Autonomous Driving

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Rapp Trans Ltd
Agenda

Automation – Definition
Automation – Technology
Automation – Strategy
Automation – Challenges
Automation in passenger transport
Automation in freight traffic
Automation – Definition

The five stages of autonomy

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>DRIVER</td>
<td>Human</td>
</tr>
<tr>
<td>1</td>
<td>FEET OFF</td>
<td>Assisted</td>
</tr>
<tr>
<td>2</td>
<td>HANDS OFF</td>
<td>Partially automated</td>
</tr>
<tr>
<td>3</td>
<td>EYES OFF</td>
<td>Highly automated</td>
</tr>
<tr>
<td>4</td>
<td>MIND OFF</td>
<td>Fully automated</td>
</tr>
<tr>
<td>5</td>
<td>PASSENGER</td>
<td>Autonomous</td>
</tr>
</tbody>
</table>

Sources: Evercore ISI, SAE International

- Can be approved for series production
- Use on private property / Pilot Operation / Research in public
Automation – Definition

Source: BMW, 2017
Automation – Definition

Autonomous Driving vs. Automated Driving

Source: iMove, 2018

Source: virtual vehicle, 2019
Automation – Technology

Autonomous Driving vs. Automated Driving

Sensors
Receive Data
One way communication
→ Stand alone

Sensors
Send & Receive Data
Two way communication
→ Connected
Automation - Technology

Sensors

- **Long-range radar**
  - Detection range ≤ 250 m, horiz. aperture angle: 30°

- **Night vision camera**
  - Detection range ≤ 150 m, horiz. aperture angle: 32°

- **Mid-range radar front**
  - Detection range ≤ 160 m, horiz. aperture angle: 45°

- **Video / stereo-video**
  - Detection range ≤ 80 m, horiz. aperture angle: 41°

- **Ultrasonic sensor**
  - Detection range ≤ 5 m, horiz. aperture angle: 120° (single sensor)

- **Rear-view camera**
  - Detection range ≤ 15 m, horiz. aperture angle: 130°

- **Near-range camera**
  - Detection range ≤ 10 m, horiz. aperture angle: 130°

- **Mid-range radar rear**
  - Detection range ≤ 100 m, horiz. aperture angle: 150°

Source: Robert Bosch GmbH, 2017

One way
Stand alone
→ Digital Accuracy
Automation - Technology

Data

Two way Connected

→ Digital Safety & Security

Source: ait.ac.at, 2019
Automation - Technology

Connectivity

Characteristics
- car to car (C2C)
- car to infrastructure (C2I)
- car to all (C2X)

or
- vehicle to vehicle (V2V)
- vehicle to infrastructure (V2I)
- vehicle to all (V2X)

source: car-2-car.org
Automation - Technology

Connectivity

C-V2X
Intelligently connecting the car to surroundings and cloud

V2V
Vehicle-to-vehicle
e.g. collision avoidance, safety systems

V2P
Vehicle-to-pedestrian
e.g. safety alerts to pedestrians, bicyclists

V2N
Vehicle-to-network
e.g. real-time traffic / routing, cloud services

V2I
Vehicle-to-infrastructure
e.g. traffic signal timing/priority

source: qualcomm.com
Automation - Technology

Data Security

Task: Ensuring subjective and objective security

source: security magazine, 2016
Automation - Strategy

Evolutionary approach  vs.  Revolutionary approach

Gradual automation of additional driving functions until fully automated operation (technical and legal) is possible.

Fully automated vehicle right from the start. Initially used in limited areas of application, successively expanded and supplemented to full extent in step with legal approval.
Automation - Strategy

Level of automation vs Scale / Diffusion

- Prototype / Test area
- Fleet / Small region
- Wide mass / Everywhere

Today

Automation - Strategy

(3) Private Autonomy
- Hightech-vehicles (level 4-5) privately owned, individual
- Manual operation

(4) Public autonomy
- Robot
- Automated operation

(1) Private Car (with assistance systems)
- traditional vehicles (level 1-3) privately owned, individual
- Manual operation

(2) Shared Economy
- disruptive mobility services (digitalisation) collective use

Owned asset

Shared asset
Automation - Challenges

source: The Orange County Register, 2015
Automation - Challenges

Type approval procedure

Level of automation

Approval of each automation level by authorities

Time

2010 2020 2030
Automation - Challenges

Type approval procedure

Commissioning of each automation level in the responsibility of the vehicle manufacturer
Automation in passenger transport
Automation in passenger transport

Car-Owning / Single Ride

Car-Owning / Ride-Pooling

Car-Sharing / Single Ride

Car-Sharing / Ride-Pooling

One car fits all
Automation in passenger transport

Variety of cars, purpose-tailored
Automation in freight traffic

Conventional  |  Platoon  |  Robot

Level of automation
Automation in freight traffic

source: EU Truck Platooning, 2017
Thank you for your attention

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