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TS91
Sensors for Automated Vehicles

State of the Art Analysis for Connected and Automated Driving within the SCOUT Project
Coordination and Support Action
Safe and Connected Automation in Road Transport

Partner
BMW, Bosch, CLEPA, CRF, Fraunhofer LBF, NEC, NXP, Renault, SERNAUTO, Telecom Italia, VDI / VDE-IT, ika

Duration
07/2016 – 07/2018
SCOUT - Structure and Responsibilities

WP 2 Capture of Goals, Expectations and Use Cases of Safe and Connected Automation (Renault)

WP 3 Analysis of the European Ecosystem for Connected and Automated Driving (ika)

WP 4 Identification of Sustainable Business Models (FHG)

WP 5 European Roadmap for Safe and Connected Automation (NXP)

WP 6 International Monitoring and Cooperation (BOSCH)

WP 7 Networking and Dissemination (CLEPA)

WP 8 Project Management (VDI/VDE-IT)

Society e.g. Cities, Interest Groups

Industry Sectors (Automotive, Telecom, Digital)

EU Project Coordinators

Public Authorities

Industry

General Public
State of the Art Analysis

Objectives

• Record the state of the art in technical and non-technical enablers and anticipate future evolutions

• Identify current and future gaps and challenges from technical, societal, economic, policy, legal and regulatory perspectives in comparison to the vision created in SCOUT

• Enable the anticipation of future development paths of the European ecosystem of connected and automated driving
Each factor of Automated Driving is addressed by using the 5-layer model:
- Societal
- Legal
- Economics
- Human factors
- Technology

Each layer is divided into:
- Vehicle
- Driver
- Environment

A holistic approach is necessary on the way towards Automated Driving, none of these factors can be removed.

Focus on **technical** and **legal** layer.
Structuring Automated Driving

5-level model on Fields of Action

Social Level
- Technical regulations, e.g.
  - Traffic regulations (e.g., StVZO)
  - ECE R79, ...
- New business models, e.g.
  - Car-haring
  - Ride-sharing

Legal Level
- Driver-Vehicle-Interaction, e.g.
  - after TOR
  - during automated driving
- Driver-Environment-Interaction, e.g.
  - Detection of critical situations
  - Reaction of other traffic participants

Economic Level
- Driver monitoring
  - Actual use of system
  - TOR = f(driver state)

Technical Level
- Environment detection
  - Sensor range
  - Redundancy

Standardization
- Design of infrastructure, e.g.
  - Physically: road markings etc.
  - Informational: connectivity

Cost/Benefit analysis
- Efficiency, Safety
- Business location Germany

Regulation / Laws for drivers
- e.g., STVO
- Vienna Convention on road traffic

Evaluation & Sign-off
- Suitable Methodologies
- Efficient Process?

HMI concept, e.g.
- Information presentation
- Logics & timing & escalation

New business models, e.g.
- Car-haring
- Ride-sharing

Environment detection
- Sensor range
- Redundancy
## Technical Layer

- **Sensor Overview**
  - In-Vehicle Sensors
  - Sensor Fusion
  - Sensor set-ups

- **Navigation and Localization**
  - Maps
  - Current Location

- **Connectivity**
  - Overview of 5G
  - 5G-PPP Automotive Vision

- **Security**

### Sensor Setup

<table>
<thead>
<tr>
<th>Radar - Short Range</th>
<th>Radar - Long Range</th>
<th>GPS</th>
<th>Lidar / Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera - Mono</td>
<td>Camera – Stereo</td>
<td>V2X – Sensor</td>
<td></td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>Infrared</td>
<td>Maps</td>
<td></td>
</tr>
</tbody>
</table>

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**Example:** Tesla Model S  
**Example:** Mercedes S-Class

 ITS WORLD CONGRESS 2017  
Montréal | OCTOBER 29 - NOVEMBER 2
Technical Layer

- Secure Car Access: Immobilizer, RKE/PKE & Smart Car Access
- Secure Processing: Secure MCU/MPU
- Secure Network: Secure Transceivers
- Secure Gateway: Secure Gateway MCU
- Secure Interfaces: Secure Element (for V2X, Telematics, ...)

Source: NXP Semiconductors
Technical Layer

End-to-End Learning:

Sensor data (e.g. Camera) → Deep Neural Network → Longitudinal and Lateral Control

Component based driving function:

Sensor data (e.g. Camera) → Sensor data processing → Sensor Fusion → Situation Understanding → Tactical Planning → Trajectory Planning → Longitudinal and Lateral Control
Legal Layer

• Legal status of connected and automated driving in Europe
  • Vienna Convention & United Nations Regulation UN-R 79
  • National Regulation
• International Regulation in several European member states
  • USA
  • Japan
  • South Korea
  • China
• Other regulation areas to be observed
  • Liability
  • Insurance
  • Personal Data Protection/Data Security
  • Type Approval
  • Other national regulations revolving around automated driving
Legal Layer
Example: Legal status in Europe/Germany

• Vienna Convention on Road Traffic (1968)
• Spring 2014: proposals for amendments → changes integrated
• National vs. international law

Germany
• January 2017: German Federal Ministry of Transport Proposal presented a legislative proposal to amend the “Straßenverkehrsgesetz” in order to establish a first legal basis for automated driving in public space
• New laws on „highly and fully automated cars“ valid since June 21, 2017
• Ethics Committee on Automated Driving → Final report from June 20

• → Available legal boundary conditions for Level 3 vehicle automation
Legal Level - Current State of the Art

Level 3 Systems are already legal in Germany

- New law on Level 3 vehicle automation valid since June 21\textsuperscript{st} 2017 in Germany
- Driver is allowed to get out of the driving loop, but needs to take over if required by the system or if he detects a danger
- Data needs to be recorded of take over requests and take over situations (to be deleted after 6 month)
- This data is to be analysed in order to determine the cause of accidents
- In total the law is not clear in all points and will need to be analysed more accurately in case of any legal problems after an accident
- Evaluation of the law in 2019

\textbf{Certification of Level 3 Systems are possible}
Social Level - Current State of the Art

German Ethics Commission on Automated Driving

- Ethics Committee on Automated and Connected Driving issued final report on June 20, 2017
- 14 independent experts involved
- 20 ethical rules for Automated and Connected Driving established

- Main conclusions:
  - Protection of humans has highest priority
  - No evaluation between human lives (one vs. many, young vs. old etc.)
  - No ethical decisions are to be programmed into system (dilemma situation)

→ The Ethics need to be taken into account
Next Steps in SCOUT

- SWOT analysis of the connected and automated driving ecosystem in Europe

<table>
<thead>
<tr>
<th>Level of Automation</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
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<tr>
<td>perfect Driver Assistance by precise information</td>
<td>cooperative highly automated driving</td>
</tr>
<tr>
<td>e.g. traffic information, eCall</td>
<td>comfortable automated driving using eHorizon</td>
</tr>
<tr>
<td>e.g. radio based danger warning</td>
<td>“swarm-driving”</td>
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<tr>
<td>“classic car”</td>
<td>Google Car without controls</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of Connectivity</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robust &amp; secure connectivity</td>
<td>...</td>
</tr>
<tr>
<td>State-of-the-art connectivity</td>
<td>...</td>
</tr>
<tr>
<td>No connectivity</td>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Level 0</td>
<td>No Automation</td>
</tr>
<tr>
<td>Level 1</td>
<td>Driver Assistance</td>
</tr>
<tr>
<td>Level 2</td>
<td>Partial Automation</td>
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<tr>
<td>Level 3</td>
<td>Conditional Automation</td>
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<tr>
<td>Level 4</td>
<td>High Automation</td>
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<tr>
<td>Level 5</td>
<td>Full Automation</td>
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Thank you!