Solutions for Safety Critical Automotive Applications

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EMEA - Automotive Sensors Marketing
## Agenda

1. The market landscape
2. Introduction to Functional Safety
3. Microcontroller & Software for Chassis & Safety Applications
4. Sensor solutions for Chassis & Safety Applications
5. Conclusion
1.3 million people are killed on world roads every year or more than 3,500 people per day.

<table>
<thead>
<tr>
<th>Country</th>
<th>USA</th>
<th>Germany</th>
<th>China</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (million)</td>
<td>306</td>
<td>83</td>
<td>1,336</td>
<td>128</td>
</tr>
<tr>
<td>Car Park (million)</td>
<td>251</td>
<td>56</td>
<td>145</td>
<td>91</td>
</tr>
<tr>
<td>Death (people)</td>
<td>42,642</td>
<td>4,979</td>
<td>89,455</td>
<td>6,639</td>
</tr>
<tr>
<td>Death / 100k people</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death / 100k cars</td>
<td></td>
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</tbody>
</table>


And in India, 105,725 killed; Russia, 33,308 killed; Brazil, 35,155 killed...

Electronic Market Growth Dynamics:
1. New systems are introduced in high end vehicles based on consumer demand for safety.
2. Government safety regulations are changed to mandate the new system.
3. Increasing legislation for safety systems (ABS, ESP) is driving the Adoption of electronic braking, and safety systems in many regions.
4. ADAS, Radar and Camera systems expected to be next for mandate.
Network Effects in Chassis & Safety

Steering
- Electric power steering
- Active front steering
- Steering Torque Sensors
- High torque EPS

Driver Assistance
- Front & rear radar
- Multifunction Camera
- Blindspot detection
- Ultra-sonic park assist
- Camera parking aid
- MPE sensors
- Adaptative Cruise Control
- Lane Keeping assistant

Suspension
- Semi active suspension
- Fully active suspension

Powertrain
- Traction control
- Regenerative Braking

Brake / Active Safety
- Anti-lock braking
- Vehicle stability control
- Electric parking brake
- Regenerative Braking

Airbag/ Passive Safety
- Front airbag, Side airbag
- Seatbelt Pretensioner
- Pedestrian Protection

- High Computing power required
- Complex Software implemented
- Functional Safety
- High Bandwidth Network
- Sensor Fusion
- Low power consumption

New: Safety controller
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New trends in Vehicle Architecture

- Vehicle E/E Architecture are
  - Too complex
  - Too much power
  - Too many ECUs
  - Too many cables
  - Too many connectors
  - Too much weight
  - Too many too many...

Higher ECU integration and emergence of domain controller will create **new challenges** in terms of **functional safety (ISO26262)**
Functional Safety, what is that?

- **Functional Safety Definition**
  - Ability of a system to **fulfil** given **functional requirements**
    - Within a set of operation **conditions**
    - Within a given **time** period
    - Within known **failure** mode

- **Two relevant safety standards**
  - **IEC 61508**
    - Generic standard for functional safety of electronic systems
    - **SIL levels** (Safety Integrity Level) 1 to 4
  - **ISO 26262 (in preparation)**
    - ‘Derivate’ of IEC 61508 for automotive applications
    - **ASIL levels** (Automotive SIL) A to B

Safety standards are becoming the **key enabler** for the design of all new **electronic** application in the vehicle and associated **semiconductor** development.
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Freescale Automotive Cores

Applications

- S08 (8-bit)
- S12(X) (16-bit)
- Power Architecture®
  - MPC55xx and MPC56xx (32-bit)
- i.MX ARM™ (32-bit)

Performance/Features

- Powertrain Electronics
  - Engine control
  - Transmission control

- Central Body Electronics
  - Body control modules
  - Gateways
  - Instrument clusters

- General Body Electronics
  - Door modules, lighting, steering column, sunroof, occupant detection, keyless entry, TPMS

- Chassis & safety
  - Telematics & Infotainment
    - Navigation
    - High-performance DIS

- High-performance DIS
A Scalable family of 32-bit 90nm Microcontroller for Chassis & Safety Application

**MPC560xP/T**
- e200z0 Single & Dual core
- Up to 64 MHz
- 192kB to 1MB Flash
- FlexCAN, LINFlex, FlexRay

**MPC564xL**
- e200z4 Dual core, Dual Issue
- Lockstep or decoupled mode
- Up to 120 MHz
- 384kB to 1MB Flash
- FlexCAN, LINFlex, FlexRay

**MPC567xK**
- e200z7 Dual core, Dual Issue
- Lockstep or decoupled mode
- Up to 200 MHz
- 1MB to 2MB Flash
- FlexCAN, LINFlex, FlexRay, Ethernet

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Airbag
Antilock Brake System
Electric Power Steering
Ultrasonic Park Assist

Surround camera
(MPC5604X version with MJPEG and FEC)

Electric Power Steering
Electronic Stability Control
24 & 77GHz radar controller
Domain Controller

Chassis Controller
Domain Controller
High Performance Radar / Camera

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Performance scale
## MCU Architectures for Safety Critical Applications

<table>
<thead>
<tr>
<th></th>
<th>Single Core</th>
<th>Asymmetric Cores</th>
<th>Lockstep Dual Core</th>
<th>Decoupled Dual Core</th>
<th>Detection of SW Errors</th>
<th>SW Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single SW Instance</strong></td>
<td>-</td>
<td>-</td>
<td>ASIL D</td>
<td>-</td>
<td>No</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Replicated SW Instances</strong></td>
<td>ASIL A (Time redundancy)</td>
<td>Not common</td>
<td>Makes little sense</td>
<td>ASIL D</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Diverse SW Instances</strong></td>
<td>ASIL A-B (Time redundancy)</td>
<td>ASIL C-D</td>
<td>ASIL D</td>
<td>ASIL D</td>
<td>Yes</td>
<td>High</td>
</tr>
<tr>
<td><strong>Core Performances</strong></td>
<td>1x</td>
<td>1.2x</td>
<td>1.0x</td>
<td>1.5x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
New Dual Core MCU for safety critical Applications

MPC5643L

- First dual-core, dual-issue controller available that can switch between lock-step mode and dual parallel mode to address functional safety and performance

- Duplication of all computational elements to address IEC61508/ISO26261 level applications

- More than 600 DMIPS performance from dual core, dual issue e200 running at 120 MHz

Winner of the 20th annual EDN Innovation Awards
April 26th, 2010
Continental Press Release, November 2009

Continental has received a safety certification according to the IEC 61508 SIL-3 standard for a chipset used as brake controller [..]

The chipset in question consists of a SPACE microcontroller and a PCU mixed-signal chip.


Freescale Press Release, October 2007

Freescale and Continental collaborate on multi-core 32-bit microcontroller for electronic braking systems [..]

The SPACE device integrates three e200 cores based on Power Architecture™ technology, making it the industry's first triple-core automotive MCU.

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Freescale, The undisputed leader in Automotive Accelerometer

Estimated Market Share for all Accelerometer suppliers in Automotive applications

Source: iSupply, Automotive MEMS H2 2009 Market Tracker
MMA6900Q Dual axis low g accelerometer

Thanks to:
- Its robust design
- Temperature stability
- Low noise
- Compact package
- Automotive qualification

MMA6900Q is suitable for **safety critical** automotive applications such as **Electronic Stability Control (ESC)** and **Electronic Parking Brake (EPB)**.

It also detects accurately vehicle tilt like for **car alarms**. For industrial applications it can be used as **inclinometers** and **low level motion detector** (Low detection threshold of 8.6mg or >= 0.5°).
MMA6900Q Accuracy of Data: 5 Key Features

Dual XY axis Sensors with fully digital signal processing:
- Digital output (10 or 11 Bits)
- 3.3V or 5V Power Supply
- Bi-directional Self-test
- Programmability (Various LP/HP filters, ...)

The following features and functions are incorporated into the MMA6900Q design to ensure accuracy of reported results:

1. Internal Voltage Monitoring
2. Programmed Data Integrity
3. Temperature Limit Detection
4. Oscillator Frequency Monitoring
5. SPI Communications Integrity
Vehicle Stability Control: Angular Rate Sensors

- Angular Rate with fully digital signal processing:
  - X-axis rate sensor: ± 100°/s to 300 °/s
  - Z-axis rate sensor: ± 100°/s to 300 °/s
- Closed loop architecture
- Digital Output (SPI) – 16 bit format
- 3.3V or 5V Power Supply
- Continuous Function Monitoring

Coriolis based double mass balanced design

Car with and without VSC
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Freescale Automotive Investment for the Future

▶ **Green Technologies**
- Multi-core Power Architecture processors for next-generation powertrain (GDI, Diesel, HEV, EV)
- Intelligent power switching (IDC, E-Switch) and communication solutions to replace hydraulic systems
- Cost reduced system solutions for emerging markets

▶ **Advanced Safety**
- High-performance Power Architecture™ solutions for active and passive safety fusion – Domain controllers
- 77 GHz RF solutions for radar
- Gyro and low-g sensors for vehicle dynamics

▶ **Infotainment**
- i.MX application processors for advanced multimedia
- Symphony audio DSPs for radio head units, external amplifiers and aftermarket audio solutions
- Cost reduced components for in car networking applications
Our common goals

ZERO

Emissions
Fatalities
Defects

Electronic is imperative to balance increasing individual transportation and reducing fuel cost, emissions and casualties.

Consumer awareness, legislation and competitive differentiation join forces driving automotive electronics