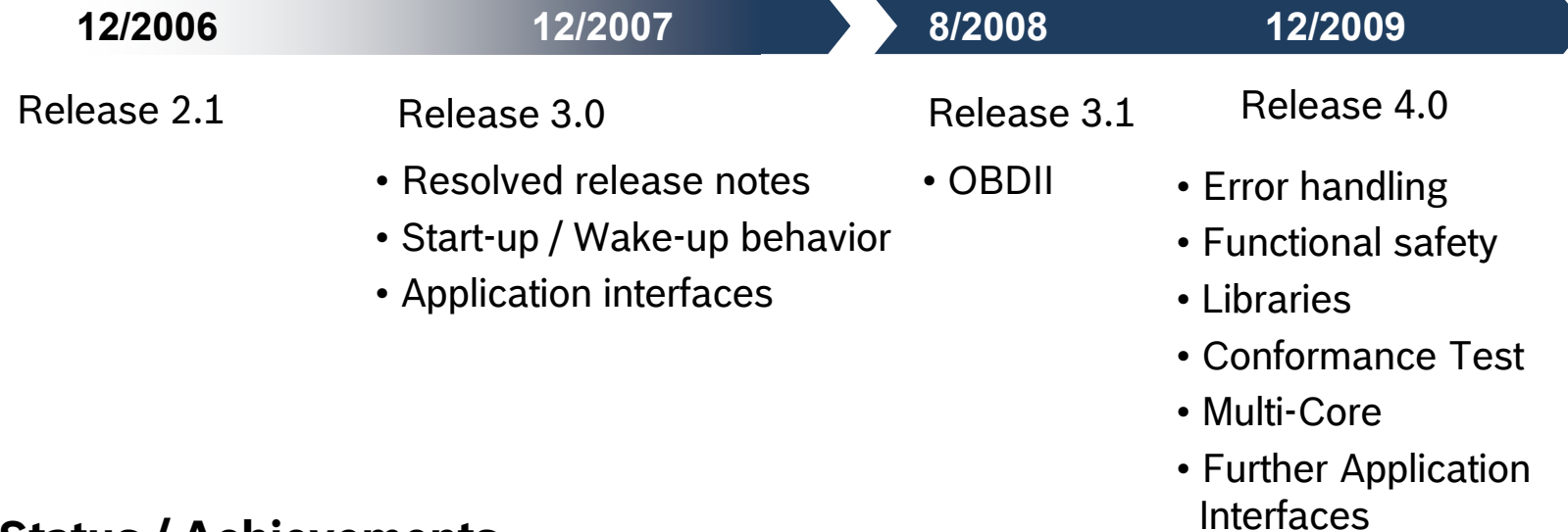
HW-specific

**AUTOSAR**



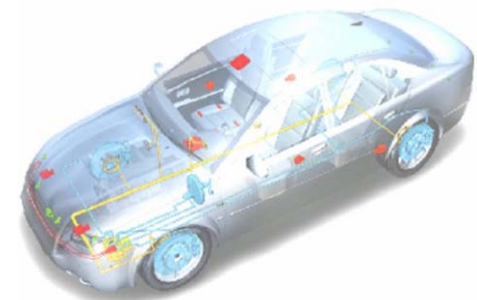
# Architecture Based Development –SW Reuse

## AUTOSAR Roadmap



### Status / Achievements

- AUTOSAR Rel. 3.0 / Rel. 3.1 released
- Product development based on AUTOSAR started at OEM and Tier X



# Processes

## Processed based development

→ Organization processes improvement  
(Capability Maturity Model Integration)



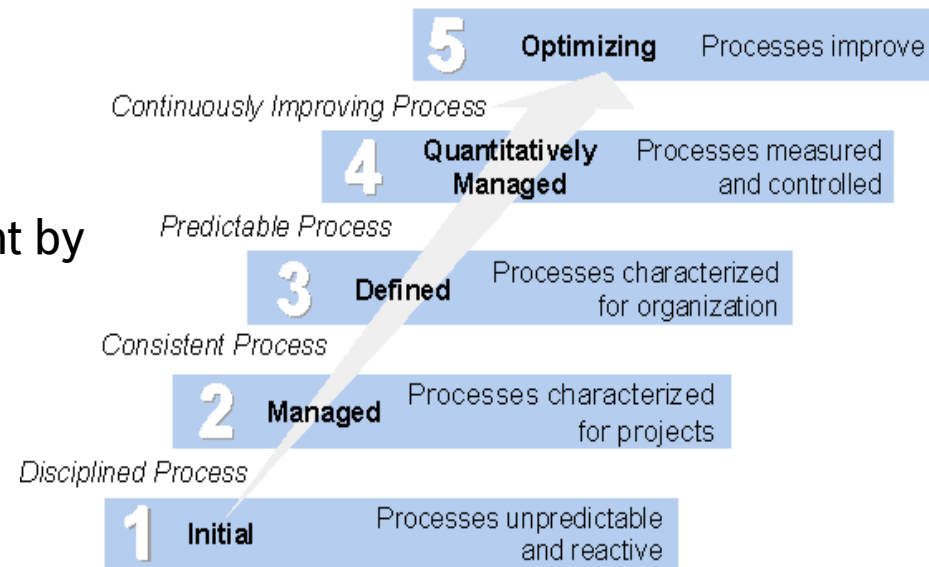
→ Process steps are defined



→ Constant process improvement by

- defined processes
- increased visibility
- traceability

→ Reproducibility





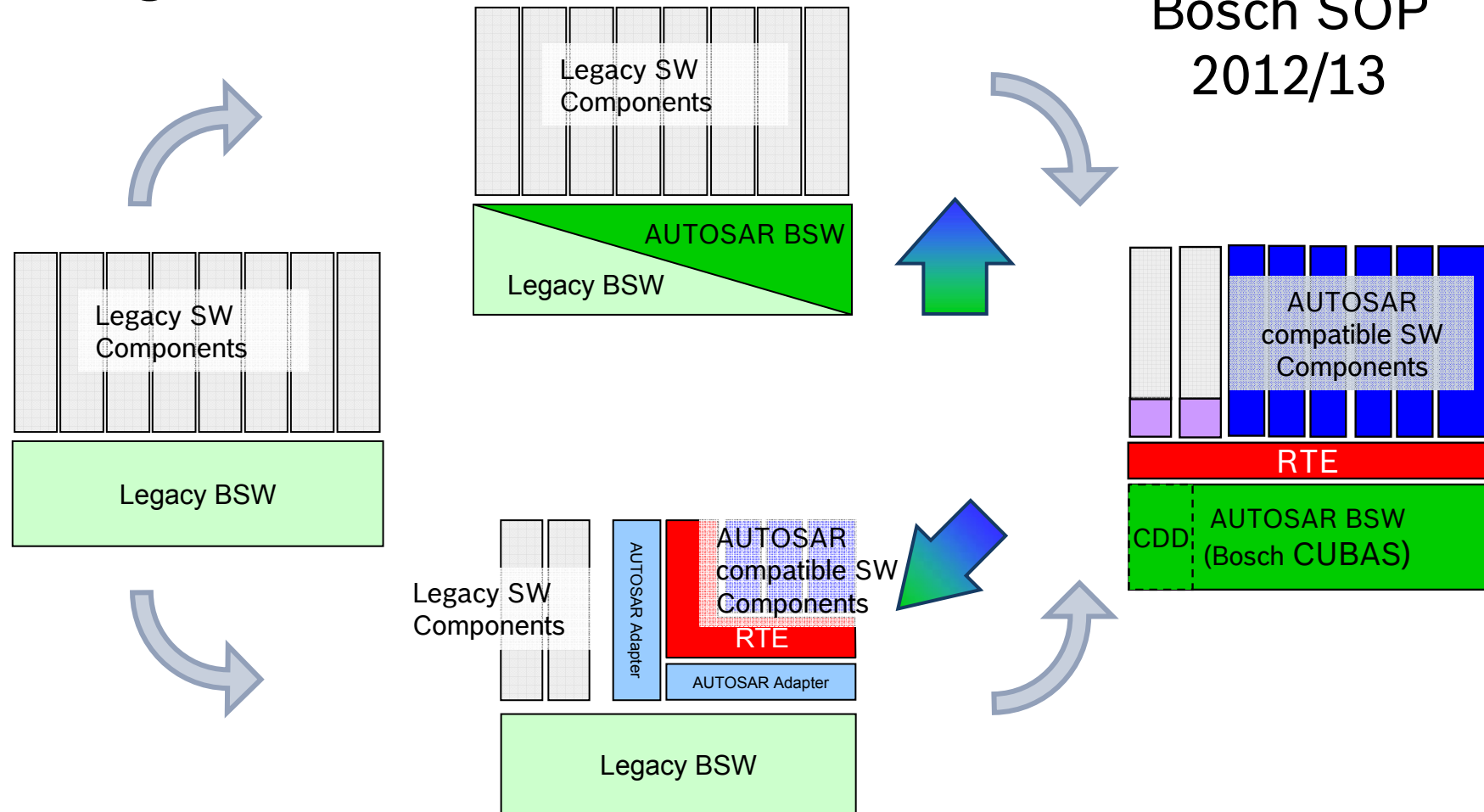
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# Architecture Based Development –SW Reuse

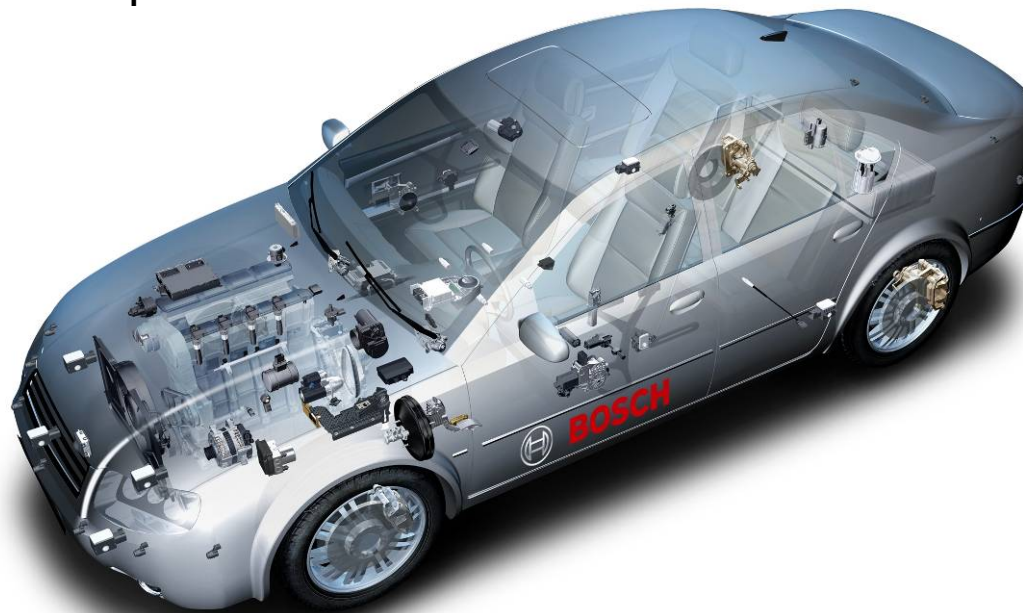
## Migration to AUTOSAR @ Bosch



# Architecture Based Development –SW Reuse

## AUTOSAR – BOSCH Application Plan\*\*

→ All BOSCH divisions are committed to exploit AUTOSAR.



Instrument Cluster  
subset of AUTOSAR  
specs incorporated

SOP 2008

Instrument Cluster  
using AUTOSAR BSW\*

SOP 2012

EDC/ME(D)17 ECU  
using AUTOSAR  
architecture

SOP 2009

FAS  
subset of AUTOSAR  
specs incorporated

SOP 2011

ACC  
subset of AUTOSAR  
specs incorporated

SOP 2009

Body ECU  
using AUTOSAR  
architecture

SOP 2011

Glow Control Unit  
subset of AUTOSAR  
specs incorporated

SOP 2009

Chassis DCU  
using AUTOSAR  
architecture

SOP 2009

ESP  
Using AUTOSAR BSW\*  
& Application Interfaces

SOP 2009

Transmission Control  
Unit using  
AUTOSAR BSW\*

SOP 2010

Airbag ECU  
using AUTOSAR  
architecture

SOP 2010

Automotive Technology

\* CUBAS: Bosch AUTOSAR Basic-SW \*\* selected products



# Processes

## Processes at Bosch

### → Bosch Engineering System (BES)

- Innovation Management
- Product Engineering

- Project Management
- Process Management
- Knowledge Management
- Competence Management

### → Maturity Model of BES is based on CMMI

### → Rollout of CMMI is part of BES: Software quality by design

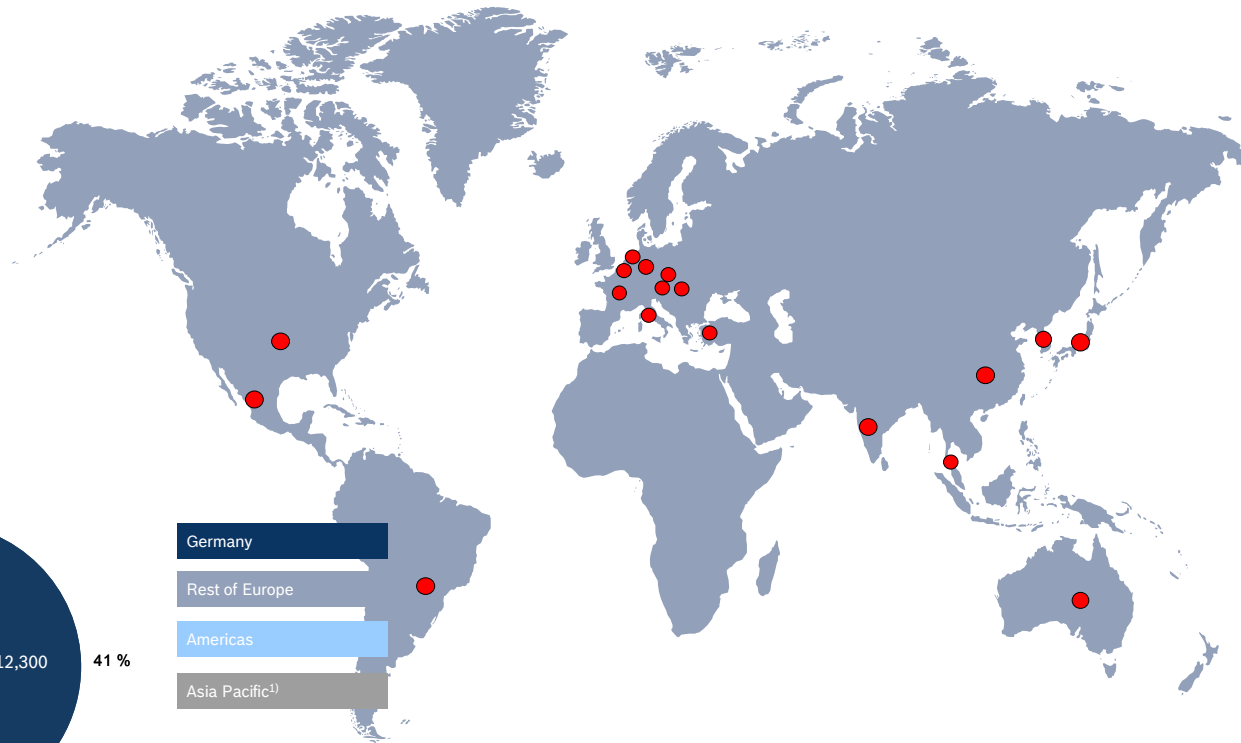
- Coding guidelines according to standards – e.g. MISRA
- Code generation (e.g. via ASCET)
- Quality Methods (e.g. FMEA, Fault-tree, DRBFM, 6-sigma, DOE)

Released man power by process based development used for new innovations



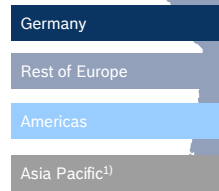
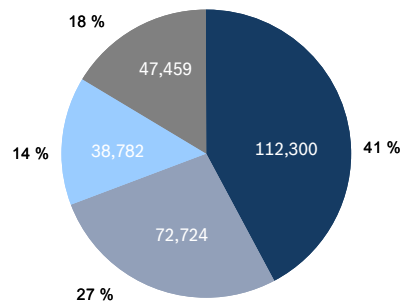
# Human Resources

## 49 Automotive Development Sites in 18 Countries



### Associates

by region



**Total: 271,265**

<sup>1)</sup> Including other countries  
As per January 1, 2008

**Development Sites with ≥ 50 Associates, Status January 2008**

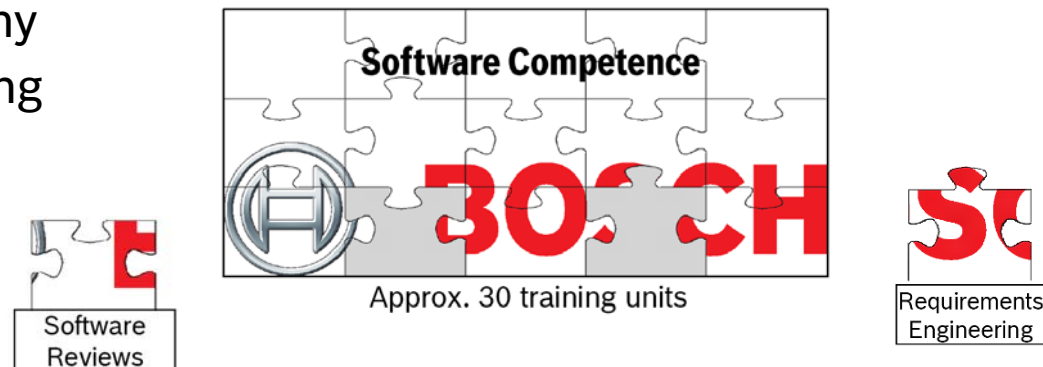
### Automotive Technology



# Human Resources

## Recruiting and Training of Software Engineers

- Engineers from German university
  - reputation of engineering is growing among students
  - many foreign students in Germany (~ 10 %), especially in engineering
- Immigration of engineers from Eastern Europe
- Offshoring – Low barrier due to internationalization of business
- Systematic training of software developers
  - Curriculum Engineering Software Intensive Systems (CMMS)
- Bosch invests in Germany some 100 Mio € in training of its associates



# Human Resources

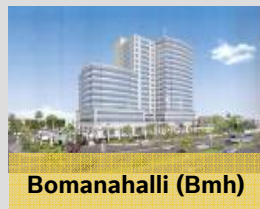
## Offshoring of Development to Bosch India

- 100% subsidiary of Robert Bosch GmbH
- No. of associates: 4500+
- Largest Bosch development centre outside Germany

- CMMI L5 (July 2006), ISO 9001:2000 company
- M2006 start of operation in Coimbatore 300 km southwest of Bangalore

Development locations at India

Marketing offices worldwide



Automotive Technology



# Human Resources

## Embedded Offshore Development at Bosch India

<b>Automotive Prod. - Software and ECU</b>	<b>Industrial Products, Consumer Goods, Building Techn.</b>	<b>Electronic Engineering</b>	<b>Business Services Processes</b>
<ul style="list-style-type: none"> <li>→ Embedded s/w</li> <li>→ Tools</li> <li>→ Diagnostics</li> <li>→ Testing</li> <li>→ h/w &amp; s/w Dev.</li> <li>→ System Dev.</li> <li>→ ECU Projects</li> </ul>	<ul style="list-style-type: none"> <li>→ PLC and CNC prog.</li> <li>→ Engineering frameworks</li> <li>→ Functional Test Bench Solutions</li> <li>→ Plant/Manufacturing Automation Solutions</li> <li>→ Embedded s/w</li> </ul>	<ul style="list-style-type: none"> <li>→ ASIC Design</li> <li>→ IC-Test development</li> <li>→ Board-Level Electronic Design</li> <li>→ PCB Layout Design</li> <li>→ SW development for ASIC and FPGA applications</li> </ul>	<ul style="list-style-type: none"> <li>→ Back office support</li> <li>→ Comm. Center</li> </ul> <b>Translation, Documentation, Web</b> <ul style="list-style-type: none"> <li>→ DE ↔ EN, EN ↔ JP</li> <li>→ Tech. &amp; Commercial</li> <li>→ Digital Archiving</li> <li>→ Web Pages</li> </ul>
<b>Business Solutions</b>	<b>E-Learning</b>	<b>Mechanical Engineering</b>	<b>Shared Services Accounting</b>
<ul style="list-style-type: none"> <li>→ SAP R/3, Consulting</li> <li>→ Oracle, Microsoft</li> <li>→ Java, IBM Solutions</li> <li>→ User Access Mngmnt.</li> <li>→ Data Migration</li> <li>→ Web Solutions</li> <li>→ IT Infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>→ Product info/ 3D animation</li> <li>→ Learning Mgmt.</li> </ul>	<ul style="list-style-type: none"> <li>→ Design</li> <li>→ FEA, Simulations</li> <li>→ Drawings, Modeling</li> <li>→ Administration</li> </ul>	<ul style="list-style-type: none"> <li>→ Accounts Receivable</li> <li>→ Accounts Payable</li> <li>→ General Ledger</li> <li>→ Fixed Assets</li> </ul>

Automotive Technology





## Human Resources

# Offshoring Embedded – Key to Sustainable Success

Strategy - Offshore Support from India/Bangalore

Psychology - Advantage for Engineers and Managers  
To Overcome Fear of Loss: Control/Responsibility/Job!

Commercial - Efficient Interfaces  
Prerequisites are processes and architecture

Communication - Regular Contacts at All Levels

Vision - Competitiveness by Cooperation



# Bosch – Associates

### High-quality training

Every year, more than 6000 young people around the world receive occupational training at Bosch.

### Attracting young talent

Bosch has considerably expanded its activities to attract young talent, especially internationally.

### Support

Apart from attractive development programs for associates, Bosch attaches importance to internal career planning within the framework of its manager development schemes.

### Family and career

Flextime working models, childcare, initiatives for parents, and social work help keep Bosch competitive.

### Demographic change

Bosch values the experience of its older associates, and employs measures specifically designed to support them, while at the same time challenging them.

### Competence management

In Germany alone, Bosch invests some 100 million euros every year in training for its associates. A structured and systematic approach ensures that the skills needed are available in the right place at the right time.

### International presence

In 2007, more than 2,300 specialists and managers were working on long-term assignments outside their home countries.



# Bosch Group

## Bosch Values

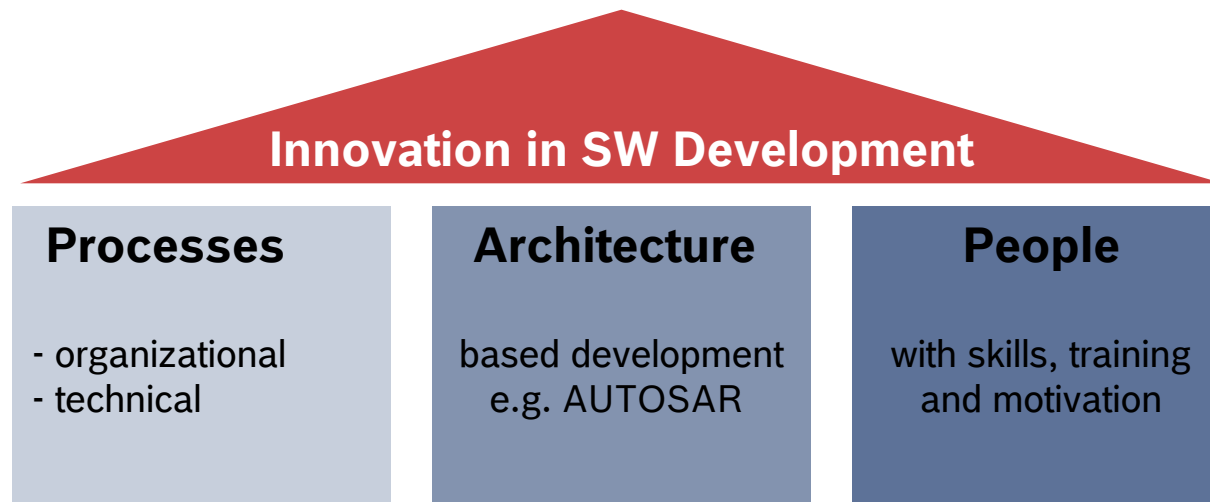
1. Future and Result Focus
2. Responsibility
3. Initiative and Determination
4. Openness and Trust
5. Fairness
6. Reliability, Credibility and Legality
7. Cultural Diversity



# Mastering the Challenges in Embedded Software Development

## Summary

- Mastering the above mentioned challenges is the basis for innovation
- Architecture and process based software development is mandatory for efficient offshoring
- Offshoring reduces the lack in engineers (global development)
- Organization needs to support the climate for innovation



## Thank You

