Automated Vehicles

- Vision and Promise
- State-of-the-Art
- Remaining Challenges

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Vision Promise
Main Targets for Automation

Cars in private ownership

- drive comfortable and safe
- individual mobility for all
- extended use of driving time
Autonomous cars allow extended individual mobility for all
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F 015 – Luxury in Motion
Main Targets for Automation

Cars in private ownership
- drive comfortable and safe
- individual mobility for all
- extended use of driving time

Cars for rent and share
- Bring the car to where it is needed
- Bring the car back to its station
- Use the best purpose car
Autonomous cars meet the drivers wherever they are needed
Our Long Term Vision of Car Sharing
Main Targets for Automation

Cars in private ownership
- drive comfortable and safe
- individual mobility for all
- extended use of driving time

Trucks to deliver goods
- extended use of driving time
- automated loading/switching
- drive safe and efficient

Cars for rent and share
- Bring the car to where it is needed
- Bring the car back to its station
- Use the best purpose car
Autonomous Trucks/Vans adapt the steady flow of goods
State-of-the-Art
Series Cars Today: Mercedes-Benz Intelligent Drive

- **PRE-SAFE® PLUS**
  - 360° camera
  - Active Parking Assist
  - ATTENTION ASSIST
  - COLLISION PREVENTION ASSIST

- **DISTRONIC PLUS**
  - with Steering Assist

- **PRE-SAFE® Brake**
  - e.g., with pedestrian detection and urban braking function

- **BAS PLUS**
  - with Cross-Traffic Assist
  - Adaptive Highbeam Assist Plus

- **Active Blind Spot Assist**
- **Active Lane Keeping Assist**
Mercedes Intelligent Drive: Not only available in luxury vehicles

- C-class
- E-class
- CLS-class
- S-class
- GLE-class
- GLC-class
Next Step on the way to autonomous and accident free driving
Next Step on the way to autonomous and accident free driving
Example: Speed Limit Pilot

**Camera**

**CAMERA BASED** e.g. traffic signs, sign gantries, temporary signs at road construction areas

**NAVIGATION BASED** e.g. city boundaries, street type (freeway, highway)
Example: Active Braking Assist with Congestion Emergency Braking

- Detection of traffic-jam scenarios without possibility of evasion
- Initiation of immediate emergency braking maneuver
- Possible speed reduction up to 90 km/h
Example: Active Braking Assist and Evasive Steering Assist

- Optical and audible warning
- Adaptive brake boosting effect, if the driver applies the brake too weak
- Autonomous braking if the driver fails to respond
- Detection of pedestrians ahead of the vehicle

Evasive Steering Assist supports the evasion and the straightening of the vehicle

Driver initiated steering maneuver
Example: Remote Park Pilot
## Further Steps: Change over of Responsibility from Driver to Car

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Automation</td>
<td>Assisted (Assistiert)</td>
<td>Partially Automated (Teilautomatisiert)</td>
<td>Conditionally Automated (Hochautomatisiert)</td>
<td>Highly Automated (Vollautomatisiert)</td>
<td>Fully Automated (Fahrerlos)</td>
</tr>
<tr>
<td>Drivers drives by his own</td>
<td>Driver has to supervise the automated function continuously. <strong>Responsibility stays at the driver</strong></td>
<td>No side activities allowed</td>
<td>System <strong>recognizes its limitations</strong> and hands over the responsibility to the driver early enough. <strong>Defined</strong> side activities allowed</td>
<td>System is able to manage all driving situations autonomously. Side activities are allowed and driverless driving is possible. <strong>Driverless driving allowed</strong></td>
<td></td>
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</tbody>
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### Fail safe
- Regulations and laws under development

### Fail operational
- Clearly defined regulations and laws
Further Steps: Autonomous Highway-Pilot

- On multi-lane roads with parallel traffic the system allows autonomous driving with driver selected cruising speed.
- All speed limits are respected, vehicle speed is adapted to traffic situations and vehicles travelling with lower speed are passed automatically.
- In Highway Pilot Mode collisions are avoided highly reliable on systems own authority (without driver interaction).
Humans do much more right when driving than they do wrong.

Accidents are almost all due to human error.

On the German Autobahn, every 7.5 million km we may catch an error.

We have to drive those 7.5 million km and must not fail a single time.

We have with some success automated to intervene when people do something wrong.

We now aim at automating those things that people do right.
Level 3+: Collision Avoidance for Highly Automated Driving is Mandatory

... but it is, depending on weather, road, traffic conditions, extremely challenging!
Further Steps: Automated Driving on Urban and Rural Roads
S500 Intelligent Drive:
Driving autonomously on the footsteps of Bertha Benz

- Regular S 500 with all emergency braking systems enabled as underlying protection
- Accurate map for localization
- Additional automotive grade sensors for object detection, traffic light recognition and positioning
Impression of Bertha Benz Drive: Overland

Few road users, unobstructed view, dedicated lanes
Impression of Bertha Benz Drive: Inner City

Driving around static obstacles with on-coming traffic
Hurdles on the Way Towards Autonomous Driving

- **Low**
  - Sensors (night/weather/traffic light)
  - Trajectory Planning
  - Actuators

- **Medium**
  - Localization

- **High**
  - Situation analysis /situation prediction
  - Social Interaction
  - Product Liability
Requirements on Software Creation Process

Today: Intelligent Drive Software is developed in house
• about 2/3 is hand coded in C
  • sensor fusion software
  • situation analysis software
• about 1/3 is model coded using Simulink (using about 20 licenses in series development)
  • control software

Future Challenges for Software Creation
• more software modules with higher ASIL requirements, up to ASIL D
• code generator which generates automatically ASIL code
• get rid of an additional code-analysis process after automatic code generation
• efficient support for software unit test
Future Development Steps Keep „Risk Balancing“ in Mind

One automation scenario at a time ...

- Roads Driven
- Driving Speed
- Automation Level

... with significantly fewer risks ...

Avoiding old faults

Creating new faults

... for the individual and society as a whole
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Our Mission

Enhance comfort, safety and grade of automation step by step to reach the vision of autonomous driving soon!