Submitted by the expert from EC

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Background to the Ec comments on the proposal for the Definitions of Automated Driving under WP.29 and the General Principles for developing a UN Regulation

- The expert from the European Commission would like to thank Japan for submitting ITS/AD-08-03 as a basis for discussion.. As a background to its comments, the expert from European Commission would like to refer to an on-going project in the EU: Adaptive. The project has developed an harmonized classification and glossary that is publicly available: https://www.adaptive-ip.eu/files/adaptive/content/downloads/Deliverables%20&%20papers/AdaptIVe-SP2-v12-DL-D2.1%20System%20Classification.pdf
- The webpage of the full project is available here: https://www.adaptive-ip.eu/
- This classification developed by Adaptive could help for the discussion of the table on Document No. ITS/AD-08-03. In particular before going to the relevant requirements for each of the SAE level it would be good to agree in a more detailed way on what is meant by the different levels.
- An extract of the study is reproduced here below(Annexes 1 and 2 are particularly relevant for the discussion on ITS/AD-08-03).

A 1.1.2 Level 1

While Level 0 systems cannot execute any parts of the dynamic driving task, Level 1 systems execute parts of the dynamic driving task (steering, accelerating/braking) The driver is in the loop completing the dynamic driving tasks consisting of the object and event detection and response (OEDR) subtask and either lateral or longitudinal control that is not being automated.

The driver's task is to monitor the driving environment, to execute either longitudinal (accele-ration/braking) or lateral (steering) dynamic driving task, to constantly supervise the dynamic driving task executed by driver assistance system, to determines when activation or deactivation of assistance system is appropriate and to take over immediately when required [2].

The system executes those portions of the dynamic driving task which are not executed by the human driver when activated and can deactivate immediately with request for immediate takeover (there is no transition/takeover demand, rather a warning by the system that it does not continue to perform) by the human driver [2].

Typical examples include: Adaptive Cruise Control (ACC), Parking Assistance with automated steering, Lane Keeping Assistance (LKA) Type II and a combination of ACC with LKA Type II systems.

Remark 1: The driver may not perform secondary side-tasks as this will hamper him in taking over immediately when required. This shall be without prejudice to commonly accepted non-driving-related activities such as changing radio stations or air conditioning settings.

Remark 2: Current LKA systems require the driver to apply a steering momentum. If the driver doesn't do so, the system is disengaged and a warning is issued, often followed by the system switching to stand-by. The driver is still responsible for supervising and executing lateral control in parts (he must apply a steering momentum) and therefore is still continuously involved into the dynamic driving task. This is true for LKA systems, which apply a course corrective steering momentum, if the vehicle is going to leave the lane (Type I systems) and also if the vehicle is going to leave the center of the lane (Type II systems). This is also true for a combination of ACC and Type I or Type II LKA so this combination is still a Level 1 system. Only a combination of ACC and lane centered lateral control, where the driver need not apply any steering momentum (LKA Type III), would be a Level 2 system.

Remark 3: Existing driver assistance systems continuously affecting longitudinal and lateral control as well as combinations of such systems are depicted in Table 5.2 together with their level of automation. Cruise Control (CC), Adaptive Cruise Control (ACC) and Lane Keeping Assistance (LKA) are explained in A2.1, A2.2 and A2.3, respectively. LKA Type I & II systems refer to LKA systems that apply a course corrective steering momentum if the vehicle is going to leave the lane or the center of the lane, while LKA Type III systems center the vehicle in the middle of the lane without the driver applying any steering momentum. It becomes obvious, that those systems and their combination are mostly Level 1 systems.

A 1.1.3 Level 2

While Level 1 systems share the dynamic driving task (steering, accelerating/braking, OEDR) between driver and system, Level 2 systems execute the lateral and longitudinal control dynamic driving subtasks completely with the driver in the loop executing the OEDR subtask.

The driver's task is to execute the OEDR by monitoring the driving environment and responding if necessary, to constantly supervise the lateral and longitudinal control dynamic driving subtasks executed by the system, to determine when activation or deactivation of the system is appropriate, and to take over immediately when required [2].

The system executes longitudinal (accelerating, braking) and lateral (steering) dynamic driving tasks when activated and can deactivate immediately upon request for immediate takeover by the human driver [2].

Typical examples include: Traffic Jam Assistance (refer to A2.9) and Key Parking (refer to A2.14).

Remark 1: As for Level 1 systems the driver may not perform secondary tasks which will hamper him in taking over immediately when required. This shall be without prejudice to commonly accepted non-driving-related activities such as changing radio stations or air conditioning settings.

Remark 2: In Level 2 systems the driver is no longer continuously involved in the lateral and longitudinal control subtask of the dynamic driving task; the driver does not have to constantly steer or accelerate/brake, so he is disengaged from constantly physically operating the vehicle e.g. by having his hands off the steering wheel and foot off pedal at the same time. Although the driver is physically disengaged, mentally the driver must be engaged and must monitor the driving environment and must immediately (there is no transition demand, rather a warning by the system that it does not continue to perform) intervene when required, e.g. in case of an emergency or system failure. A driver availability recognition function (could be realized as hands-on detection) could evaluate the driver's involvement in the monitoring task.

A 1.1.4 Level 3

While Level 2 systems require the driver to be attentive and to monitor the driving environment, Level 3 systems allow the driver to turn his attention away from the complete dynamic driving task (steering, accelerating/braking, OEDR) in certain domains that the system is designed to operate in, e.g. during a traffic jam on a motorway.

The driver's task is to determine when activation of the automated driving system is appropriate and to take over upon request within a limited period of time (transition demand). The driver may also request deactivation of the automated driving system [2]. The driver must remain sufficiently vigilant as to acknowledge the transition demand (and thus the system status), acknowledge vehicle warnings (e. g. TPMS, empty fuel tank, changes in ride comfort due to a

faulty mechanical shock absorber that is not being diagnosed by the Lv3 system and thus not necessarily issues a transition demand, etc.) and acknowledge e.g. emergency vehicles approaching. In general, Level 3 systems still require a driver to take over manual driving at a certain point in time. (Thus the driver must remain in a posture and in a mental state as to allow a manual takeover in a timely manner at all times during the Level 3 driving phase. – statement already contained in Remark 1). Thus the driver is considered to be part of the loop.
The system monitors the driving environment when activated; permits activation only under conditions (use cases and operational design domain) for which it was designed; executes longitudinal (accelerating/braking) and lateral (steering) portions of the dynamic driving task when activated; deactivates only after requesting the driver to take-over with a sufficient lead time; may − under certain, limited circumstances − transition (at least initiate) to minimal risk condition if the human driver does not take over; and may momentarily delay deactivation when immediate human takeover could compromise safety [2].
Typical example: Traffic Jam Chauffeur (refer to A2.15).
Remark 1: For Level 3 systems, with the driver providing the ultimate fallback performance, he must be in position to resume control within a short period of time when a takeover request occurs. This may happen with an increased lead time, but the driver must react. Therefore only secondary tasks with appropriate reaction time are allowed. This would in an extreme case exclude e.g. sleeping or leaving the driver's seat. Driver (availability recognition) activation monitoring might be used to avoid such unintended use. Potential technical solutions range from detecting the driver's manual operations to monitoring cameras to detect the driver's head position and eyelid movement.
Remark 2: To enable predictable and reproducible takeover scenarios it would be beneficial if vehicle displays that are controlled by the automation system would be used for secondary tasks (e.g. texting, internet surfing, video-telephony). If a takeover request occurs the secondary task content on the display is faded out and the takeover request is displayed instead.
Remark 3: The driver may capable of reacting to emergency braking maneuvers of the vehicle in front of the driver due to secondary tasks. Such scenarios must be accomplished by the system and not be expected from the driver.

A 1.1.5 Level 4

The driver's task is to determine when activation of the automated driving system is appropriate, and to take over upon request within lead time. The driver may also request deactivation of automated driving system [2].
The system monitors the driving environment when activated, permits activation only under conditions (use cases and operational design domain) for which it was designed, and executes longitudinal (accelerating, braking) and lateral (steering) portions of the dynamic driving task as well as OEDR when activated. It also initiates deactivation when design/boundary conditions are no longer met - e.g. requests driver to take over and initiates deactivation to reach a minimal risk condition if driver does not respond to the takeover request - fully deactivates only after human driver takes over or minimal risk condition is achieved; transitions to minimal risk condition if human driver does not take over, and may momentarily delay deactivation when immediate human takeover could compromise safety [2].
Typical example: Driverless Valet Parking, (, Traffic Jam System Lv4, Campus Shuttle, "City Taxi" limited to e.g. an geofenced area) (refer to A2.19, A2.21).
Remark: Level 4 systems do not require the driver to provide fallback performance. Therefore the system must be capable of transferring the vehicle to a minimal risk condition within the operational design domain. This might increase technical effort.
A driverless Valet Parking system or a campus shuttle system do not require a driver to takeover at the end of the use-case, thus a driver is not needed and hence the driver is out of the loop. In contrast, if the motorway or traffic jam system still require a driver to finally take over at the end of use case, a driver is still needed (although a minimal risk maneuver is being performed until stillstand, if there is a takeover demand it means that the driver is asked to resume control).

A 1.1.6 Level 5

While Level 4 systems accomplish vehicle guidance only in a specific operational design domain e.g. during a traffic jam on a motorway and do not offer high automation apart from that specific operational design domain, level 5 systems can accomplish the complete journey from origin to destination in a high automation modus, and can do so anywhere on-road that a human can legally drive a vehicle. Except activation, deactivation and determining waypoints and destinations, no human driver is required any longer – and hence the driver cannot be in the loop.
The driver may activate the automated driving system and may request deactivation of the automated driving system [2].
When activated, the system monitors the driving environment, executes longitudinal (accelerating/ braking) and lateral (steering) as well as the OEDR subtasks of the dynamic driving task, deactivates only after the human driver takes over or vehicle reaches its destination, transitions to a minimal risk condition as necessary if failure in the automated driving system occurs, and may momentarily delay deactivation when immediate human driver takeover could compromise safety [2] – if the human driver has the means of deactivation at all.
Typical example: Universal Robot Taxi (refer to A2.27).
Remark 1: Level 5 systems can complete any on-road journey from origin to destination without the help of a human driver. Consequently typical driver controls are not required in an extreme scenario (no steering wheel, pedals or instrument cluster). Completely new vehicle designs or even completely new classes of vehicles are possible.