Automated Driving
Submitted by the experts of OICA as input to the IWG ITS/AD

Matthias Esser

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VDA Offices Berlin, Germany
Motivation for automated driving

Driver assistance and automated driving today

Definition of terms: Role of the driver vs. role of the system

Roadmap to automated driving and exemplary functions

Need for action

Conclusion
## Motivation for Automated Driving

<table>
<thead>
<tr>
<th></th>
<th>Road Safety: Vision Zero</th>
<th>Traffic management</th>
<th>Reducing Emissions</th>
<th>Demographic Change</th>
<th>Innovation High technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Road safety improvements by reducing human driving errors</td>
<td>Optimization of traffic flow management</td>
<td>Reduction of fuel consumption &amp; CO2 emission (through optimization of traffic flow management)</td>
<td>Support unconfident drivers</td>
<td>New economic paradigm – supporting innovation policies of regions, nations</td>
</tr>
<tr>
<td>2</td>
<td>Traffic management</td>
<td>Convenient, time efficient driving via automation</td>
<td></td>
<td>Enhance mobility for elderly people</td>
<td>Competitiveness / high skill employment</td>
</tr>
</tbody>
</table>
Today's Driver Assistance/Automated Systems - examples

**Longitudinal Control**
- Adaptive Cruise Control
- Forward Collision Warning

**Lateral Control**
- Lane Keeping Assistance

**Parking, Maneuvering**
- Automated Parallel Parking Assistance

**Longitudinal+Lateral Control**
- ACC combined with Lane Keeping Assistance

**Longitudinal+Lateral Control**
- Traffic Jam Assist
- ACC incl. Stop-&Go combined with Lane Keeping Assistance

**Parking, Maneuvering**
- Automated Cross Parking Assistance
## Today’s Automated Driving – industrial projects

<table>
<thead>
<tr>
<th>Bertha Benz drive</th>
<th>Super Cruise</th>
<th>Motorway Pilot</th>
<th>Automated Highway Driving</th>
<th>Traffic Jam Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Mercedes</td>
<td>2014 GM</td>
<td>2011 BMW</td>
<td>2014 HONDA</td>
<td>2012 Audi</td>
</tr>
<tr>
<td>Highway Automated Driving</td>
<td>Drive Me</td>
<td>Automated Driving</td>
<td>Field Test on Highway</td>
<td>Automated Highway Driving</td>
</tr>
<tr>
<td>2014 PSA</td>
<td>2013 Volvo</td>
<td>2014 Renault</td>
<td>2013 Nissan</td>
<td>2014 Toyota/Lexus</td>
</tr>
<tr>
<td>Automated Driving</td>
<td>Automated Highway Driving</td>
<td>Automated Transport Solution</td>
<td>Automated Driving</td>
<td></td>
</tr>
<tr>
<td>2015 Future Truck 2025 MB Trucks</td>
<td>2015 Freightliner Inspiration Truck</td>
<td>Scania Autom. Transport Solution</td>
<td>Volvo Trucks</td>
<td></td>
</tr>
</tbody>
</table>

(4th ITS/AD, 15 June 2015, agenda item 3-2)
<table>
<thead>
<tr>
<th>Category A</th>
<th>Category B: Intervening in Emergency (close-to-accident situations)</th>
<th>Category C: Automated (From advanced driver assistance towards „automated driving“)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only indirect influence on the dynamic driving task by the driver (driver controls everything)</td>
<td>Direct influence on the dynamic driving task (driver is definitely not able to master the situation)</td>
<td>Direct influence on the dynamic driving task (driver can always switch off or override the system)</td>
</tr>
<tr>
<td>Examples:</td>
<td>Examples:</td>
<td>Examples:</td>
</tr>
<tr>
<td>• Speed Limit Information</td>
<td>• Automatic Emergency Braking</td>
<td>• Adaptive Cruise Control</td>
</tr>
<tr>
<td>• Lane Departure Warning (e.g. steering wheel vibration)</td>
<td>• Emergency Stop Assistant (e.g. in a medical emergency case)</td>
<td>• Parking Assistant</td>
</tr>
<tr>
<td>• Lane Change Warning/Blindspot Detection (e.g. flashlight in the mirror base)</td>
<td>• ESC, ABS</td>
<td>• Traffic Jam Assistant</td>
</tr>
</tbody>
</table>

Based on a concept of BASt (Federal Highway Research Institute, Germany)
Driver monitors the automated driving functions at all times.

Partial Automation

Driver monitors the automated driving functions at all times.

Conditional Automation

System monitors its performance limits and transfers to the driver within a transition time when reaching the performance limits.

High Automation

System copes with all tasks within a specific use-case.

Full Automation

System copes with all tasks in all situations. No driver required.

Levels of Automated Driving (Category C)

Level 0-1

Level 2

Level 3

Level 4

Level 5

No Automation

Driver Only / Assisted

Partial Automation

Conditional Automation

High Automation

Full Automation
Levels of Automated Driving (Category C)
Updated from WP29-162-20 (March 2014)

Driver continuously performs the longitudinal and lateral dynamic driving task

Driver continuously performs the longitudinal or lateral dynamic driving task

Driver must monitor the dynamic driving task and the driving environment at all times

Driver does not need to monitor the dynamic driving task nor the driving environment at all times; however, he must be attentive to and follow the system’s requests / warnings to resume the dynamic driving task.

Driver is not required during defined use case

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

→ Autonomous Vehicle

**Level of automation**

*terms acc. to SAE J3016*
### Driver

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>can always override or deactivate the system engaged</td>
<td>not applicable</td>
</tr>
<tr>
<td>performs the longitudinal and lateral dynamics</td>
<td>yes</td>
</tr>
<tr>
<td>monitors the driving environment</td>
<td>yes</td>
</tr>
<tr>
<td>is attentive to and responds to the vehicle’s requests/warnings</td>
<td>yes</td>
</tr>
</tbody>
</table>

**Conclusion:** The driver is in the loop and performs all tasks:
- Performs the dynamic driving task (longitudinal and lateral dynamics),
- monitors the driving environment,
- is attentive to and responds to vehicle’s requests/warnings.

*Document No. ITS/AD-04-14 (4th ITS/AD, 15 June 2015, agenda item 3-2)*
Role of the driver and system in Level 1

**Driver***

- can always override or deactivate the system engaged
- performs the longitudinal and lateral dynamics
- monitors the driving environment
- is attentive to and responds to the vehicle’s requests/warnings

**System**

- performs the complementary driving dynamics and monitors the driving environment to a limited degree
- activates system
- overrides system
- deactivates system
- performance limits reached

*The driver must be ready to immediately intervene if necessary, since the system cannot guarantee to recognize its performance limits (e.g. due to weather conditions, missing lane markings, etc.), neither reliably detect the driving environment.

**Conclusion:** The driver is in the loop because he/she must perform the longitudinal or lateral dynamic driving task and remain ready to intervene at all times in the other driving task.
Role of the driver and system in Level 2

**Driver**
- can always override or deactivate the system engaged
- performs the longitudinal and lateral dynamics
- monitors the driving environment
- is attentive to and responds to the vehicle’s requests/warnings

**System**
- performs the dynamic driving task and monitors the driving environment
- activates system
- overrides, deactivates system
- performance limits reached

Conclusion: The driver is in the loop because he/she must remain ready to intervene at all times in the dynamic driving task.

*The driver must be ready to immediately intervene if necessary, since the system cannot guarantee to recognize its performance limits (e.g. due to weather conditions, missing lane markings, etc.).
Role of the driver and system in Level 3

**Driver***

- can always override or deactivate the system engaged
- performs the longitudinal and lateral dynamics
- monitors the driving environment
- is attentive to and responds to the vehicle’s requests/warnings;
- is aware of the system status

**System**

- performs the dynamic driving task and
- monitors the driving environment
- indicates the system control status

*In case of reaching the performance limits (e.g. due to weather conditions, missing lane markings, etc.) the driver is expected to resume the dynamic driving task since he/she is the system’s fallback. The driver will be given a transition time for an orderly takeover.

Conclusion: The driver is considered to be part of the loop because he/she must remain sufficiently attentive in order to be able to intervene upon system’s request within a transition time for an orderly takeover.
**Driver**

- can always override or deactivate the system engaged
- performs the longitudinal and lateral dynamics
- monitors the driving environment
- *Driver may naturally look from time to time at the driving environment, however he is not expected to have a response on the driving task.*
- is attentive to and responds to the vehicle’s requests/warnings

**System**

- performs the dynamic driving task and monitors the driving environment
- indicates the system control status

---

*Minimal risk condition can be achieved in case of a system failure under any driving situation during the entire use case and/or when the human driver fails to respond to the takeover request.*

**Driver is not in the loop** during the use-case but is expected to takeover at the end of the use-case within a transition time.

Automated Driving, OICA, June 15, 2015
Role of the driver and system in Level 5

**Driver** (if present)
- can always override or deactivate the system engaged
- performs the longitudinal and lateral dynamics
- monitors the driving environment
- Is attentive to and responds to the vehicle’s requests/warnings

**System***
- performs the dynamic driving task and monitors the driving environment

*In case of system failure, system can achieve the minimum risk condition out of any driving situation during the whole trip. Driver not necessarily present.

Conclusion: The activated system performs all driving tasks at all times. Driver is not necessarily present anymore and therefore not in the loop.
Overview of existing definitions/terminology

<table>
<thead>
<tr>
<th>Organisation</th>
<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>BASt(^1)</td>
<td>Driver Only</td>
<td>Assisted</td>
<td>Partial Automation</td>
<td>Conditional Automation</td>
<td>High Automation</td>
<td>Full Automation</td>
</tr>
<tr>
<td>SAE(^2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OICA(^3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHTSA(^4)</td>
<td>No Automation</td>
<td>Function-Specific Automation</td>
<td>Combined Function Automation</td>
<td>Limited Self-Driving Automation</td>
<td>Full Self-Driving Automation</td>
<td></td>
</tr>
</tbody>
</table>

- BASt, SAE & OICA have consistent understanding of automation levels
- NHTSA shows divergence with SAE, OICA and BASt, different terminology, no distinction between level 4 and 5

[3] OICA working group „Automated Driving“. The definitions herein are not intended to supersede any existing regional standards, like for example SAE J3016.

Automated Driving, OICA, June 15, 2015

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Motivation for automated driving

Driver assistance and automated driving today

Definition of terms: Role of the driver vs. role of the system

Roadmap to automated driving and exemplary functions

Need for action

Conclusion
The technical complexity influences the roadmap to automated driving

<table>
<thead>
<tr>
<th>Low Velocity</th>
<th>High Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traffic Jam</strong></td>
<td><strong>Highways</strong></td>
</tr>
</tbody>
</table>
| Level 2 (limited*) already introduced  
Level 3 in development | Level 2 (limited*) already introduced  
Level 3 in development |

| Unstructured  
(complex) Traffic Environment | Parking and Maneuvering | Urban and Rural Roads |
|--------------------------------|-------------------------|-----------------------|
|                                | Level 2 already introduced  
Level 4 in research/development | Level 2 (limited*) already introduced  
Level 3 in research |

Automated Functions like Traffic Jam-, Highway- and Parking System are currently in development and can be introduced in midterm perspective.

* Current UN R 79 allows above 10 kph only corrective steering (lateral assistance). Therefore steering capability of today’s Level 2 functions is still limited.
OICA suggests that the IWG ITS/AD focuses on midterm relevant scenarios as a first priority.

<table>
<thead>
<tr>
<th>Urban and Rural Roads</th>
<th>Highway</th>
<th>Traffic Jam</th>
<th>Parking and Maneuvering</th>
</tr>
</thead>
<tbody>
<tr>
<td>already introduced (limited*)</td>
<td>already introduced (limited*)</td>
<td>already introduced (limited*)</td>
<td>already introduced</td>
</tr>
<tr>
<td>research area longterm relevant</td>
<td>research area longterm relevant</td>
<td>research area longterm relevant</td>
<td>future research area longterm relevant</td>
</tr>
</tbody>
</table>

* Current UN R79 allows only corrective steering above 10 km/h (lateral assistance). Therefore steering capability of today's Level 2 functions is still limited.
# Roadmap Automated Driving - Example Functions

<table>
<thead>
<tr>
<th>ADAS new</th>
<th>AEBS</th>
<th>FCW</th>
<th>ACC</th>
<th>Park Steer Ass.</th>
<th>Traffic Jam Ass.</th>
<th>Park Ass.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAS established</td>
<td>ABS</td>
<td>ESC</td>
<td>LKAS</td>
<td>Driver Only</td>
<td>Assisted</td>
<td>Partial Automation</td>
</tr>
<tr>
<td>Intervening only in Emergency</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **ADAS:** Advanced Driver Assistance Systems
- **AEBS:** Advanced Emergency Braking
- **ABS:** Antilock Braking System
- **ESC:** Electronic Stability Control
- **LKAS:** Lane Keeping Assistance
- **FCW:** Forward Collision Warning
- **ACC:** Adaptive Cruise Control
- **ACC:** Adaptive Cruise Control
## Roadmap Automated Driving - Example Functions

<table>
<thead>
<tr>
<th>Automation Gen. 1</th>
<th>ADAS new</th>
<th>ADAS established</th>
<th>Intervening only in Emergency</th>
<th>Driver Only</th>
<th>Assisted</th>
<th>Partial Automation</th>
<th>Conditional Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low velocity in structured environment</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

- **ADAS** Advanced Driver Assistance Systems
- **AEBS** Advanced Emergency Braking
- **ESC** Electronic Stability Control
- **ABS** Antilock Braking System
- **LKAS** Lane Keeping Assistance
- **FCW** Forward Collision Warning
- **ACC** Adaptive Cruise Control
- **ESC** Electronic Stability Control
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- **ESC** Electronic Stability Control
- **ABS** Antilock Braking System
- **AEBS** Advanced Emergency Braking
- **FCW** Forward Collision Warning
- **ACC** Adaptive Cruise Control

**Key Functions:**
- Traffic Jam Ass.
- Park Ass.

**Legend:**
- Existing
- Low velocity in structured environment

**Note:**
- LKAS: Lane Keeping Assistance
- FCW: Forward Collision Warning
- ACC: Adaptive Cruise Control
# Roadmap Automated Driving - Example Functions

## Automation Generations

<table>
<thead>
<tr>
<th>Automation Gen. 2</th>
<th>Automation Gen. 1</th>
<th>ADAS new</th>
<th>ADAS established</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>AEBS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ABS</td>
</tr>
</tbody>
</table>

## Automation Levels

- **Driver Only**
- **Assisted**
- **Partial Automation**
- **Conditional Automation**
- **High Automation**

<table>
<thead>
<tr>
<th>Intervening only in Emergency</th>
<th>Driver Only</th>
<th>Assisted</th>
<th>Partial Automation</th>
<th>Conditional Automation</th>
<th>High Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing</strong></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Low velocity in structured environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High velocity in structured environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Highway System**
- **Valet Parking System**
- **Highway Traffic Jam-System**

- **ESC**: Electronic Stability Control
- **ABS**: Antilock Braking System
- **AEBS**: Advanced Emergency Braking
- **FCW**: Forward Collision Warning
- **LKAS**: Lane Keeping Assistance
- **ACC**: Adaptive Cruise Control

**Adaptive Driver Assistance Systems (ADAS)**

- ADAS: Advanced Driver Assistance Systems
- AEBS: Advanced Emergency Braking
- ESC: Electronic Stability Control
- ABS: Antilock Braking System

**Legend**

- **Green**: Existing
- **Blue**: Low velocity in structured environment
- **Red**: High velocity in structured environment
## Roadmap Automated Driving - Example Functions

<table>
<thead>
<tr>
<th>Longterm Gens.</th>
<th>Urban &amp; rural roads</th>
<th>Robot Taxi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation Gen. 2</td>
<td>Highway System</td>
<td>Valet Parking System</td>
</tr>
<tr>
<td>Automation Gen. 1</td>
<td>Highway Traf. Jam-System</td>
<td></td>
</tr>
<tr>
<td>ADAS new</td>
<td>Traffic Jam Ass.</td>
<td>Park Ass.</td>
</tr>
<tr>
<td>ADAS established</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEBS</td>
<td></td>
<td></td>
</tr>
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<td>ABS</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>LKAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Park Steer Ass.</td>
<td></td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Intervening only in Emergency</th>
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<th>Conditional Automation</th>
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<th>Full Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Low velocity in structured environment</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>High velocity in structured environment</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Unstructured environment</td>
<td></td>
<td></td>
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</tr>
</tbody>
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ADAS Advanced Driver Assistance Systems
AEBS Advanced Emergency Braking
ESC: Electronic Stability Control
ABS: Antilock Braking System
LKAS: Lane Keeping Assistance
FCW: Forward Collision Warning
ACC: Adaptive Cruise Control
## Roadmap Automated Driving - Example Functions

<table>
<thead>
<tr>
<th>Long Term Gens.</th>
<th>Automation Gen. 1</th>
<th>ADAS established</th>
<th>ADAS new</th>
<th>Urban &amp; rural roads</th>
<th>Robot Taxi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Automation Gen. 1

- **ADAS established**
  - AEBS
  - ABS
  - ESC
  - LKAS
  - Park Steer Ass.

- **ADAS new**
  - FCW
  - ACC
  - Park Ass.

### Automation Gen. 2

- Traffic Jam Ass.
- Park Ass.

### Intervening only in Emergency

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Full Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>Low velocity in structured environment</td>
<td>High velocity in structured environment</td>
<td>Unstructured environment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Driver Only**
  - 0

- **Assisted**
  - 1

- **Partial Automation**
  - 2

- **Conditional Automation**
  - 3

- **High Automation**
  - 4

- **Full Automation**
  - 5

- **Urban & rural roads**
- **Highway System**
- **Valet Parking System**

**Legend**

- LKAS: Lane Keeping Assistance
- FCW: Forward Collision Warning
- ACC: Adaptive Cruise Control
- AEBS: Advanced Emergency Braking
- ABS: Antilock Braking System
**Exemplary functions**

**Level 2**
Partial Automation

**Parking Assistant**
Automated, driver initiated parking. Driver must monitor continuously, intervenes if necessary.

**Level 3**
Conditional Automation

**Lane Change Assistant**
Automated, driver initiated lane change. Limited to motorways. Driver must monitor continuously, intervenes if necessary.

**Level 4**
High Automation

**Valet Parking**
Automated valet parking. Driver initiates the function and can leave the scene.

**Low speed maneuvering**

**Steering maneuvers of limited duration combined with ACC**

**Driving for longer periods**

**Traffic Jam / Motorway Systems**

Automated longitudinal and lateral control. Limited to motorways. Driver must monitor continuously, intervenes if necessary.

Automated longitudinal and lateral control. Limited to motorways. Driver need not monitor continuously; will be requested to take over.

Automated longitudinal and lateral control. Limited to motorways. Driver need not monitor at all. Takeover by the driver is expected before the exit of the motorway.

Technology is already available or will be available soon.

Technology will probably be available as of 2020.

Technology will probably be available as of 2025.

**Source:** OICA, June 15, 2015
Current regulatory situation for UN Regulation and Road Traffic Code / Law

**UN R 79 steering equipment**
- Automatically Commanded Steering Function allowed only up to 10 km/h (parking maneuvers)
- Beyond 10kph, only „corrective steering function“ is allowed (LKAS)

Some Level 2, 3, 4, 5 systems are impossible with current requirements of UN-Regulations R 79 Amendment is necessary and urgent as a prerequisite for automated driving functions.

**VIENNA Convention & GENEVA Convention**
- The VIENNA Convention includes harmonized minimum requirements for the signatories
- A driver shall at all times be able to control his vehicle (Vienna Convention Art. 8 and 13)
- Requires a driver (Vienna Convention Art. 1 and 8)

Future Level 4 and 5 systems are mostly impossible with the current Vienna Convention and with the amendment from 2014, because a driver may not be required. Therefore, further evolution is necessary.

**National Traffic Laws**
- Often based on the VIENNA Convention, but details can be different for each country.

Level 3, 4 and 5 require evaluation for each country. Amendments may become necessary.
Roadmap/Principles on how to treat Automated Driving in UN regulations

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Vienna and Geneva Convention Amendment from March 2014</td>
</tr>
<tr>
<td>2015</td>
<td>Standardisation activities at ISO, CEN…etc… expected</td>
</tr>
<tr>
<td>2016</td>
<td>Amendment to UN R79 to allow Automatically Commanded Steering above 10kph</td>
</tr>
<tr>
<td>2018</td>
<td>Further evolution of the Vienna and the Geneva Convention expected</td>
</tr>
</tbody>
</table>

WP.29 1958 Agreement

WP.1

Standardisation organisation
Agenda

- Motivation for automated driving
- Driver assistance and automated driving today
- Definition of terms: Role of the driver vs. role of the system
- Roadmap to automated driving and exemplary functions
- Need for action
- Conclusion
Conclusion

• Levels of automation as presented are widely used
• Views on short/medium/long term introduction of systems are becoming clearer: level 4 (except some systems) and level 5 are not coming soon
• The higher the speed and the more complex the driving environment, the longer it will take to introduce automated driving
• Introduction of Automated Driving functions is expected to happen step-by-step and in an evolutionary way
• OICA reviewed all relevant elements in driving tasks and presented its understanding of DIL/DOL applied to the Levels of Automation
• OICA suggests that the IG ITS-AD:
  • uses the levels as presented as basis for further discussion
  • focusses on systems/levels that will be introduced in the short or medium term
• OICA aims at actively cooperating with UN stakeholders to jointly and positively advance the topic of automated driving and to make this a reality.
Backup
## Role of the Driver/System Proposal

<table>
<thead>
<tr>
<th>Role of the driver</th>
<th>Level0</th>
<th>Level1</th>
<th>Level2</th>
<th>Level3</th>
<th>Level4</th>
<th>Level5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic driving task</td>
<td>Yes</td>
<td>Yes</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>(Lateral or Longitudinal)</td>
<td>(Use case)</td>
<td>(Use case)</td>
<td>(Use case)</td>
<td>(All case)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving environment monitoring</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, but not at all times</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>(At all times)</td>
<td>(At all times)</td>
<td>(At all times)</td>
<td>(All case)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Be attentive to and follow system’s requests / warnings to resume the DDT</td>
<td>n.a.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, but only at the end of the use-case</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>(At all times)</td>
<td>(At all times)</td>
<td>(use case)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Role of the system</th>
<th>Level0</th>
<th>Level1</th>
<th>Level2</th>
<th>Level3</th>
<th>Level4</th>
<th>Level5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving dynamics</td>
<td>n.a.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>(Lateral or Longitudinal)</td>
<td>(Lateral/ Longitudinal combination)</td>
<td>(Lateral/ Longitudinal combination)</td>
<td>(Lateral/ Longitudinal combination)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving environment monitoring</td>
<td>n.a.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>(At all times)</td>
<td>(At all times)</td>
<td>(At all times)</td>
<td>(At all times)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Request the driver with sufficient lead time to control when performance limits are reached</td>
<td>n.a.</td>
<td>n/a*</td>
<td>n/a*</td>
<td>Yes</td>
<td>Yes (only at the end of the use-case)</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognize Performance Limits</td>
<td>n.a.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Achieve minimum risk condition</td>
<td>n.a.</td>
<td>No</td>
<td>No</td>
<td>No**</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*since driver has to react immediately
**System can not achieve minimal risk condition at all times. Fallback Performance of dynamic driving task is with the driver.
Exemplary Level Comparison for a Motorway Scenario

- System relieves driver and potentially enhances safety to traffic
- Driver must deliberately activate system and can override/switch off the system at any time
- Longitudinal and lateral control is performed by the system

**Motorway System (Level 2)**

**Driver**
Monitors the driving environment at all times, must be ready to intervene immediately if necessary.

**System**
Performs longitudinal and lateral control on motorways in simple traffic situations with well developed infrastructure.

**Motorway System (Level 3)**

**Driver**
Does not need to monitor the driving environment at all times but must remain attentive to system's requests and warnings in order to take over within a transition time. !Attentive to system requests and ready to take over!

**System**
Performs longitudinal & lateral control (as well in emergency situations) in typical traffic situations like long distance driving, traffic jams, tunnels, high curvature geometry. Warns the driver when performance limits are reached - takeover is necessary.

**Motorway System (Level 4)**

**Driver**
Driver is not required, has however the possibility to override/switch off at any time.

**System**
Performs longitudinal & lateral control in all encountered traffic situations on motorways. Request the driver to take over at the end of the use case. A risk-minimal maneuver is guaranteed if the driver fails to takeover the driving tasks.
Glossary of Terms

- **Dynamic Driving Task**: Performing the lateral and the longitudinal driving task by considering the driving environment.

- **Driving Environment**: The outside surrounding of the vehicle in on-road traffic e. g.:
  - Road markings, road signs, road infrastructure
  - Other vehicles, objects on the road/roadside, other traffic members (pedestrians, cyclists, etc…)

- **Monitoring (according to SAE J3016)**: The activities and/or automated routines that accomplish comprehensive object and event detection, recognition, classification, and response preparation, as needed to competently perform the dynamic driving task.

- **Defined Use Case**: A driving scenario (including e. g. the driving environment, expected velocities) for which the dynamic driving task (longitudinal and lateral control) is automated. Example: Highway Chauffeur – a function that performs only on a highway, up to a max. velocity and limited or not to certain manoeuvres (according to the system limitations and thus the level of automation).
<table>
<thead>
<tr>
<th><strong>Driver in the Loop</strong></th>
<th><strong>ADAS Principle: RE3 Annex5–Appendix 3 (Extract)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The notion of <em>driver-in-the-loop</em> means that a driver is involved in driving task and is aware of the vehicle status and road traffic situation. Being <em>in-the-loop</em> means that the driver plays an active role in the driver–vehicle system. They actively monitor information, detect emerging situations, make decisions and respond as needed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Driver in Control</strong></th>
<th><strong>Regulatory Road Law: Vienna Convention (Extract)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Article 8 and 13</strong></td>
</tr>
<tr>
<td></td>
<td>“<em>Every driver shall at all times be able to control his vehicle or to guide his animals.</em>“</td>
</tr>
<tr>
<td></td>
<td>“<em>Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him.</em>“</td>
</tr>
<tr>
<td></td>
<td>The above mentioned articles require the driver to be in <em>control</em> at all times. According to the recent proposal for amendment from 2014, systems are deemed to be in compliance with this requirement as long as they can be overridden or deactivated by the driver at any time. If stipulated different by other UNECE/GTR vehicle regulation, the system is also in compliance with this requirement.</td>
</tr>
</tbody>
</table>
With regard to automated driving, following requirements are important:

**Control:**

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

Article 13 (Speed and distance between vehicles), Paragraph 1:
“Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him. […]”

**Driver:**

Art. 8.1:
“Every moving vehicle or combination of vehicles shall have a driver.”

Art. 1 Definition (v):
“Driver” means any person who drives a motor vehicle or other vehicle (including a cycle), or who guides cattle,…, on a road.

Art. 1 Definition (d):
“Road” means the entire surface of any way or street open to public traffic.