Inventing the Automotive Future

Berthold Hellenthal
Competence Center Electronics & Semiconductor
Audi Semiconductor Strategy
Progressive Semiconductor Program (PSCP)
Audi AG

B. Hellenthal, Audi AG, Competence Center Electronics & Semiconductors, Progressive SemiConductor Program – PSCP
SEMICON Korea 2016, Seoul, January 27th, 2016
The next era of automotive innovation is already here

The era of Cloud, Data and Business Model Innovation

1900 1970 1990 2010 today

Era of mechanics
Era of Electronics
Era of Software / Networking
Era of Cloud / Data / Business Model

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Automotive Electronic Megatrends

- Lighting technology
- Infotainment
- Audi connect
- Controls & displays
- Piloted driving
- Electric mobility
- Electronic Architecture

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Megatrends in Automotive Electronics
Automotive Electronic Megatrends

Lighting technology

Infotainment

Audi connect

Controls & displays

Piloted driving

Electric mobility

Electronic Architecture

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Infotainment
Modular infotainment platform (MIB)

Concept
- Multimedia Module (MMX)
- Radio & Car Control Unit (RCC)

Supplier structure
- Tier 1

Innovations:
- HMI
- Navigation
- Phone
- Connectivity
- Media
- Radio
- Amplifier
- Power management
- Car functions
- Diagnostics

e.solutions
- Google
- Nuance
- QNX
- Bosch

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**Infotainment**
Processing power updated annually

<table>
<thead>
<tr>
<th>Year</th>
<th>MIB1</th>
<th>MIB2</th>
<th>MIB2+</th>
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<tr>
<td>2012</td>
<td>~4,000 DMIPS&lt;br&gt;node 65 nm</td>
<td>~8,000 DMIPS&lt;br&gt;node 40 nm</td>
<td>~12,000 DMIPS&lt;br&gt;node 28 nm</td>
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<tr>
<td>2014</td>
<td>~</td>
<td>~</td>
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<tr>
<td>2015</td>
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<tr>
<td>2017</td>
<td>~</td>
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</tbody>
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Modular infotainment platform and technology network enables innovation cycles like in the consumer industry

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Over the last decade, the vehicle has become totally connected within itself.
This decade, it is being connected seamlessly with customers, the infrastructure and other vehicles.

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Audi connect
Car2x communication & swarm intelligence

Navigation map online
Cloud architecture
IT backend
Piloted driving

Local hazard info
Connected ACC
Mobile key
Parking & navigating

New innovative customer functions by connecting the vehicle with the infrastructure and other vehicles.

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German premium OEMs are joining forces to build a high-definition map as a strategic asset for future applications.
Infotainment & Audi connect
Shortened innovation cycles

- **Shortened innovation cycles** closed to consumer industry
- Increasing demand to use technologies from the consumer world
- Time gap to consumer is getting shorter and shorter
- **Reduced “comfort zone”** for automotive applications

Early adoption of new technologies in Automotive to enable new customer functions

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**Infotainment & Audi connect**

**Semiconductor challenges and trends**

- **Development trends of Audi infotainment and connect systems using**
  - Modular hardware platforms: Enable fast innovation cycles
  - Process evolution: More Moore – use leading edge technology nodes
  - RF integration: 3G: UMTS, 4G: LTE advanced, 5G

- **Key challenges**
  - Speed - accelerate innovation cycles
  - Quality - at high speed with new technologies
  - Build and maintain a strong technology network and support

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Controls & displays
The new Audi A4

The A4 again defines the benchmark in the segment.

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Innovative technologies of the digitalization shape the driver experience of the future.

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The Audi e-tron quattro concept is the focal point of Audi’s future technologies.

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Megatrend: Control & displays
HMI challenges and trends

- Continuous new technologies enable new customer HMI experience
  - OLED displays: provide new design options
  - Flexible displays: enable fully integrated HMI
  - Touch & gesture recognition: offers new HMI experience
  - Natural speech command: allows seamless human interface

- Key challenges
  - New materials
  - Reliability - high temperature stability, lifetime performance
  - Integration of consumer technologies in automotive applications

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Piloted driving

Recognizing surrounding environment

Further development of sensors (functions, performance) enables 3D 360° recognition of the surrounding environment.
Piloted driving
Central FAS control unit

**Benefits:**
- High integration of multiple control units
- Modular architecture (application and hardware decoupled)
- Modular possibility of adding functions
- Significantly improved recognition of the vehicle’s surroundings through fusion of sensor data
- Information is available to all FAS functions

Integrated functional architecture
**Piloted driving**
**Semiconductor challenges and trends**

- **Development trends of piloted driving applications**
  - Higher integration level: more performance on less space
  - System solutions: system integration on package level
  - New memory solutions: 3D memory, i.e. Hybrid Memory Cube (HMC), HSM/HBM, V-NAND, alternative memory technologies – MRAM, ReRAM, PCRAM

- **Key challenges**
  - Higher performance & reliable over lifetime
  - System cost reduction
  - New players with new responsibilities – ISO 26262, …
  - New challenges for failure analysis

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Piloted driving
Audi milestones

- **2009**
  - Salt Lake, Utah

- **2012**
  - Nevada

- **January 2015**
  - 900 km
  - California - Nevada

- **April 2015**
  - Federal Ministry Dobrindt at BAB 9 Highway

- **July 2015**
  - Sonoma Raceway

- **2010**
  - Pikes Peak, Colorado

- **2014**
  - RS7 piloted driving Hockenheim

- **March 2015**
  - Audi SQ5
  - US West to East Coast

- **May 2015**
  - Shanghai Urban traffic
80%

The core of all innovations: semiconductors

#drivenbyVorsprung

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Audi comprehensive semiconductor strategy
Audi Progressive SemiConductor Program (PSCP)

Audi Progressive SemiConductor Program (PSCP)

Demands on semiconductors and their application

Prelaunch, Launch, Application, Lifetime support

On time, Competence, Communication, Innovation, Quality

Partnership with semiconductor manufacturer at eye level

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The effective project environment
Solution Space – Tension Triangle

... only synergy enables new potentials

Semiconductor manufacturer

Tier 1

New Partner: semiconductor manufacturer

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Electric/electronic supply chain collaboration
yesterday/today

SC manufacturer

Tier 1

Semiconductor specification

ECU & function specification

Car manufacturer

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Electric/electronic supply chain collaboration
today/tomorrow

SC manufacturer

Semiconductor specification

Tier 1

Semiconductor specification

ECU & function specification

Car manufacturer

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Vorsprung durch Technik

AUDI Progressive SemiConductor Program - PSCP

Innovation Mining

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**Push – Pull Strategy**

**Definition**

![Diagram of Push vs. Pull Strategy]

- **Technology push**
  - Research & Development → Production → Marketing → Need?

- **Market pull (demand pull)**
  - Research & Development → Production → Marketing → Expressed Market Need

*Quelle: Wikipedia*

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PSCP Innovation Mining
Innovation-Pull Strategy

Research & Development
Semiconductor Company

Research & Development
AUDI AG

Market
AUDI AG / VW Group

Production

Marketing / Sales

PSCP Innovation-Pull Process Steps:
1. review needs
2. review new technologies
3. cross pollinate
4. develop/invent new solutions
5. develop/invent new functions
6. evaluate benefits
7. find mutual business case
8. prioritize
9. demonstrate
10. productize / industrialize
11. market first – lead application
12. open market

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Strategic partnership with semiconductor companies is key to innovation and increases the speed of projects as well as the solution quality.

**Audi Progressive SemiConductor Program - PSCP**

**Example of living reliability and speed**

**Audi phone box with wireless charging**
- from first concept to working car implementation (including EMI) in eight months

**Benefits of Audi PSCP**
- decrease time-to-market of innovations
- breaking the ground for the use of mobile/consumer semiconductors in automotive applications
- influence/specify semiconductors for a maximum benefit
- increase quality speed on returns/failures
- top support by semiconductors partners

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Innovation creates looser – the match example
AUDI  Progressive SemiConductor Program - PSCP

Robust Semiconductor Program

Innovation  PSCP  Innovation mining  Quality  Vorsprung

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What is an automotive semiconductor?

What is a consumer semiconductor?
Semiconductors in automotive applications
Requirements from technology to application

Automotive Requirements: Reliability, Zero Defects, Supply Guarantee, ....

Standards: ISO26262, AEC-Q100/101/200, TS16949, ...

Automotive Requirements
- **Reliability**: Long life under extreme temperature ranges, high humidity, unstable voltage conditions and harmful chemicals & gases
- **Zero Defects and robust operation**: Driven by safety applications & warranty costs
- **Logistics**: Reliable & long-term supply, fast response to incidents

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Summary

- **Semiconductors** are the **core of automotive innovations**

- **Taking advantage** of the **semiconductor innovation speed is key to success** in the global market

- **Semiconductors** become an important **strategic OEM topic**

- **Synchronizing** the **speed of innovation and reliability** is a key challenge

- **Strategic partnerships** enable **speed, innovation, quality** and **new business cases**

Audi will actively “drive” semiconductors
Thank you!