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

June 15, 2015, VDA Berlin

Corrected version 03.11.2015, Geneva
Slides 9, 10, 11 - Basic categories of system functions - harmonized with published categories of BAS (Federal Highway Research Institute), Federal Republic of Germany

B = automated systems (instead C)
C = systems that intervene in emergency (instead B)
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>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Road Safety: Vision Zero</strong></td>
<td>Road safety improvements by reducing human driving errors</td>
</tr>
<tr>
<td>2</td>
<td><strong>Traffic management</strong></td>
<td>- Optimization of traffic flow management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Convenient, time efficient driving via automation</td>
</tr>
<tr>
<td>3</td>
<td><strong>Reducing Emissions</strong></td>
<td>Reduction of fuel consumption &amp; CO2 emission (through optimization of traffic flow management)</td>
</tr>
<tr>
<td>4</td>
<td><strong>Demographic Change</strong></td>
<td>- Support unconfident drivers</td>
</tr>
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<td>- Enhance mobility for elderly people</td>
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<tr>
<td>5</td>
<td><strong>Innovation High technology</strong></td>
<td>- New economic paradigm – supporting innovation policies of regions, nations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Competitiveness / high skill employment</td>
</tr>
</tbody>
</table>
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
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

Bertha Benz drive
2013 Mercedes

Super Cruise
2014 GM

Motorway Pilot
2011 BMW

Automated Highway Driving
2014 HONDA

Traffic Jam Pilot
2012 Audi

Highway Automated Driving
2014 PSA

Drive Me
2013 Volvo

Automated Driving
2014 Renault

Field Test on Highway
2013 Nissan

Automated Highway Driving
2014 Toyota/Lexus

Automated Driving

Automated Highway Driving

Automated Transport Solution

Automated Driving

2015 Future Truck 2025 MB Trucks

2015 Freightliner Inspiration Truck

Scania Autom. Transport Solution

Volvo Trucks
Agenda

- Motivation for automated driving
- Driver assistance and automated driving today
- Definition of terms: Role of the driver vs. role of the system
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### Basic Categories of System Functions

<table>
<thead>
<tr>
<th>Category A</th>
<th>Category B: Automated (From advanced driver assistance towards „automated driving“)</th>
<th>Category C: Intervening in Emergency (close-to-accident situations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information and Warning (classic driver assistance)</td>
<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>
</tr>
<tr>
<td>Examples: • Speed Limit Information • Lane Departure Warning (e.g. steering wheel vibration) • Lane Change Warning/Blindspot Detection (e.g. flashlight in the mirror base)</td>
<td>Direct influence on the dynamic driving task (driver can always switch off or override the system)</td>
<td>Examples: • Automatic Emergency Braking • Emergency Stop Assistant (e.g. in a medical emergency case) • ESC, ABS</td>
</tr>
</tbody>
</table>

Based on a concept of BASt (Federal Highway Research Institute, Germany)

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Automated Driving, OICA, June 15, 2015
Levels of Automated Driving (Category B)

- **Level 0-1**: Driver Only / Assisted
  - No Automation

- **Level 2**: Partial Automation
  - Driver monitors the automated driving functions at all times.

- **Level 3**: Conditional Automation
  - System monitors its performance limits and transfers to the driver within a transition time when reaching the performance limits.

- **Level 4**: High Automation
  - System copes with all tasks within a specific use-case.

- **Level 5**: Full Automation
  - System copes with all tasks in all situations. No driver required.
Levels of Automated Driving (Category B)
Updated from WP29-162-20 (March 2014)

Level of automation*

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 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 a defined use case.

System performs the lateral and longitudinal dynamic driving task in all situations in a defined use case. Recognizes its performance limits and requests driver to resume the dynamic driving task with sufficient time margin.

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

→ Autonomous Vehicle

Level 0
Driver Only

Level 1
Assisted

Level 2
Partial Automation

Level 3
Conditional Automation

Level 4
High Automation

Level 5
Full Automation

*terms acc. to SAE J3016
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.
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

*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

*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.).

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

**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;

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.
Role of the driver and system in Level 4

**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.
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>BAS1, SAE2, OICA3</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>NHTSA4</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>

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

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

Agenda

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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>
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</thead>
<tbody>
<tr>
<td><strong>Traffic Jam</strong></td>
<td><strong>Highways</strong></td>
</tr>
<tr>
<td>Structured Traffic Environment</td>
<td>Unstructured (complex) Traffic Environment</td>
</tr>
<tr>
<td>Level 2 (limited*) already introduced Level 3 in development</td>
<td>Level 2 (limited*) already introduced Level 3 in development</td>
</tr>
<tr>
<td>Parking and Maneuvering</td>
<td>Urban and Rural Roads</td>
</tr>
<tr>
<td>Level 2 already introduced Level 4 in research/development</td>
<td>Level 2 (limited*) already introduced Level 3 in research</td>
</tr>
</tbody>
</table>

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.
Roadmap’s influence on the Informal Working Group

→ OICA suggests that the IWG ITS/AD focuses on midterm relevant scenarios as a first priority

<table>
<thead>
<tr>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>already introduced (limited</em>)</td>
<td>research area longterm relevant</td>
<td>research area longterm relevant</td>
<td>future research area longterm relevant</td>
</tr>
<tr>
<td>Urban and Rural Roads</td>
<td>Highway</td>
<td>Traffic Jam</td>
<td>Parking and Maneuvering</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>ADAS established</th>
<th>Intervening only in Emergency</th>
<th>Driver Only</th>
<th>Assisted</th>
<th>Partial Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AEBS</td>
<td>FCW</td>
<td>ABS</td>
<td>ESC</td>
<td>LKAS</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Park Steer Ass.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ACC</td>
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<tr>
<td></td>
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<td>Park Ass.</td>
</tr>
<tr>
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<td></td>
<td>Traffic Jam Ass.</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

Existing
### 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>AEBS</td>
<td>FCW</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td></td>
<td></td>
<td>ABS</td>
<td>LKAS</td>
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<td></td>
<td></td>
<td>ESC</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Park Ass.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Park Steer Ass.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Traffic Jam Ass.</td>
<td></td>
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<tr>
<td></td>
<td>Highway Traf. Jam-System</td>
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</tr>
</tbody>
</table>

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

**Existing**
- Low velocity in structured environment

**Note:**
- ADAS Advanced Driver Assistance Systems
- OICA: Organization for International Motor Vehicle Co-operation
- ITS/AD: Intelligent Transport Systems/Advanced Driver Assistance Systems

**Source:**
- Automated Driving, OICA, June 15, 2015

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## Roadmap Automated Driving - Example Functions

<table>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Automation Gen. 1</td>
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<td></td>
</tr>
<tr>
<td>ADAS new</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADAS established</td>
<td>AEBS</td>
<td>FCW</td>
<td>ACC</td>
<td>LKAS</td>
<td>Park Steer Ass.</td>
</tr>
<tr>
<td></td>
<td>ABS</td>
<td>ESC</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Intervening only in Emergency

<table>
<thead>
<tr>
<th>Driver Only</th>
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<th>Conditional Automation</th>
<th>High Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Highway System**

**Valet Parking System**

**Highway Traf. Jam-System**

**Traffic Jam Ass.**

**Park Ass.**

**Existing**

**Low velocity in structured environment**

**High velocity in structured environment**

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**Legend:**

- 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
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**Notes:**

- 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
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## Roadmap Automated Driving - Example Functions

<table>
<thead>
<tr>
<th>Longterm Gens.</th>
<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>
<td>ABS, ESC, LKAS</td>
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### Intervening only in Emergency

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<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### Environment types

- **Existing**: Low velocity in structured environment
- **Low velocity in structured environment**
- **High velocity in structured environment**
- **Unstructured environment**

### System Types

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

### Functions

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

**Legend**

- **ADAS**: Advanced Driver Assistance Systems
- **AEBS**: Advanced Emergency Braking Systems
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- **ACC**: Adaptive Cruise Control

**Note:**
Automated Driving, OICA, June 15, 2015
### Roadmap Automated Driving - Example Functions

#### Long Term Gens.

#### Automation Gen. 2

#### Automation Gen. 1

#### ADAS new

<table>
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</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>
</tbody>
</table>

#### Example Functions

- **Urban & rural roads**
- **Robot Taxi**
- **Urban & rural roads**
- **Highway System**
- **Valet Parking System**
- **Highway Traffic Jam-System**
- **Traffic Jam Ass.**
- **Park Ass.**

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ADAS Advanced Driver Assistance Systems
AEBS Advanced Emergency Braking
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Exemplary functions

**Level 2** Partial Automation

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

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

**Level 3** Conditional Automation

- **Traffic Jam / Motorway Systems**
  Automated longitudinal and lateral control. 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.

- **Takeover by the driver is expected before the exit of the motorway.**

- **Low speed maneuvering**
  - **Steering maneuvers of limited duration combined with ACC**

- **Driving for longer periods**

  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.

Terms acc. to SAE J3016

Automated Driving, OICA, June 15, 2015
Motivation for automated driving

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

Roadmap to automated driving and exemplary functions

Need for action

Conclusion
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

- Amendment to UN R79 to allow Automatically Commanded Steering above 10kph
- Vienna and Geneva Convention Amendment from March 2014
- Further evolution of the Vienna and the Geneva Convention expected
- Standardisation activities at ISO, CEN…etc…

Timeline:
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

WP.29 1958 Agreement
WP.1
Standardisation organisation
Agenda

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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
  • focuses 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.
## Role of the Driver/System Proposal

<table>
<thead>
<tr>
<th>Role of the driver</th>
<th>Level0</th>
<th>Level1 (Lateral or longitudinal)</th>
<th>Level2 (Use case)</th>
<th>Level3 (Use case)</th>
<th>Level4 (Use case)</th>
<th>Level5 (All case)</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>Driving environment monitoring</td>
<td>Yes</td>
<td>Yes (At all times)</td>
<td>Yes (At all times)</td>
<td>Yes, but not at all times</td>
<td>n.a. (use case)</td>
<td>n.a.</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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Role of the system</th>
<th>Level0</th>
<th>Level1 (Lateral or Longitudinal)</th>
<th>Level2 (Lateral/ Longitudinal combination)</th>
<th>Level3 (Lateral/ Longitudinal combination)</th>
<th>Level4 (Lateral/ Longitudinal combination)</th>
<th>Level5 (Lateral/ Longitudinal combination)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving dynamics</td>
<td>n.a.</td>
<td>Yes (At all times)</td>
<td>Yes (Lateral/ Longitudinal combination)</td>
<td>Yes (Lateral/ Longitudinal combination)</td>
<td>Yes (Lateral/ Longitudinal combination)</td>
<td>Yes (Lateral/ Longitudinal combination)</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>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>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 *takeover within a transition time*.

**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.

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**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 takeover 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 manoeuvers (according to the system limitations and thus the level of automation).
### ADAS Principle: RE3 Annex5–Appendix 3 (Extract)

| **Driver in the Loop** | The notion of *driver-in-the-loop* means that a driver is involved in driving task and is aware of the vehicle status and road traffic situation. Being *in-the-loop* 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. |

### Regulatory Road Law: Vienna Convention (Extract) Article 8 and 13

| **Driver in Control** | “Every driver shall at all times be able to control his vehicle or to guide his animals.”

“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.”

The above mentioned articles require the driver to be in control 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. |
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.

adressed by the amendment from 2014