Automated Driving

What is it?

Do we need changes in UNECE Technical Regulations?

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OICA Secretary General
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
Regulatory situation
Conclusion
Today’s Driver Assistance/Automated Systems

Examples of what already exists

**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
## Basic Categories of System Functions

<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><strong>Information and Warning (classic driver assistance)</strong></td>
<td><strong>Only indirect influence on the dynamic driving task by the driver (driver controls everything)</strong></td>
<td><strong>Direct influence on the dynamic driving task (driver is definitely not able to master the situation)</strong></td>
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<tr>
<td><strong>Examples:</strong></td>
<td><strong>Examples:</strong></td>
<td><strong>Examples:</strong></td>
</tr>
<tr>
<td>• Speed Limit Information</td>
<td>• Lane Departure Warning (e.g. steering wheel vibration)</td>
<td>• ESC, ABS</td>
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<tr>
<td>• Lane Change Warning/Blindspot Detection (e.g. flashlight in the mirror base)</td>
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<td>• Adaptive Cruise Control</td>
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</table>

Based on a concept of BASf (Federal Highway Research Institute, Germany)
Levels of Automated Driving (Category C systems)

- **Level 0 (Driver Only)**: Driver continuously performs the longitudinal and lateral dynamic driving task. No intervening vehicle system active.

- **Level 1 (Assisted)**: Driver continuously performs the longitudinal or lateral dynamic driving task. The other driving task is performed by the system.

- **Level 2 (Partial Automation)**: Driver must monitor the dynamic driving task and the driving environment at all times. System performs the lateral and longitudinal dynamic driving task in a defined use case.

- **Level 3 (Conditional Automation)**: 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. 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.

- **Level 4 (High Automation)**: 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. Autonomously.

- **Level 5 (Full Automation)**: System performs the lateral and longitudinal dynamic driving task in all situations in a defined use case.

* Levels of automation based on terms acc. to SAE J3016.
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

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.
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 detects the driving environment to a limited degree

*Driver must be ready to immediately intervene if necessary: 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: he/she must perform the longitudinal or lateral dynamic driving task and remain ready to intervene at all times in the other driving task.
The driver must be ready to immediately intervene when 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.
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; aware of the system status

System

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

**In case the system reaches its performance limits (e.g. weather conditions, missing lane markings, etc.), the driver is expected to resume the dynamic driving task: driver 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: 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
  - \(\text{**Driver may naturally look from time to time at the driving environment, however he is not expected to have a response on the driving task.**}\)
- 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.
Level 5: Role of the driver and system

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.

The activated system performs all driving tasks at all times. Driver is not necessarily present anymore and therefore not in the loop.
The technical complexity influences the roadmap to automated driving

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

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

* Current UN R79 allows, above 10 kph, only corrective steering (lateral assistance). Therefore steering capability of today's Level 2 is still limited.
Current regulatory situation for UN Regulations 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-Regulation R 79 (steering) 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, 5 systems are mostly impossible even with the 2014 amendment to the Vienna Convention, because a driver may not be required depending on the use case. 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 regulatory/standardisation aspects

Amendment to UN R79 to allow Automatically Commanded Steering above 10km/h

Vienna and Geneva Convention Amendment from March 2014

Further evolution of the Vienna and the Geneva Convention expected

Standardisation activities at ISO, CEN…etc…

WP.29 1958 Agreement

WP.1

Standardisation organisation

Conclusion

- Levels of Automation as presented are widely used.
- Views on short/medium/long term introduction of automated driving are becoming clearer: level 4 (except for 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.
- The key issue in terms of technical regulations (UNECE) is the amendment to UN R79 currently in development to allow automatically commanded steering functions at speeds > 10 km/h.
- Other existing UN Regulations do not appear to prevent the introduction of automated vehicles at increasing levels – only minor adjustments may be needed (e.g. automatic activation of direction indicators).
- There is no perceived contradiction between the future expected evolution of the Vienna Convention and the absence of specific UN Regulation(s) for automated vehicles: the "driver" will still be in control (switch on/off and override) in the foreseeable future.
- Main issue in general is with traffic code and the risk of fragmented conditions depending on the country/region.
Thank you for your attention