Drive Innovation From The Inside Out ..
Burkhard Huhnke, Birmingham October 2\textsuperscript{nd}, 2018
... TO EVERYTHING AUTOMONOUS
Safety: The Driver as Uncertainty Factor
Causes Fatal Accidents (84% misjudgment)

MENTAL FACTORS
- Sleep: 38%
- Distraction
- Medical Reasons

INCORRECT DECISIONS
- Car in Front: 46%
- Vehicle dynamics
- Passing
- Lane keeping
- Parked Car

UNEXPECTED BEHAVIOR
- Peds / Animals: 8%
- Accident
- Other

TECHNOLOGY: 8%
Dude where is my self driving car?

- 90 %!
Software & Electronics Become Core Competencies of Automotive Industry

This competence is the key Success Factor of Future Products

Drivers of Innovation

- Direct injection
- Climatronic
- Keyless entry
- Park assist
- Emergency brake
- Lane assist
- Rear view camera
- Hard drive storage
- Active seat A/C
- Illumination
- Tire pressure monitor
- ESC
- Park pilot
- iPod adapter
- DVD
- Navigation
- Touch screen
- ACC
- Remote control
- Front assist
- Hard drive storage
- Active seat A/C
- Illumination
- Tire pressure monitor
- Climate
- Multi function Display
- Central locking
- Remote control
- Rain sensor
- Touch screen
- Easy Close Light
- Park Assist 3.0
- Towing assistant
- Emergency assist
- Traffic jam assist
- Area view with obstacle recognition
- Active info display
- Drive profile select (suspension)
- LED Headlamps with curve light
- Car-Net (connectivity to VW backend)
- Proactive multi airbag passenger protect
- Side assist
- Traffic sign recognition
- City emergency brake system
- Pedestrian recognition

TODAY

2020

2010

2000

1990

1980

1970
Robust / Comprehensive Design Required

.. along the product chain
- SoC
- ECU
- System (multiple ECUs)
- Vehicle

Safe, Secure, Certified: Hard & Software

Recall Statistics
(electronics)
≈ 5%
Increasing Software & Electronics Content

1995
- 5% Car
  - ($700)
  - 60% Mechanic
  - 35% Electronic
  - 5% Software

VS.
- 2010
  - 50% Mechanic
  - 35% Electronic
  - 15% Software

2025
- 25% per car
  - ($3500)
  - 40% Mechanic
  - 40% Electronic
  - 25% Software

~$14k unit costs per car
Comprehensive Automotive Design – Safe & Secure

- **Electronics Hardware**
  - CHIP
  - SYSTEM
  - VEHICLE

- **Software**
  - SAFE
  - SECURE
  - QUALITY

- **Safety Monitor**
  - DIAGNOSTIC CAPABLE
  - FROM SOC
  - TO SYSTEM
  - TO CAR
  - TO END OF CAR LIFE

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Software Lines Of Code (SLOC)

AUDI A8 2010
10M SLOC

F-35 LIGHTING
75M SLOC

AUDI A7 2018
150M SLOC

MOUSE
200M SLOC
Automotive Software Cybersecurity & Quality

11 of the top 15
Auto OEMs…and leading Tier 1s & Semiconos use Synopsys Software Integrity

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<th>Static Analysis</th>
<th>Security Testing</th>
<th>Supply Chain Management</th>
<th>Security Services</th>
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<tr>
<td>Find critical defects and vulnerabilities in code</td>
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<td>Find known vulnerabilities in Open Source &amp; 3rd party code</td>
<td>Gap analysis / remediation planning</td>
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<tr>
<td>Automotive compliance (MISRA, ISO26262)</td>
<td>Fuzzing for automotive protocols</td>
<td>Supply chain total health with SW BoM</td>
<td>Remediation plan execution</td>
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<td>OWASP Top 10 and CWE Top 25</td>
<td>Ethernet, WiFi, CAN, Bluetooth, SMS, DHCP</td>
<td>Secure integration of connected systems</td>
<td>On-going program execution</td>
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VOLKSWAGEN GROUP SHIPPED (WITH CARS) 36 BILLION SEMICONDUCTORS IN 2014
Electronic Architecture in Cars

**GENERATION**

1st Generation

**HIGH-LEVEL ARCHITECTURE**

**MAIN FEATURES**

- Independent ECUs
- Isolated Functions
- Each function has its ECU (1:1 connection)

Information provided by McKinsey & Company®
Electronic Architecture in Cars

**GENERATION**
1st Generation

**HIGH-LEVEL ARCHITECTURE**

**MAIN FEATURES**
- Independent ECUs
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VW Beetle in 1949: A Historical E/E Architecture
Electronic Architecture in Cars

Hardware & Software (ECU)

Hardware (ECU) – Part # HW01

Software (ECU) – Version # SW01

Part # & SW Version #
Electronic Architecture in Cars

3rd generation central gateway

**GENERATION**
- 1st Generation
- 2nd Generation
- 3rd Generation
- TODAY

**HIGH-LEVEL ARCHITECTURE**

- Distributed E/E Architecture
- Body/Comfort
- Chassis
- Power-train
- Infotainment

**MAIN FEATURES**

- **1st Generation**
  - Independent ECUs
  - Isolated Functions
  - Each function has its ECU (1:1 connection)

- **2nd Generation**
  - Collaboration of ECUs within one domain
  - Domains: body/comfort, chassis, powertrain, and infotainment
  - 3-4 independent networks
  - Limited communication between domains

- **3rd Generation**
  - Stronger collaboration via central gateway
  - Cross-functional connection
  - Ability to handle complex function, e.g. ACC

**TODAY**

Information provided by McKinsey & Company*
Networking Architecture Gen III
Electronic Architecture in Cars

4th generation central gateway

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<td>• Independent ECUs</td>
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<td>2nd Generation</td>
<td>Distributed E/E architecture</td>
<td>• Collaboration of ECUs within one domain</td>
</tr>
<tr>
<td>TODAY</td>
<td>Domain centralized E/E architecture</td>
<td>• Central domain controller</td>
</tr>
<tr>
<td>3rd Generation</td>
<td>Domain centralized E/E architecture</td>
<td>• Stronger collaboration via central gateway</td>
</tr>
<tr>
<td>4th Generation</td>
<td>Domain centralized E/E architecture</td>
<td>• Cross-functional connection</td>
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</table>

Information provided by McKinsey & Company*
Central Domain Controller

- POWERTRAIN (ECU)
- ADAS
- BCM (Body Control Module)
- INFOTAINMENT
- GATEWAY & CONNECTIVITY
© 2018 Synopsys, Inc.
 Automated Valet Parking
Fast, Safe, Driverless

“Integration steps for complex functions”

Critical error curve!
Integration steps for complex functions

Shift left
Uncritical error curve!
Disrupting the Current Development Process

Hardware / Software CoDesign for Automotive Electronics

TODAY
- All virtual development process
- Hardware / Software CoDesign
- Virtual Prototyping
- Simulation model
- Semiconductor industry standard

TOMORROW
- Virtual development process
- Hardware / Software CoDesign
- Virtual Prototyping
- ECU simulation models

Information provided by Audi DVNCON2017 Keynote Berthold Hellenthal Audi*

Pre-System Development
- Develop Earlier
  - Pre-System Debug Efficiency
- System HW Samples
- Increase Coverage
  - Frontload test development
  - Fault and coverage testing

Continuous System Testing
- Accelerate Cycles
  - Virtualize Testbench
  - Regression

Infotainment Systems
Instrument Cluster
Advanced Driver Assistance Systems
Chassis
Powertrain
Serving the Automotive Supply Chain from SoCs to ECUs

Technologies – Semiconductor Collaborations – Automotive Flows – Deployment Expertise

Automotive Virtual Prototyping

- Automotive Flows Integration
  - Hybrid HW
  - SW Debug & Coverage
  - Calibration & Measurement
  - Fault Injection
  - Test Automation
  - System Simulation
  - Architecture Design

- Virtual SoC and Virtual ECU System Debug and Analysis Tools

- Model and Virtual Prototype Assembly Tools

- Automotive IP Models
- Automotive MCU and SoC Models

Center of Excellence

vECU System Integrator

Virtual ECU

Virtual SoC
Automotive Require Different SoC Architectures

Processors: ARC, Embedded Vision, Sensor & Control Subsystem
Security: ARC Secure Processors, tRoot Hardware Secure Modules
Interfaces: USB, Ethernet (AVB, 10/100/1000), MIPI, HDMI, PCIe, SATA, ADC, LPDDR4
Foundation: Logic Libraries, Memory Compilers, NVM
Process: 40nm → 28nm → 16/14nm → 7nm
### ADAS Fastest Growing Application

- **ADAS**: fastest growing automotive application
- $3.0B of semi demand from OEM ADAS systems by 2019
- Almost $1B of demand for ADAS application processors
- Market expected to expand rapidly following Euro NCAP rules in 2016

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**Source:** ADAS Challenges and Opportunities, Strategy Analytics, Jan 2013 report
Road to Unreliability?

Pessimistic Speculation, Please do not use as data

Will this happen?
Orchestrating Functional Safety in Todays Automotive SoCs
A Mixed Distributed – Centralized Solution

- Mission critical Automotive ICs require ECC to keep low FIT rates
- Highly automated flow generating test bench and Verilog RTL, synthesis scripts and other MASIS documentation
- High Reliability with Multi-bit Correction
- Enables insertion of test and repair IP within the chip implementation flow
- Enhanced to allow selecting multiple test algorithms in-field
- Performs test, diagnosis & redundancy analysis
- Perform periodic checks of the SoC Safety critical components with Memory BIST and Logic BIST
Changing ASIL Requirements for Autonomous Driving

ASIL B/C
Driver Assist
- Radar: ASIL C
- Front View Camera: ASIL B
- Smart Rear View Camera: ASIL B

ASIL D
Driver safety-critical
- Automatic Braking: ASIL D
- Airbag: ASIL D
- Electric Power Steering: ASIL D
- Radar: ASIL D
- Front View Camera: ASIL D
- Smart Rear View Camera: ASIL D
Reduce Risk and Accelerate Qualification for Automotive SoCs

- **Functional Safety**
  - ISO 26262:2011 CERTIFIED
  - Ensures ASIL levels A to D
  - Accelerates assessments

- **Reliability**
  - AEC Q100 QUALIFIED
  - Temp. Grades 1 & 2
  - Reduces risk & time
  - Speeds AEC-Q100 qual.

- **Quality Management**
  - Infrastructure & processes
  - Quality manuals
  - FMEDA reports…
What’s Hot in ARC Processors – Automotive!

- **ARC EM Safety Islands**: Industry’s First Commercially Available **ASIL D Ready** Lockstep Solution

- **ARC EV6x w/Safety Enhancement Package**: Industry’s First **ASIL D Ready** Embedded Vision Processor

- Unified **ASIL D Ready** software development environment based on ARC MetaWare Toolkit

- Comprehensive safety documentation to accelerate ISO 26262 compliance certification
Arbe Robotics Selects ARC Processor IP for Its New 4D High-Resolution Imaging Radar SoC

Application

– Next-generation sensor designed for ADAS and Level 4 & 5 autonomous vehicles

– Senses environment at 100-degree field of view in high-resolution

– Captures size, location, and velocity data of objects surrounding the vehicle

– Create detailed image of road at more than 1,000 feet

Solution

– ARC EM6 Safety Island + EV62 Vision Processor with Safety Enhancement Package

– ARC MetaWare EV Development Toolkit for Safety

“Synopsys’ DesignWare ARC EM Safety Island and EV62 Processor deliver performance and safety features that are easily integrated into the complex operations necessary for Arbe's 4D imaging radar…”

-- Kobi Marenko CEO, Arbe Robotics
Collaboration is Imperative