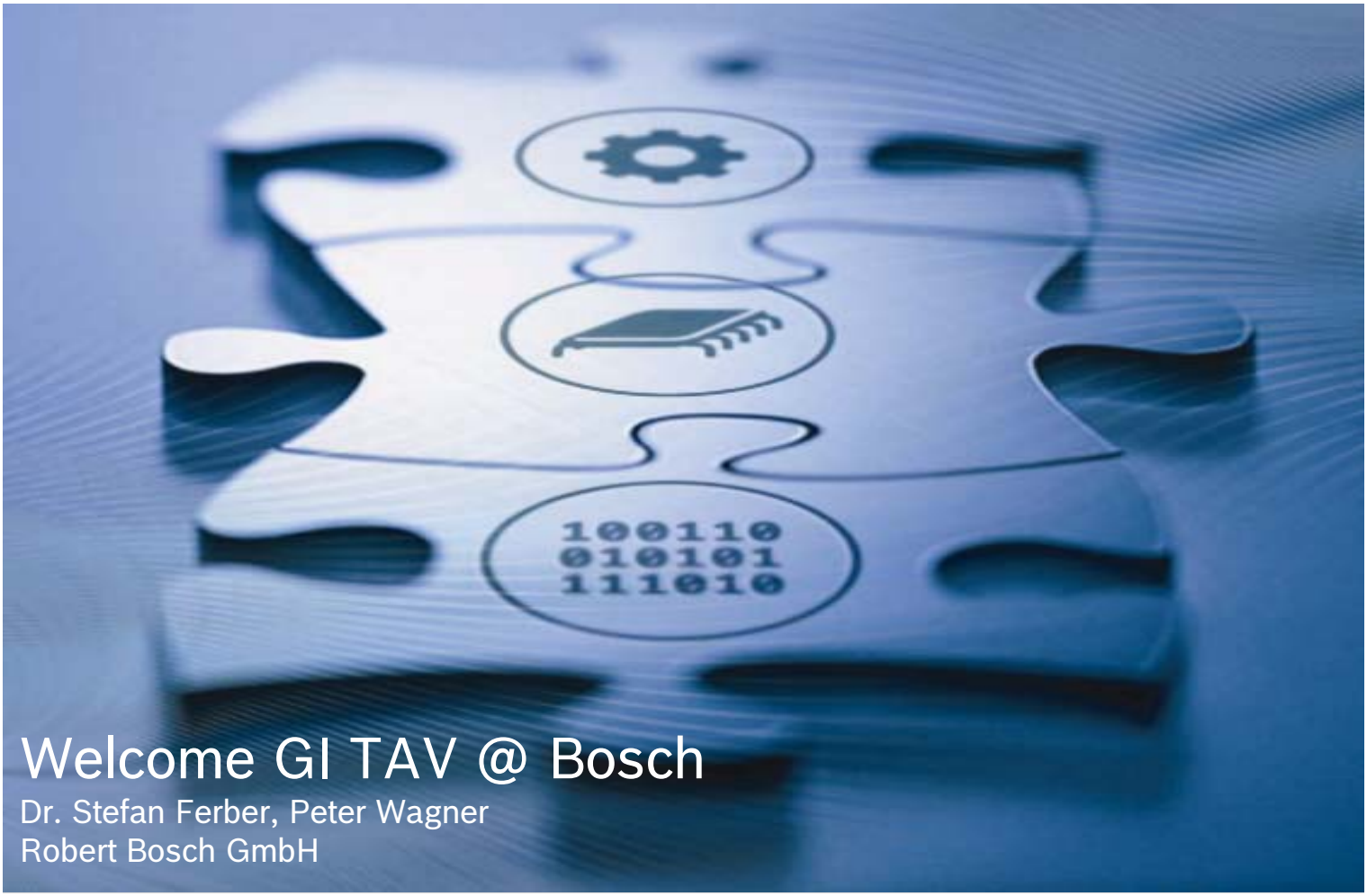


Welcome GI TAV @ Bosch

Dr. Stefan Ferber, Peter Wagner
Robert Bosch GmbH

Agenda (Part 1)

- About Bosch
- About Corporate Research and "Software Intensive Systems"
- Engineering Process Improvement at Bosch
- Challenges
- How we turn the tables (Exemplary Measures)
- Opportunities

BOSCH

Structure of the Bosch Group

Business sectors

Bosch Group
Sales: 43.7 billion euros
Associates on Jan. 1, 2007: 261,300

Automotive Technology [1) 2)]
Sales: 27.2 billion euros

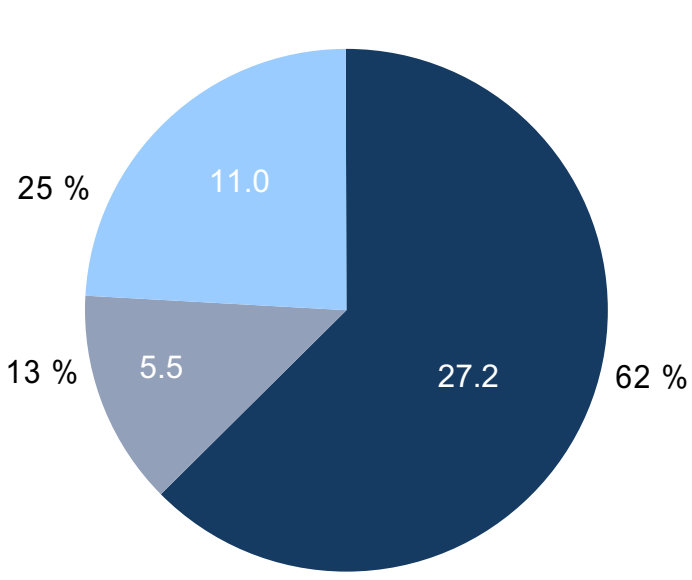
Industrial Technology [1) 2)]
Sales: 5.5 billion euros

Consumer Goods & Building Tech. [1) 2)]
Sales: 11 billion euros

[1)] Temporarily until Annual Press Conference on April 25, 2007 [2)] As per January 31, 2007

Distribution of sales 2006

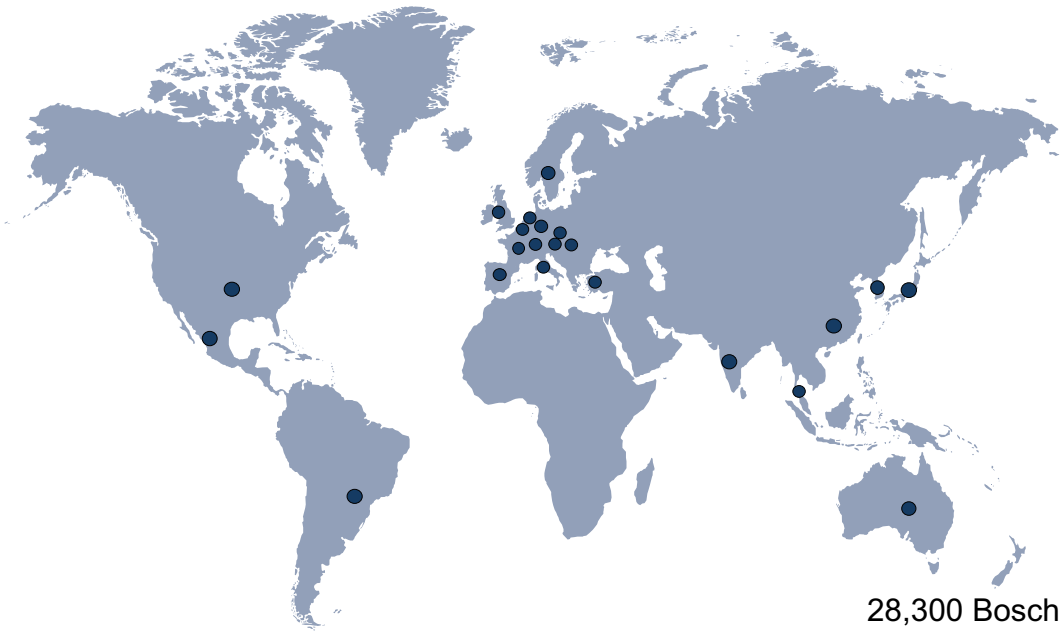
by business sector



Total: 43.7 billion euros

[1)] Temporarily until Annual Press Conference on April 25, 2007 [2)] As per January 31, 2007

Bosch R&D Countries Worldwide



28,300 Bosch R&D Associates
80 R&D Locations Worldwide
with » 50 Associates, Status E.2006

Patents

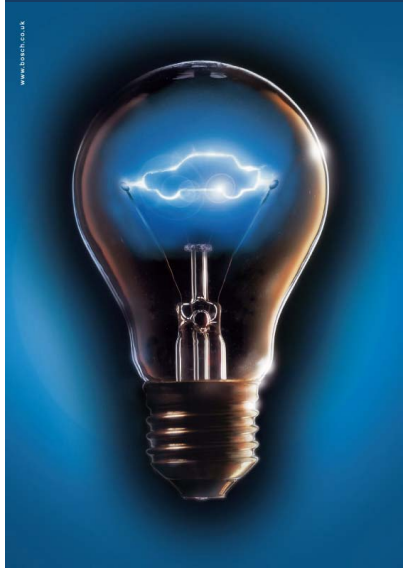
In 2005, Bosch applied for patents for 2,803 new inventions.

In the field of automotive technology, Bosch occupies first place in the major markets:

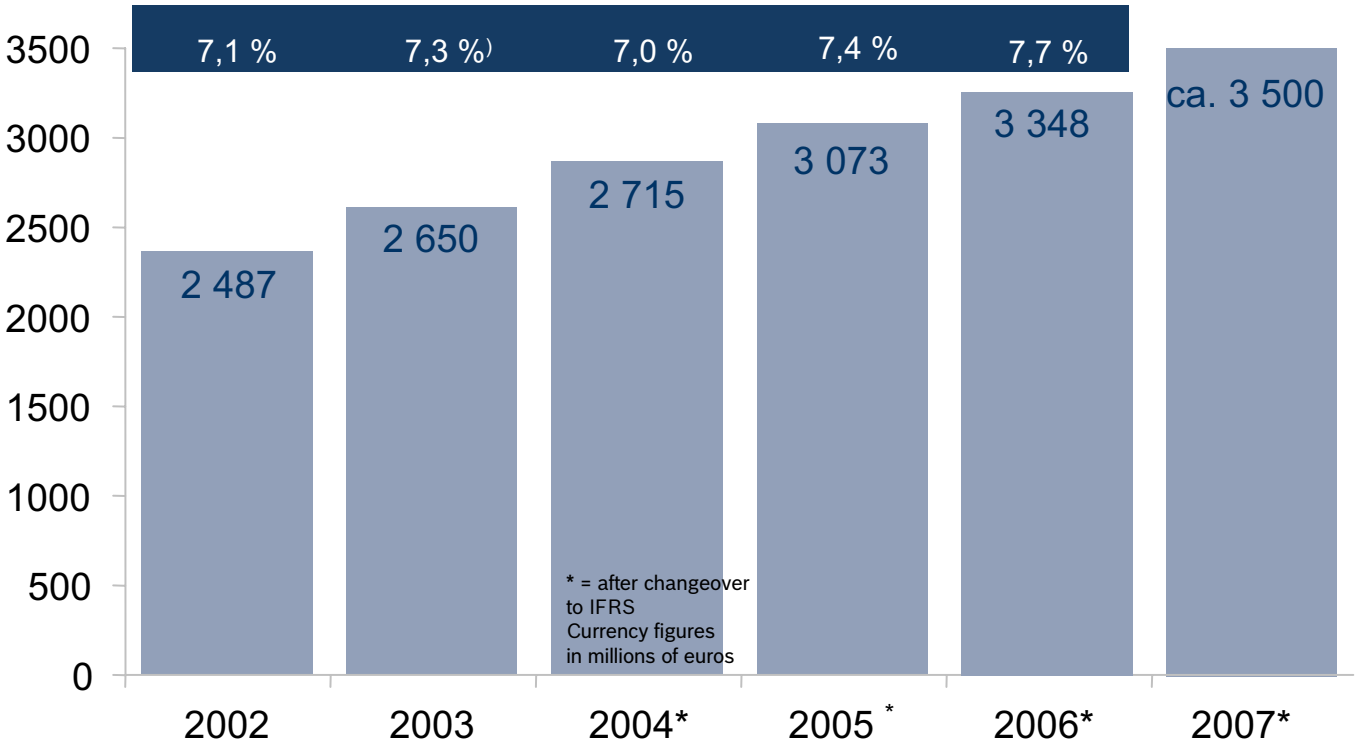
- Germany: 1st place (German Patent and Trademark Office)
- EP: 1st place (European Patent Office)
- U.S.: 1st place (United States Patent and Trademark Office)

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

Bosch patents by the hour × 12 new patents every working day

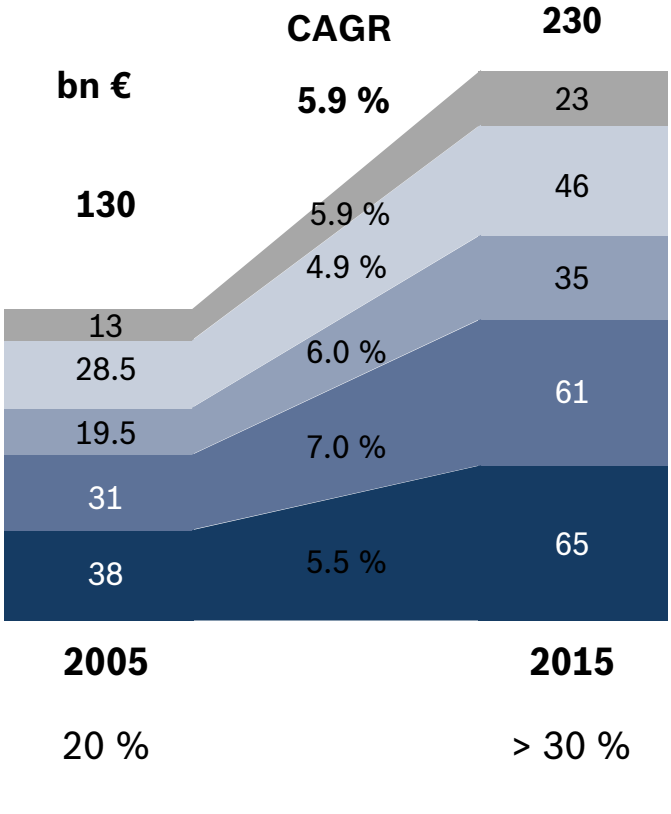


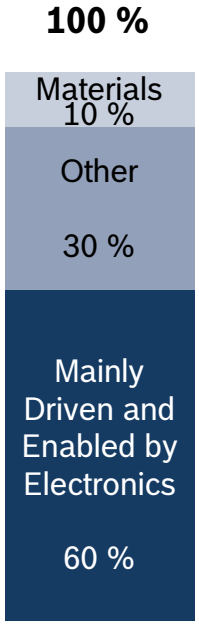
Research and development expenditure



BOSCH

Market Trend: Electronics in Vehicles



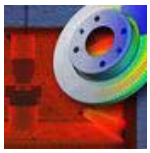


Key Innovations until 2015

Quelle: Mercer, Automotive Electronics, 2006

BOSCH

Corporate Research and Advance Engineering



- Systems of the Future
  - Future Automotive Systems
  - Software Intensive Systems (Embedded Systems)
  - Future Systems for Industrial Technology, Consumer Goods and Building

- Technologies of the future
  - Advanced Functional Materials and Microsystem Technologies
  - Principles and Design of Components for Energy Conversion
  - Metal and Plastics Technology, Production Automation

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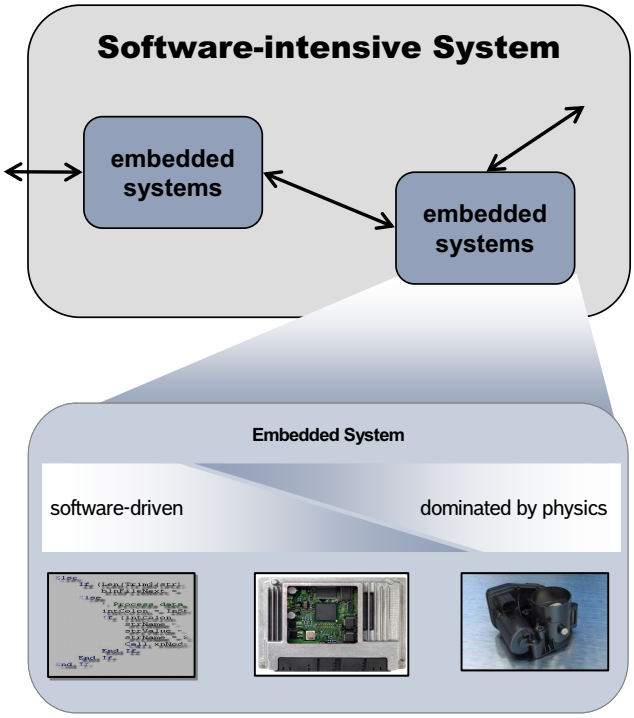
Areas of Competence

- Systems Engineering
- Software Engineering
- Hardware Engineering
- Mechatronic Engineering
- Process Engineering



Embedded Systems:

IT –Systems which are embedded within lager non-IT-Systems

BOSCH

Automotive Electronics in the German Press

„Elektronik macht zu schaffen“

Murks in Germany

Elektronik-Innovationen nicht um jeden Preis

Elektronikfehler im Auto nehmen weiter stark zu

Fahrzeug steht, Kunde läuft

Durch digitale Steuersysteme wurden Autos sauberer, sicherer und komfortabler – doch inzwischen ist die Elektronik auch Pannenursache Nummer eins. Mit einer gemeinsamen

Elektronik macht Autos anfälliger

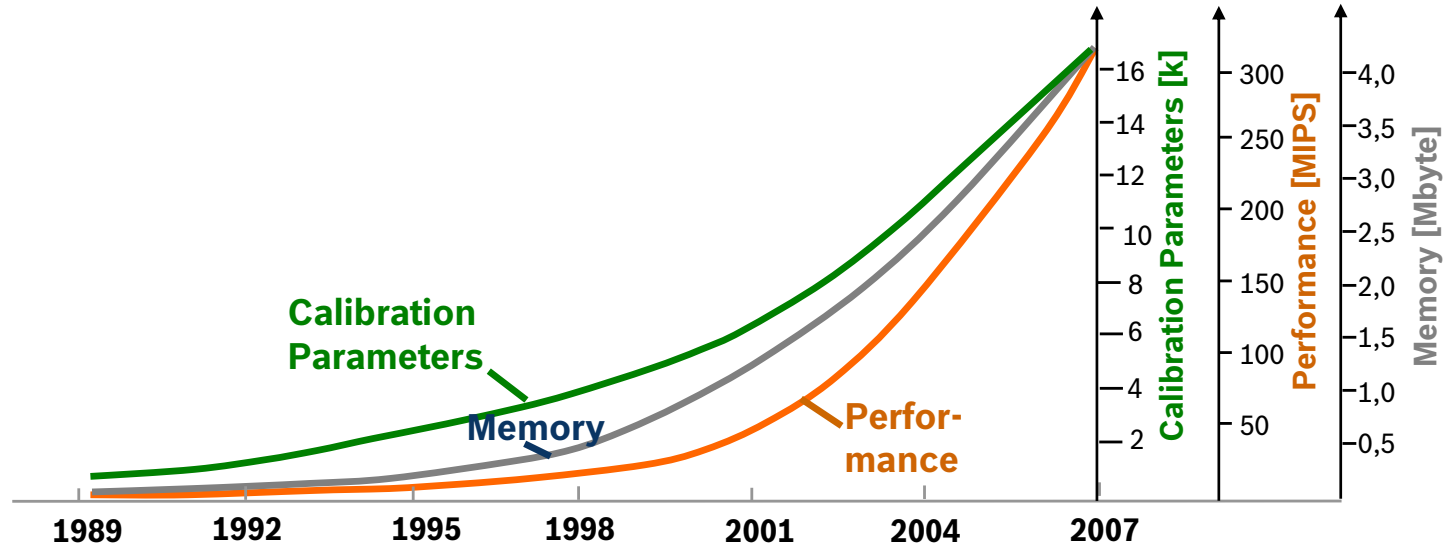
Autohersteller stecken in der Elektronikfalle

Rückruf-Aktionen auf Rekordniveau – Pannenanfälligkeit steigt mit zunehmender Komplexität

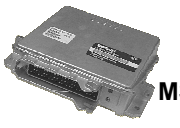
Automobil: Programmierungs-Problematik ist Ursache für drei Viertel aller Elektronikausfälle

Software ist im Auto ein Knackpunkt

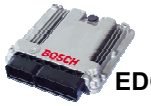
Complexity growth (Diesel Systems)




MSA6


MSA11


EDC15


EDC16


EDC17

Source: Bosch Diesel Systems 2007; DS/PJ-EER; EEH0_07_024

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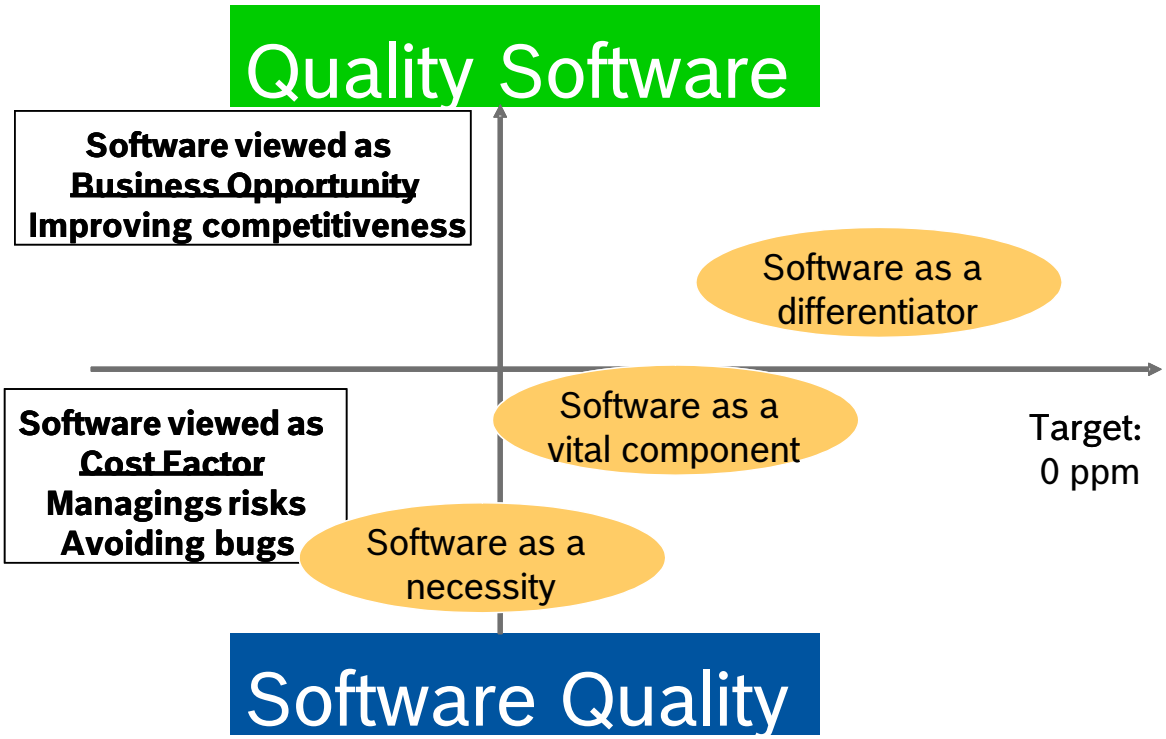
Bosch Initiative for Software-Intensive Systems (BISS)



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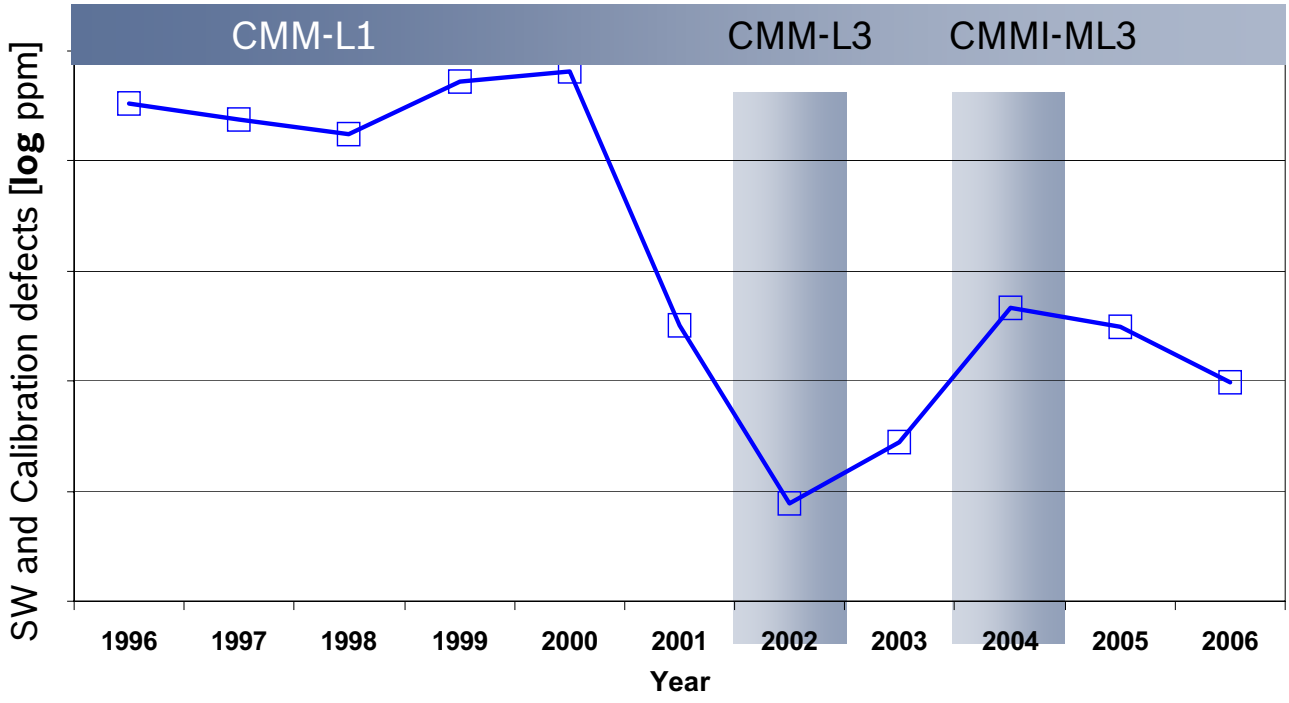
0-km Complaints / SW Engineering Maturity Level



Source: Bosch Conference on Software Engineering 2007; Siegfried Dais, Deputy Chairman

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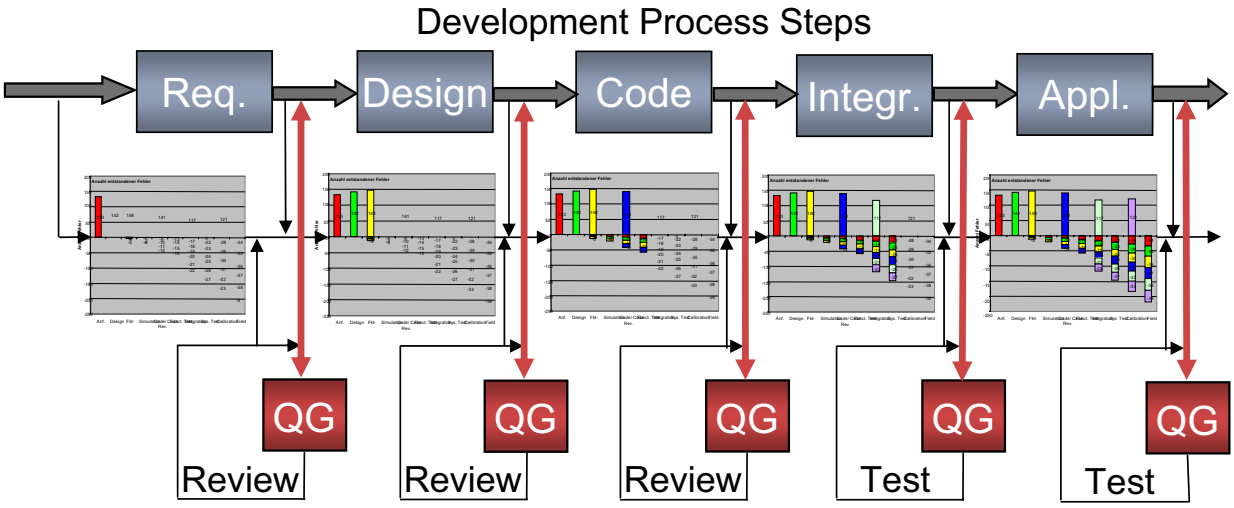
Defect Flow Model



DFM: Defect Flow Model
QG: Quality Gate

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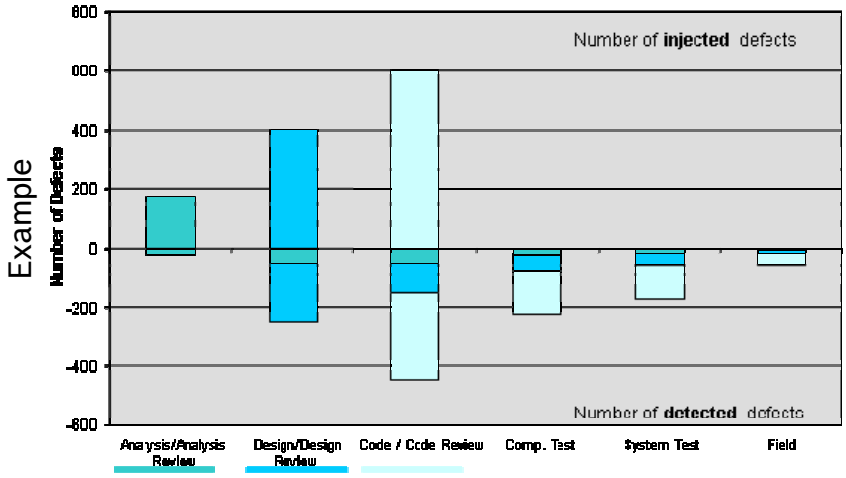
Defect Flow Model

Goal:

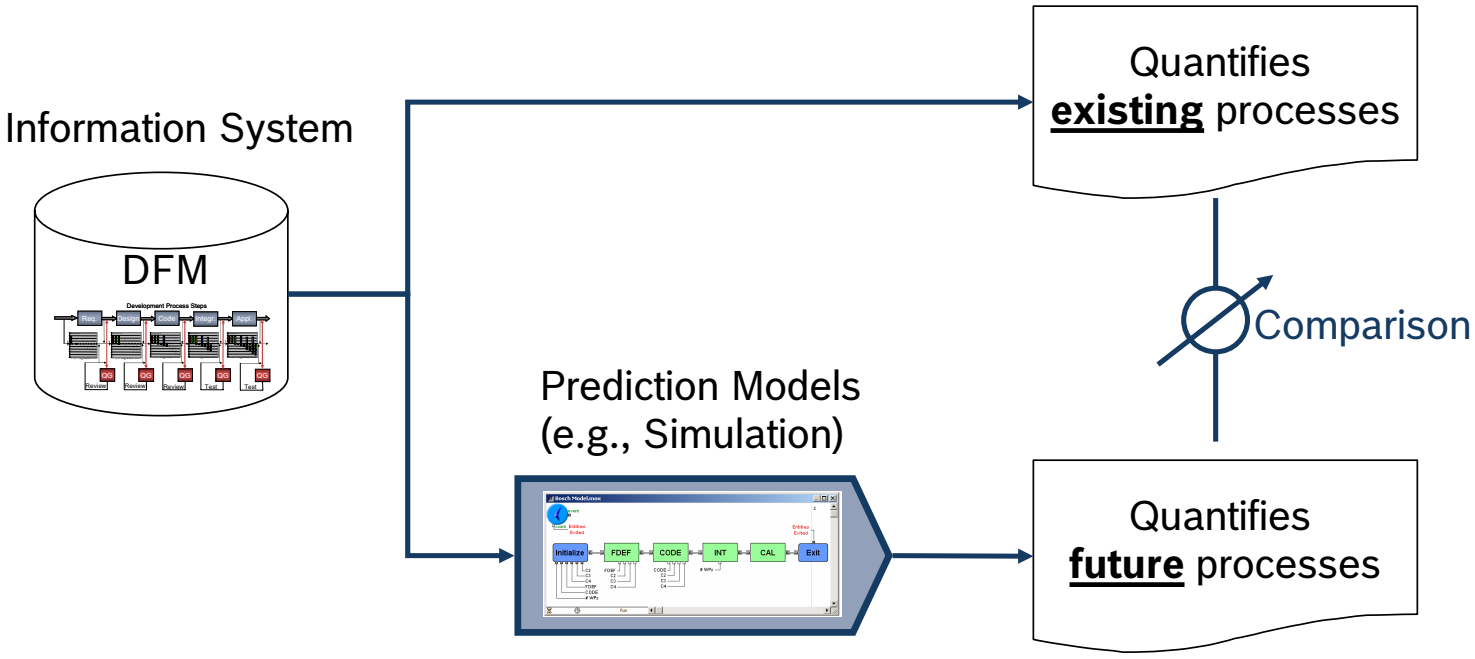
Support the derivation of improvement activities by providing transparency



- Quantitative feedback to development process, quality (V&V) measures, products
- Identification of defect sources and sinks, defect accumulation and causes
- Information about effectiveness and efficiency of quality measures

- Derivation and prioritization of improvement activities
- Evaluation of process changes and improvement measures
- Provision of data for statistical process control

From Measurement to Managerial Decision Making



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Opportunitiy Examples

Quality

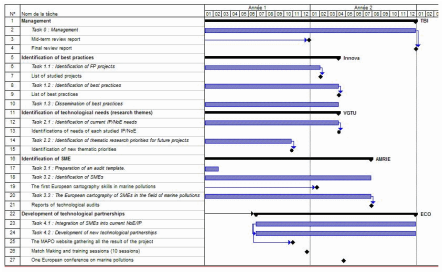
- **Fail-safe, robust systems with capable services**
- **Enhanced end-user benefit by remote services for diagnostics, maintenance and updates**

Cost

- **Reliable and predictable project planning and execution with OEM**
- **Efficient global systems engineering projects**

Functionality

- **Prompt and reliable integration of modern „everyday devices“**
- **Take proactive advantage of IT trends (e.g. in the consumer electronics market)**



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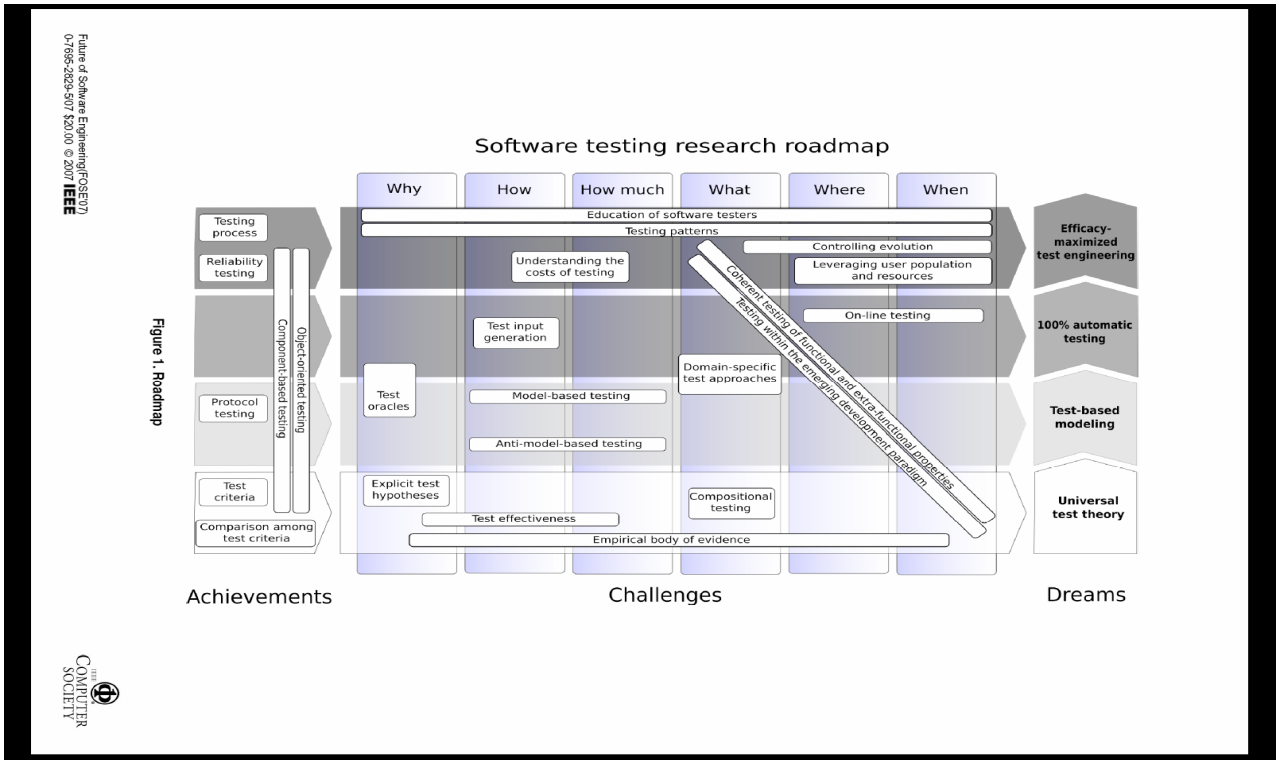
Summary Part 1

- **Broad-based Process Engineering for software intesive Systems**
  - Institutionalization within Bosch after Initiative
- **Quantitative Management**
  - Defect Flow Model, Process Simulation
- **Challenges turned to Opportunities**
  - Quality, Cost, Functionality for Products, Services

Agenda (Teil 2)

- Softwaretest `global`
- Herausforderungen SW Test bei Bosch
- Aktuelle Testthemen
- Externe und interne Aktivitäten
- Ausblick

Softwaretest `global´



Quelle: ICSE 2007 Antonia Bertolino: Achievement, Challenges, Dreams

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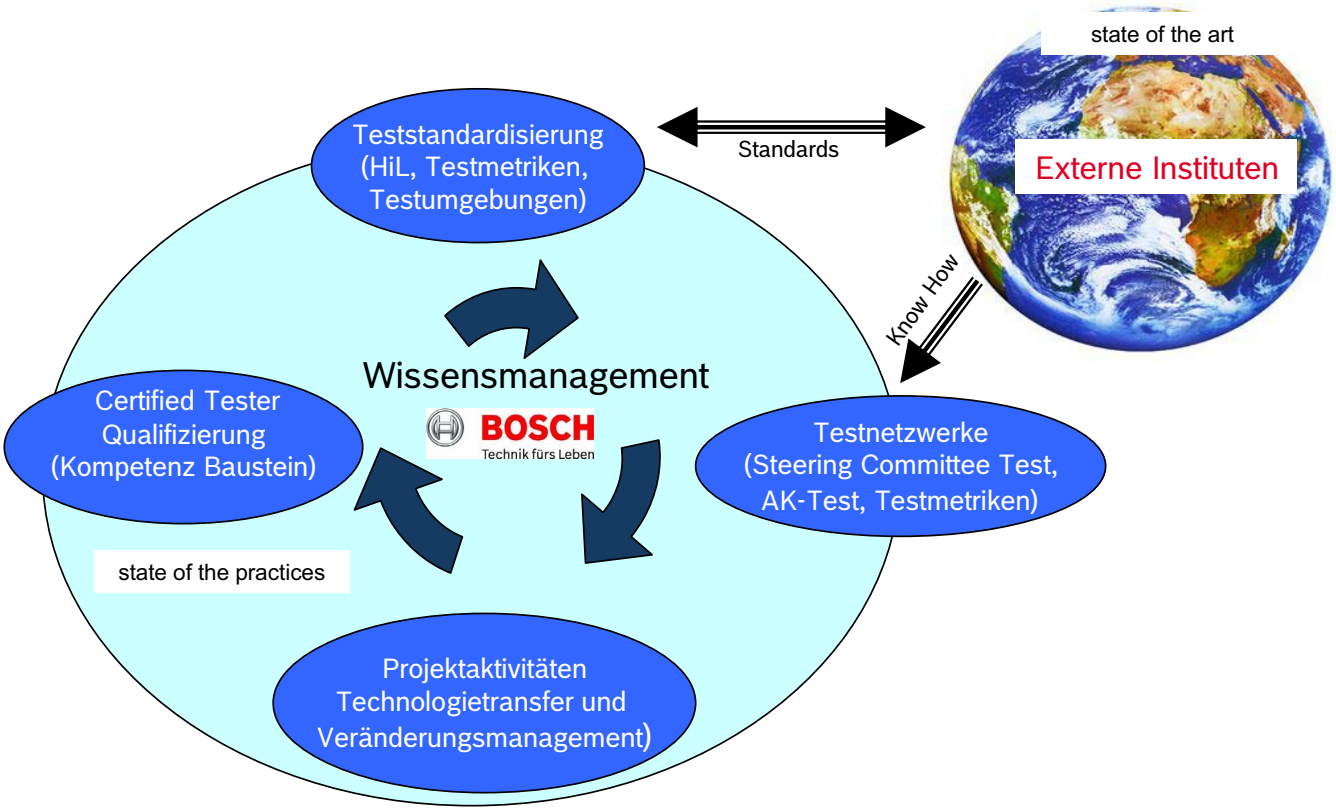
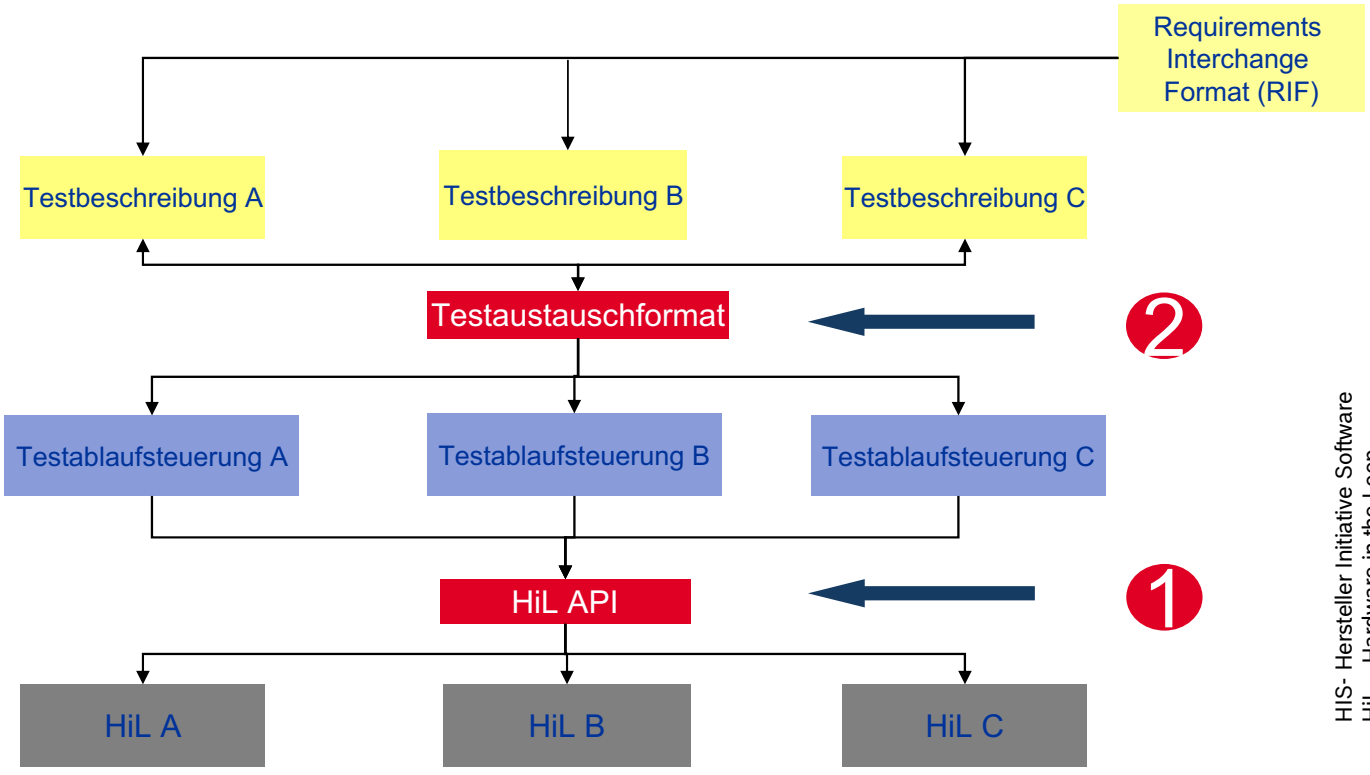
Herausforderungen SW-Test bei Bosch

- Qualitätsziele erreichen (<10 ppm)
- Testprozesse beherrschen (Reifegrad Level3; -> CMMi, automotivSPICE, TPI und Life Cycles)
- Testaufwand reduzieren (unter 50% anteilig der Entwicklungskosten)
- Standardisierung vorantreiben (ASAM, Testmetriken, ...)
- Erfahrungen austauschen (Synergie)
- neue Prüftechnologien einführen (adaptiert auf ´embedded systems`)
- integrierte Entwicklungs- und Testumgebung entwickeln (Test global)
- Testerqualifizierung stärker ausbauen (´Certified SW-Tester´, Embedded Tester, HW-Tester)
- Entwicklungsstandorte weltweit vernetzen (Aufbau von Testzentren, ...)

Aktuelle Testthemen



HiL AG: Harmonisierung von Schnittstellen



HIS- Hersteller Initiative Software
HiL – Hardware in the Loop
API – Application program interface
AG -Arbeitsgruppe

Quelle: HiL AG

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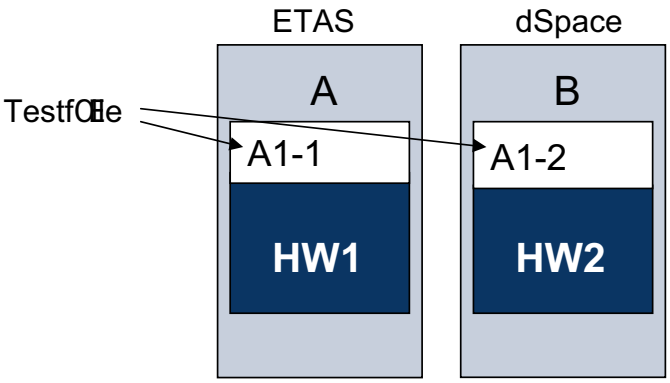
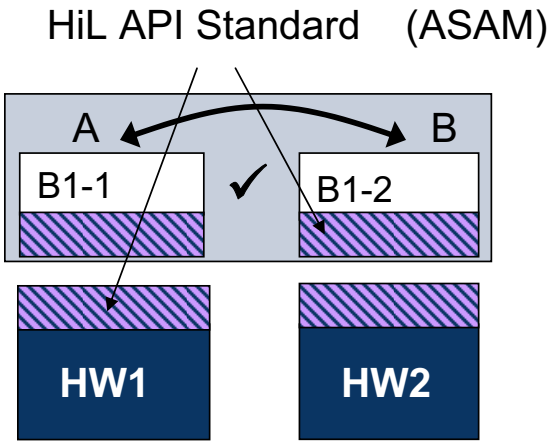
Trennung von Test-HW und SW durch standardisierte APIs





-Testfälle tool- und HW-abhängig
- kaum Reuse der Testfälle
- Kombination „beste“ Test-SW mit der „besten“ HW nicht möglich

- Freiere Kombinierbarkeit von HW und SW
- Testfälle Reuse
- Einsatz einer einheitlichen Test-SW auch auf bestehender Test-HW
- Vereinfachter Wechsel der Test-HW

Weiterer Schritt: standardisiertes Testaustauschformat zu definieren

Quelle: HiL AG

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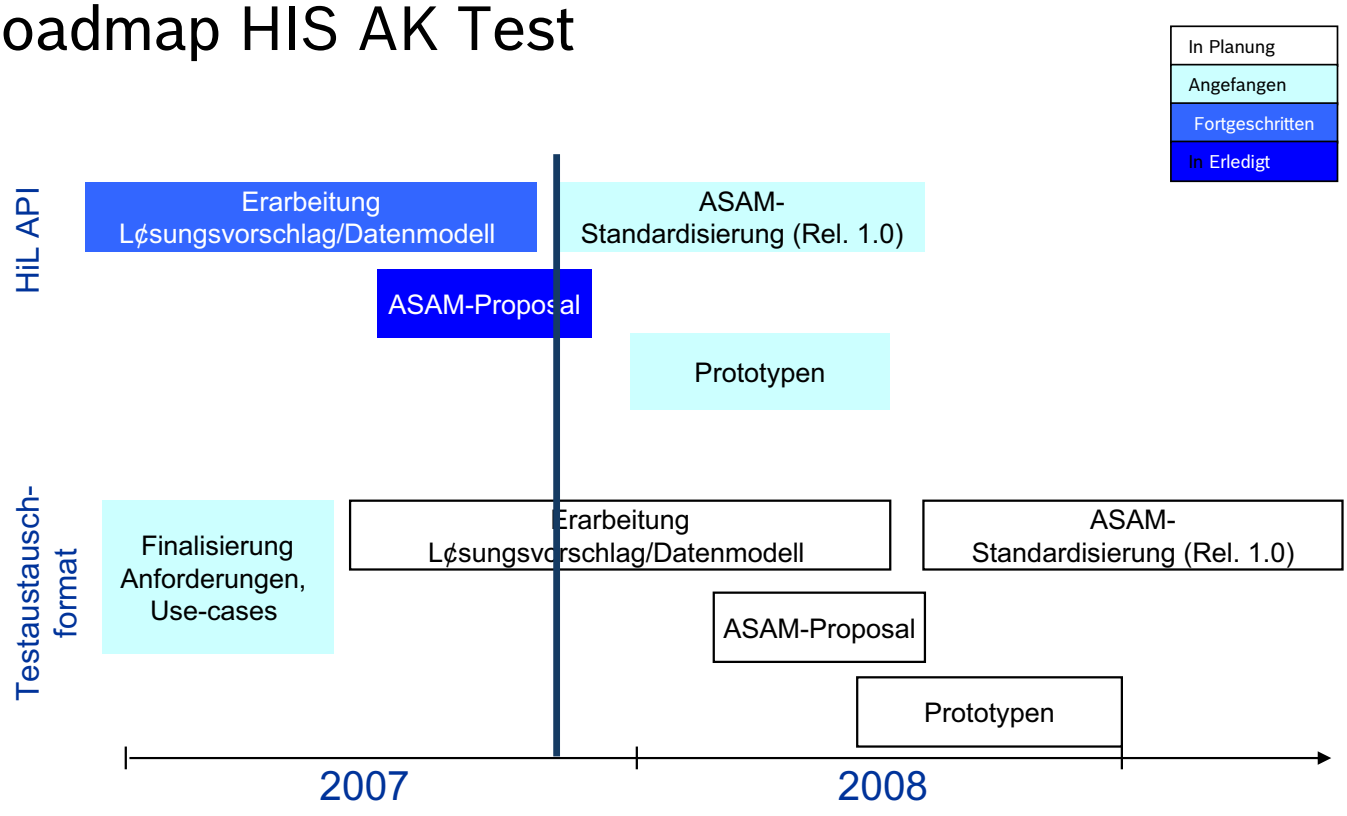
Roadmap HIS AK Test



Quelle: HIS AK Test

Standardisierung der Testmetriken

- Bunte Vielfalt von Testmetriken sogar innerhalb der Produktbereichen
- Gründung interner Steuerkreis
- Ziel: weinige, einheitliche, Kunden orientierte Testmetriken zu definieren drei Klassen sind ausgewählt:
  - Testfortschritt (Termin)
  - Testabdeckung (Testmanagement)
  - Restfehlerrate (Kosten)
- sehr unterschiedliche Sichten je Produktbereich
- Konsolidierung nach ´state of the art´
- Datenerfassung weitgehend automatisieren

Qualifizierung Certfied Tester

ISTQB Certified Tester Foundation Level

Bei Bosch 2007:
Foundation Level: implementiert

Ab 2008:
Advanced Level - Test Manager
Advanced Level - Functional Tester
Advanced Level - Technical Tester
Advanced Level (CTAL) - Full Advanced Level
(nach Bestehen der o.a. Teilprüfungen Advanced Level)

Expert Level - in Vorbereitung

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Ausblick

- Test-, Fehler- und Risikomanagement miteinander verbinden
- Unterstützung der Testprojektleiter bei der Planung (Aufwand, Methoden, Tools, ...)
- Testkosten reduzieren durch Teststandards, wieder verwendbare Testfälle, höhere Testtiefe, Risikominderung, ...
- durch stärkere OEM Kontakte wesentlich bessere Testanforderungen spezifizieren (HIS AK Test)
- Base lining der Testprozesse durch TPI-Assessment und gezielte Verbesserungen vorantreiben
- ‚state of the art' im Testbereich sichern
- Bosch interne Qualifizierung der Tester ausbauen
- Unterstützung Testzentren weltweit (Test global)

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