Automated Driving – Industry Perspective
Robert Bosch GmbH, Chassis Systems Control
Stephan Stass
Senior Vice President  Business Unit Driver Assistance
Advanced Driver Assistance: Trends & Growth

Mega Trends
- Energy Efficiency
- Connectivity
- Aging Society
- Urbanization
- Health & Wellbeing

Market Drivers
- Safety
- Comfort
- Democratization
- Automated Driving

Market Growth
- 2014 2016 2021
- CAGR: 20%
- CAGR: 18%
- CAGR: 18%

Chassis Systems Control
Bosch own market analysis/data 2014
CAGR 2014-2021
## Automated and connected – social benefits

<table>
<thead>
<tr>
<th>Reduced congestion</th>
<th>Fewer traffic jams and less waiting time at intersections and lights → 80% improvement in traffic throughput¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher fuel efficiency</td>
<td>Synchronised traffic flow → 23 to 39% improvement in highway fuel economy²</td>
</tr>
<tr>
<td>Gain in productivity</td>
<td>Time in transit becomes more productive → 56 minutes per day freed up for other uses (US)³</td>
</tr>
<tr>
<td>Democratization of mobility</td>
<td>Over-65 segment growing 50% faster than overall population → Allow a variety of age ranges to be mobile</td>
</tr>
<tr>
<td>Improved safety</td>
<td>Reduction in global road fatalities → 90% of car accidents caused by human error⁴</td>
</tr>
</tbody>
</table>

---

² Atiyeh, Clifford (2012), Predicting Traffic Patterns, One Honda at a Time, MSN Auto, June 25.
³ US Department of Transportation Highway Safety Administration (2011), Report # FHWA-PL-II-022
⁴ Bosch accident research; car accidents leading to personal injuries
Roadmap

Partially automated

System takes control of longitudinal and lateral guidance in specific use cases.

Driver still keeps a watchful eye

- **Highway assist 2018**
- **Integrated cruise assist 2017**
- **Traffic jam assist 2015**
- **Automatic emergency braking 2010**
Highly automated driving

- Traffic jam assist 2015
- Integrated cruise assist 2017
- Highway assist 2018
- Highway pilot 2020
- Fully automated driving: Auto pilot
- Traffic jam pilot 2017

Fully automated driving without driver in the loop
Key technologies for automated driving

- **Surround sensing:**
  - Camera, radar, ultrasonic, …

- **Localisation in online map data:**
  - To provide long range planning information

- **Functions:**
  - Decision making in dynamic situations

- **Driver supervision:**
  - System has to be able to return control to the driver at any time

- **Vehicle motion control:**
  - Braking, steering, accelerating
Surround sensing – vehicle sensor concept

- Long-range radar
- Mid-range radar
- 3rd sensor principle
- Stereo-video
- Long-range radar
- Mid-range radar
- Near-range cameras
- Ultrasonic sensors

360° surround sensing by combination of different sensors

- Long- and mid-range radar prerequisite for driving at higher speed
- Satisfy reliability requirements by using multiple sensors for each area
Highly automated driving requires latest high-precision map data
- Aggregated information processing and delivery via the cloud
Principle for decision making of 3 Levels

**Strategic**
high level task oriented planning, similar to standard navigation,
e.g. "drive from A to B, take road X and Y"

**Tactical**
driving maneuvers,
e.g. "drive on right lane and then turn right"

**Reactive**
low level driving primitives,
e.g. "master dynamic situations"

Automated Driving must incorporate all levels of planning done by a human
Highly automated driving changes on-board network

Fail-safe architecture

Fail-operational architecture

Drivers of E/E architecture:
• increasing computing power
• demands for automated driving functionalities

Consequences:
• HW/SW repartitioning (sensor/ECU/cloud)
• use of CE components (µC, FPGA, GPU…)
• redundancies at marketable costs

Redundant power supply, interfaces, and processing units required
Need for highly reliable architecture will change on-board network completely
Fail-operational architectures guarantee safety at any time
Driver as backup – monitoring necessary

- Distraction detection
  ... because 80% of accidents caused by inattentive drivers

- Drowsiness detection
  ... because 30% of drivers have experienced microsleep events

- Health monitoring
  ... because 10% of fatal accidents caused by medical conditions

- Identification
  ... because it enables the vehicle to adapt to the person driving

- Adaptive assistance
  ... because it enables the vehicle to react according to the driver's state

Driver monitoring will be a key element for automated driving functions

- System has to be able to return control to the driver at any time

1 NHTSA-Report DOT HS 810 593, April 2006
2 DVR-Report 3/2012, representative survey of 2 000 persons
3 Destatis Fachserie 8 Reihe 7, 2010
SMMT CONNECTED – Automated Driving

Safety – reliable actuation elements

Redundant steering, braking, and stabilisation systems required
- Modular actuation concept offers a perfect solution for automated driving
SMMT CONNECTED – Automated Driving

Legislation Frameworks & Main Activities

Current legal framework

- National laws
- Geneva convention (1949)
- Vienna convention on road traffic (1968):

  Article 8 (5):
  „Every driver shall at all times be able to control his vehicle or to guide his animals“

Legislation framework no longer reflects technical progress

- Need for adaptation to take account of highly automated driving
Conclusions

- Automated driving increases safety and comfort
  - That’s what we call “Invented for life”

- Stepwise implementation starts with highway driving and parking functions

- The path towards automated driving has to overcome new challenges for sensors, maps, system architecture, validation standards and regulation

- Bosch has all necessary key technologies available and is getting them ready for market entry
Thank you for your attention!