From Assisted to Automated Driving

Alfred Eckert, Head of Advanced Engineering, Continental Chassis & Safety Division
Business Trend
Increasing Level of Automation
Consumer Demand
Euro NCAP Rating Scheme 2013 - 2017

AEB City share in AOP 8%
Adult Occupant Protection
Frontal ODB
Frontal FW
Side Barrier
Side Pole
Whiplash Front
Whiplash Rear
AEB City

Seat Belt Reminder
ESC
Speed Assist System
LDW / LKA
AEB Inter-Urban

AEB IU share in SA 23%

AEB VRU share in PP 14%
Pedestrian Protection
Headform
Upper Legform
Lower Legform
AEB VRU (2016)

Child Occupant Protection
Active Safety

AEB-IU: Autonomous Emergency Braking Inter-Urban, LKA: Lane Keeping Assist, LDW: Lane Departure Warning, VRU: Vulnerable Road Users
Advanced Driver Assistance Systems
Key Technologies

**Electronic Stability Control ESC**
MK 100 ESC®

**Lane Departure Warning**
Multi Function Camera MFC

**Advanced Emergency Braking System**
Short Range Lidar SRL
Advanced Radar Sensor ARS
### Cooperative Safety

**Vehicle-to-X - Short Range & Long Range Communication**

<table>
<thead>
<tr>
<th>Short Range</th>
<th>Long Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="V2X@ Continental Application Unit with M2XPro®" /></td>
<td><img src="image" alt="Backend &amp; Cloud Services@ Continental eHorizon Telematics Box" /></td>
</tr>
</tbody>
</table>
| - V2X (safety) applications  
- Real-time data processing  
- Data security | - Vehicle-to-Backend Applications  
- Big Data processing with IBM  
- High precision maps with Nokia HERE |

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Cooperative Safety
Left Turn Assist

Left Turn Assist (LTA) and Intersection Movement Assist (IMA) – could prevent up to 592,000 crashes and save up to 1,083 lives saved per year in the U.S.  

Study On Readiness of V2V (2014), NHTSA
Future Vision of Autonomous Driving
Evolution of Driving Functions

Driver Assistance – Quo Vadis?

Level 0
Driver Only
1959 (Porsche 356)

Level 1
Assisted
1998 (Mercedes S-Class)

Level 2
Partial Automation
2013 (Mercedes S-Class)

*Level of automation* © terms acc. to SAE draft J3016

Source: AutoBild / Nr. 19 / 13. Mai 2011 © AUTO Bild/N.Oskamp
Future Vision of Autonomous Driving

Evolution of Driving Functions

Level 0
Driver Only
1959 (Porsche 356)

Level 1
Assisted
1998 (Mercedes S-Class)

Level 2
Partial Automation
2013 (Mercedes S-Class)

Level 3
Conditional Automation
System performs the lateral and longitudinal dynamic driving task in all situations in a defined use case. Recognizes performance limits and requests driver to resume dynamic driving tasks with sufficient time margin.

Level 4
High Automation
System performs the lateral and longitudinal dynamic driving task in all situations encountered during the entire journey. No driver required.

Level 5
Full Automation

Level of automation* *terms acc. to SAE draft J3016

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Assisted Driving / Automated Driving

Interaction Scheme
Assisted or Partial Automation

Conditional, High or Full Automation

Driving Task
Keep Distance
Keep Lane

Driver
Instinct / Knowledge
Motion Command Arbitration
Motion Control & Actuation
Safe & Comfortable Driving

Driver monitors permanently

Brake & Steer Redundancy: Driver is Fallback

Driver need not monitor (permanently)

Machine
Motion Command Arbitration
Motion Control & Actuation
Accelerating
Braking
Steering

Signal, Software & E/E Redundancy
Brake & Steer Redundancy: System is Fallback

Telematics

Division Chassis & Safety
Public
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† Source: BASf-study - Definitions of Automation and Legal Issues in Germany, 25th July 2012, Tom M. Gasser / Daniel Westhoff, German Federal Highway Research Institute
Automated Driving
Motivations & Success Factors

**Motivation 1:**
Converting driving time to higher valued time

**Success depends on consumer valued benefit/cost ratio**

**Motivation 2:**
Accident-free driving, the prerequisite for Motivation 1 (boosting Vision Zero)

**Success depends on economic valued benefit/cost ratio**
(e.g. 174 bn. €\(^1\) economic saving potential in EU should be motivation for politics)

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\(^1\) Acc. to REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning Type-approval requirements for the general safety of motor vehicles, Impact Assessment, (COM(2008) 316) (SEC(2008) 1909) Brussels, 23.05.2008, total economic damage in EU amounts to 229 bn €. \(\Rightarrow 229 \text{ bn } \varepsilon \ast 0.76 = 174 \text{ bn } \varepsilon\)

\(^2\) Acc. to European Commission, Directorate General Information Society and Media, Informal document No.: ITS-13-07 (13th session of ITS, 23 June 2006, agenda item 3.) in 76% of the cases the human is solely to blame of all road accidents.
## Assist and Automation

<table>
<thead>
<tr>
<th>Period</th>
<th>System</th>
<th>Driver</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2025</td>
<td>Fully AD</td>
<td>The driver need not (permanently) monitor the system</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>Highly AD</td>
<td>fail operational (redundant)</td>
<td></td>
</tr>
<tr>
<td>2013 (Mercedes S-Class)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial Automation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998 (Mercedes S-Class)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assisted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Level 0</td>
<td></td>
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</tbody>
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The Interaction More Structured
Functional Architecture as the Basis for the System Approach

- Driver Monitoring
- Environment & Vehicle Sensing
- Connectivity & Backend

Modeling
- Driver Model
- Vehicle Model
- Environment Model

HAD Functions
- Traffic Jam
- Parking
- City
- Highway

HMI

Action (Motion Control)
- Steering
- Brakes
- Engine
- Gearbox

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E/E-Architecture
Distributed Architecture with High Complexity
Scalable E/E-Architecture
Layered Approach for Different Levels of Automation

Command Generation
Motion Vector
Motion Control
Vehicle Motion

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E/E: Electric/Electronic
Data Fusion
Necessary for an Efficient Environment Perception and Integration
Sensors, Maps and Online Data – Dynamic eHorizon
The Vehicle Looks Around the Corner

Vehicle sensor range
0-300m

[Image of a vehicle looking around a corner with sensor coverage indicated]
Human-Machine-Interface
Augmented Reality will be Key for Driver Acceptance
Modular Redundant Electronic Brake System for Highly Automated Driving
Hurdles on the Way to Automated Driving
Security Protection
Automated Driving Roadmap – Market Launch
C&S Hardware & Architecture Generations / Goals

**CURRENT**
- L2 Highways
- L3 Highways
- L3 enhanced Highways

**INTERMEDIATE**
- L2 Urban
- L3 Urban

**TARGET**
- L4 Highways
- Goal: L5 parking (restricted areas)

**L2: Partial Automation**
**L3: Conditional Automation**
**L4: High Automation**
**L5: Full Automation**

Goal:
- L4 Highways

2016
2018
2020
2022
2025
2030

L2 NCAP
L2 parking (remote)
L2 parking (trained)
Goal: L5 parking (restricted areas)
valet parking

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Function Remote Parking

Description

› Parking Assist provides an automated parking facility.

› Free parking spaces are detected and displayed in the surround view image.

› The driver nominates a particular parking space using a touch screen display and may exit the vehicle.

› The system controls the steering to manoeuvre the vehicle into the parking space, while the driver remotely controls the forwards/backwards motion.
Continental – On the Way to Automated Driving

Current testing regions worldwide