## Electronics Share increase

**Vehicle cost, EUR, not adjusted for inflation**

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exemplary new features/innovations</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td>11,000</td>
<td>13,000</td>
<td>14,100</td>
</tr>
<tr>
<td>ESP</td>
<td>3,300</td>
<td>3,500</td>
<td>5,100</td>
</tr>
<tr>
<td>Airbags</td>
<td>3,000</td>
<td>9,000</td>
<td>3,500</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>1,400</td>
<td>1,400</td>
<td>2,000</td>
</tr>
<tr>
<td>Power windows</td>
<td>2,300</td>
<td>2,300</td>
<td>2,600</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16,400</td>
<td>28,900</td>
<td>40,000</td>
</tr>
</tbody>
</table>

**Share of electronics**

- **2002**: 25%
- **2010**: 35%
- **2015**: 40%
Complex functions in a complex electronic architecture

Electronic Architecture and Function Mapping
Electronic architecture issues

- Standardization and Modularity
- Safety of complex functions
- Quality of the design

→ We need to define the electronic architecture early in the development
OSCAR: Safety and Electronic Architecture Design Tools

Supervisor

MATLAB and Simulink
SCB
Mint

Ethernet

SW for ECU 1 MPC 555

I/O A/D

Failure injection

Ethernet

XPC Target

Environment Model

Real Time computer

SW for ECU 2 C 166

CAN

I/O A/D

Ethernet

Ethernet
Goals with OSCAR

- Guarantee that the electronic architecture design ensures the requirements:
  - Functional
  - Dysfunctional (failure injection)

- First evaluation of the impact on the networks and on the ECU
Principles

Vehicle test + Rapid prototyping

Model (Simulink) → Requirements
Principles

Validated Simulink

Model In the Loop MIL

Software in the Loop SIL

Processor in the Loop PIL

Environment model

Tests

Real time environment
Fault injection

Tests

Hardware in the Loop HIL

Code C

Code generation validation

Optimized C code

Code for ECU 1

Code for ECU 2

Functional and dysfunctional Electronic architecture design validation
Advantages with OSCAR

- Allows common works for all teams with one model
- Incremental design from system level to implementation
- Results used in components specifications
- Continuous test and verification
- Detection of errors early in the development

- To get higher performances, we need to define rules on the Simulink model
Simulink maturity Level

Level 0: CCL without constraint

Level 1: N1 + discret Block
Prototype validation

Level 2: Guideline perimeter

Level 3: N2 + ...
Real-Time Workshop
Embedded Coder

For concept evaluation

DSpace/RTI
XPC Target
Architecture design tools

Manual coding
Other automatic coding tools
Model verification

- Simulink model Level n
- Check the quality level of the Model
- Use configurable valid blocks
- Check and correct if necessary
- OK for level n+1
- Guideline
- Verification Tool
- Library
- Simulink Model
- Control law design
- Verification Tool (Static analysis)
- Simulink model Level n+1
Next steps

- Establish links to our requirement and configuration management tools
- Work on the electronic environment models
- Remove the physical components and work in full Model-Based Design
- Link OEM and supplier Model-Based Design processes