TRL feedback on ALKS

1 Introduction

The Commission have requested TRL to provide feedback on a draft proposal for Automated Lane Keeping Systems (ALKS), 'Proposal for Technical Requirements for an Automated Lane Keeping System', to support a UN informal working group in the development of requirements and tests for these types of systems.

From our understanding an ALKS is designed to operate at speeds below 60 km/h (low speeds) and on roads where 1) pedestrian and cyclists are prohibited and 2) there is a physical separation dividing the traffic moving in opposite directions (motorways), portraying a motorway traffic jam type of system.

This document is divided into four sections. The first highlights our concerns with certain aspects of the Driver Availability Recognition System; the second highlights potential additions and adaptations to the text; the third highlights other considerations; and the fourth covers aspects which need to be clarified.

The document is written well and is easy to read.

2 Driver Availability Recognition System

2.1 Drowsiness

One of the requirements for the Driver Availability Recognition System for ALKS is to monitor the driver's availability to take over the dynamic driving task safely without endangering themselves or other road users. According to the regulation, a driver will be deemed available if they meet at least one of the following requirements:

- Input to any driver-exclusive vehicle controls during a rolling interval of 30 s
- Driver shows conscious head or body movement during a rolling interval of 35 s
- Drivers eyes have not been detected continuously for a rolling interval of 4 s

If a driver does not fulfil at least one of the requirements, where a minimum of [two] needs to be monitored by the system (Clarification required, please refer to Section 5.1), the system will provide a distinctive warning until appropriate action(s) of the driver is detected or until a transition demand is initiated. Depending on the system configuration (dependent on OEMs), the driver may have up to 15 s to display an appropriate action before a transition demand is initiated.

From our understanding of the availability requirement highlighted above and in Section 2.6.2 in the 'Proposal for Technical Requirements for an Automated Lane Keeping System', the system is assessing whether the driver is asleep or awake (unconscious or conscious), where the length of time that driver can be asleep before detection by the system is dependent on the two availability criteria being assessed by the system. For example:

- If eye closure and input to any driver-exclusive vehicle controls were being monitored, a driver can be asleep for 4 s before the system detects they are asleep
- If input to driver-exclusive vehicle control and head or body movement were being monitored, a driver can be asleep for up to 30 s before the system detects that they are asleep

It is well established that a drowsy driver is unable to drive a vehicle safely i.e. slower steering responses, increased variation in lane position, reduced reaction time, decreased awareness to safety-critical tasks and impaired visual awareness etc, and the driving behaviours characteristic of a drowsy driver become worse as the driver's level of drowsiness increases. The only way in which the driver can recover from this state is by sleeping or taking a break from the driving task. This is evident with the work TRL are supporting the European Commission with on DDAM systems. These systems are designed to alert the driver before they reach a level of drowsiness which is unsafe for driving, encouraging the driver to take a break before they reach an unsafe level or fall asleep.

With regards to ALKS, the system is not only allowing the driver to exceed a drowsiness level which is unsafe for driving but is also allowing the driver to fall asleep. When this occurs, the driver is expected to take back control of the vehicle and to perform the driving task safely, which is highly unlikely due to their drowsy state. For example, if a driver were to be unexpectedly woken up, the driver will likely exhibit dangerous drowsy driving behaviours (high level of drowsiness) and may fall asleep again. The driver will likely be able to perform the appropriate action as stated by the regulation to prevent a transition demand from being initiated; however, the driver will still be in a state that is unsafe for driving and should not be allowed to take back control of the vehicle until their drowsiness level has reduced to a safe level. Moreover, if a transition demand were to occur due to the driver not responding appropriately or due to other factors such as an increase in the speed over 60 kph, manual deactivation or overriding the system, the driver could meet the requirements for driver attentiveness (hands on the steering wheel and eye gaze on the driving task), but be in an unsafe state to drive increasing the risk of an accident occurring.

Also, if a driver were to experience a microsleep (several seconds up to 30 seconds), the system may not detect that the driver has fallen asleep, allowing the driver to have several microsleeps whilst ALKS is activated. Alternatively, if the system does detect the driver is experiencing a microsleep, the driver can respond appropriately preventing a transition demand and allowing the driver to have several microsleeps whilst ALKS is activated. It is also important to note that if the driver is deemed unavailable, the system allows up to 15 seconds for the driver to respond appropriately before a transition demand is initiated, allowing the driver an additional 15 seconds of sleep.

Therefore, if a driver falls asleep whilst ALKS is activated, the driver is not in a position to drive the vehicle safely, and hence the system should not hand control of the vehicle back to the driver, irrespective of whether they are deemed attentive. Instead, the vehicle should be continuously monitoring the driver's level of drowsiness and should only hand back control, if the driver is deemed to be at a drowsiness level which is safe for driving (i.e. the driver's level of drowsiness should be below a yet-to-be-determined drowsiness threshold). If the driver is approaching the yet-to-be-determined drowsiness threshold, the ALKS should inform

the driver that they are approaching this threshold and will need to take back control of the vehicle. This is a safer approach to the one highlighted in this proposal as it ensures the driver is not taking back control when they are in an unsafe driving state. Moreover, the soon-to-be regulated Driver Drowsiness and Attention Monitoring (DDAM) system which will be activated once control is handed back to the driver, will continue to monitor the driver's drowsiness state and, will detect and alert the driver when they are approaching a drowsiness level which is unsafe for driving encouraging them to take a break.

Another safety concern, which further emphasises the need to monitor driver drowsiness levels, surrounds the deactivation and override functions of the system. Currently the driver is able to perform these functions irrespective of their fatigued state, which is extremely dangerous i.e. a driver is able to have a microsleep and is able to override the system directly afterwards if they wish to do so. This can be overcome by monitoring the driver's drowsiness level and only having ALKS activated when the driver is at a drowsiness level which is deemed safe for driving (i.e. before the yet-to-be-determined drowsiness threshold).

With regards to activation, the driver should only be able to activate the system if they are deemed to be below the yet-to-be-determined drowsiness threshold. This, for example, can be monitored by the vehicles Driver Drowsiness and Attention Monitoring system (DDAM), which will be implemented in all newly manufactured vehicles in the Europe from the end of 2020.

Monitoring the driver's level of drowsiness against the yet-to-be-determined drowsiness threshold ensures the driver is always in a safe state to drive the vehicle. It is recommended that the established threshold is at a drowsiness level where the driver is able to take back control of the vehicle safely and is able to continue driving for an extended period of time without placing themselves or other road users in danger (i.e. predicting the on-set of fatigue or detecting very early signs of drowsiness).

2.2 Driver attentiveness

The draft regulation text states that one of the ways in which a driver can be deemed attentive is if their head movement is confirmed as primarily directed towards the driving task. It should be noted that a driver can have their head directed forward or towards the driving task but have their eyes directed in a completely different direction. In these situations, the driver is not attentive and should not be able to take back control of the vehicle. For example, if the head is directed towards the passenger wing mirror, the monitoring system may determine the driver is attentive; however, the driver could be gazing at and engaging with a passenger and is not yet ready to take back control. Also, vertical peripheral vision (up and down), particularly upwards peripheral vision, of the human eye is limited, as such, if a driver's head is positioned towards the instrument cluster or steering wheel and they are gazing below this looking at a book or mobile phone, the driver will not be able to see the road or the environment in their peripheral vision. However, if their eyes were looking at the instrument cluster or steering wheel, they would be able to see the road and environment in their peripheral vision. TRL believes that the only way to determine whether a driver is visually attentive is by monitoring the drivers eye position or movement. Therefore, we advise that

this option is not sufficiently robust in determining whether the driver is visually attentive to the road scene.

3 Potential additions and adaptations

There are some elements of the regulatory text which may need further consideration or adaptation. These are listed below.

3.1 Driver Availability Recognition System effectiveness

The effectiveness of the Driver Availability Recognition System in detecting driver presence, driver availability and driver attentiveness is vitally important in ensuring road safety. Thus, if not already included, it is advised that this is demonstrated by the manufacturers and is included in the documentation package required in Annex [Y] [CEL].

3.2 Wording and phrasing

3.2.1 Driver Availability Recognition System definition (2.6)

There is no mention that the Driver Availability Recognition System should monitor driver attentiveness in the definition of the system (2.6 – paragraph 3). The text should be adapted to include this. For example: "The driver availability recognition system shall detect that the driver is present in the driver seat, the safety belt of the driver is fastened, and that the driver is available **and attentive** to take over the driving task" (bold text added).

3.2.2 System information data (2.11.3)

Similarly to Section 2.2, the draft regulation requires manufactures to provide information about how the system detects that the driver is available to take over control of the vehicle (2.11.3). It is recommended that this statement is rephrased to include driver presence and driver attentiveness e.g. "Information about how the system detects that the driver **is present in the driving seat** and is available **and attentive** to take over the control (bold text added).

3.2.3 Information presented to the driver (2.8.1)

The wording is inconsistent for bullet 3 and 4 under the heading 2.8.1 – information presented to the driver. Bullet 3: transition demand by **at least** an optical and **in addition** an acoustic and/or haptic warning signal. Bullet 4: minimum risk manoeuvre by **an** optical signal and **either** an acoustic or a haptic warning signal. To eliminate confusion please consider changing one of the bullet points to correspond to the wording in the other bullet point. For example:

- Bullet 3: transition demand by **at least** an optical and **in addition** an acoustic **or** haptic warning signal.

  Bullet 4: minimum risk manoeuvre by **at least** an optical signal and **in addition** an acoustic **or** a haptic warning signal.

3.2.4 Incorrect wording (2.8.3)

In Section 2.8.3 “confirm” needs to be changed to “conform”.

3.3 Dual purpose or co-located interface optical signals (2.8.2 and 2.8.3)

Section 2.8.2 and 2.8.3 discusses the interface design requirements for the system status (active mode and system unavailability) and, transition phase and minimum risk manoeuvre optical signals respectively. It is currently unclear in the text whether these optical signals can be located in the same interface or occupy the same space (i.e. dual purpose / co-located alerts). Thus, if the transition phase and minimum risk manoeuvre optical signals can or cannot be situated in the same place as the interface for the active mode or system unavailability optical signals (replaces it when initiated), this should be stated in the text.

4 Other considerations

4.1 Types of situations (2.3.5 and 2.7.1)

The text states that the manufacturer shall declare the types of situations in which the vehicle will generate a transition demand. It also states in 2.7.1 that the system shall recognise all situations in which it needs to transition the control back to the driver. In the text, the following types of situations were identified (not in a list or in a single place):

1) When the driver is not present
2) When a driver is unavailable
3) On roads where pedestrians and cyclists are prohibited, and is separated by a central divide, and
4) Failure of any system/function needed for operation.

The latter situation is extremely broad consisting of numerous types of situations, which could be excluded from a system if not specified in the text, raising a safety concern. For example, only focusing on lane-marking sensor failure, a transition demand should be activated when a sensor is damaged, there is dirt on the sensor, the lane markings are no longer present due roadworks, the lane marking unexpectedly change or are inconsistent due to roadworks, lane markings are in poor conditions or deteriorated etc.

As these systems are new and innovative, a technical service may not have encountered this type of system before or know the types of situations that should be accounted for by ALKS, which further increases the risk if the vehicle obtains type-approval. Some of these types of situations are known and if specified can reduce this risk. Thus, it is recommended that safety critical situations (i.e. system failure due to lane markings unexpectedly disappearing) are specified in the regulation as a minimum requirement, where other types could be recommended (i.e. system failure due to faded or deteriorated lane markings).

4.2 Sudden sickness and driver drowsiness

During the stakeholder engagements, it was identified that a driver monitoring system for automated vehicles should monitor driver presence, driver drowsiness, driver attentiveness and sudden sickness. The current system does not monitor driver drowsiness or sudden sickness. Driver drowsiness is mentioned in detail in Section 2.1.

With regards to sudden sickness, the draft regulation does monitor some aspects which could detect whether a driver has fallen ill (i.e. conscious body or head movement, and eye closure). The questions which arise, which should be investigated further or considered, is 1) how does the system determine whether a person has fallen asleep or is ill and 2) what action should the system take if the system determines the driver is unwell?

4.3 Appropriate actions (2.6.2)

The regulation states that if the driver is deemed unavailable, a warning shall be initiated until appropriate actions of the driver are detected or until a transition demand is initiated. What is meant by appropriate action? For example, if appropriate action means waking up and opening their eyes, then the driver can continuously have microsleeps, emphasizing the need to monitor drowsiness. This needs to be defined and/or specified.

5 Clarification

5.1 Driver availability requirement (2.6.2.1)

The regulatory texts states: “Driver availability shall be assessed based on **[at least two]** availability criteria (e.g. input to driver-exclusive vehicle control, eye blinking, eye closure or conscious head and body movement)”. It also states: “The driver shall be considered available by the system when the driver is present in the driving seat with safety belt fastened, and **at least one** of the following conditions are met…” (TRL emphasis).

This text is difficult to interpret and should be clarified. Potential interpretations include:

1. The manufacturer is required to monitor at least two driver availability criteria and if at least one of these does not meet the minimum requirement for availability, the system shall alert the driver
2. The manufacture is required to monitor at least one of the minimum requirements for availability and, if the driver does not meet the minimum requirement for this measure, the system shall alert the driver

Note that earlier parts of this feedback document assume the former interpretation.

5.2 Minimum requirement for the initiation of a minimum risk manoeuvre (2.7.4.1)

Regulatory text: 2.7.4.1 “In case the driver is not responding to a transition demand by deactivating the system either manually as per paragraph 2.4.4. or automatically as per

paragraph 2.4.5, a minimum risk manoeuvre shall be started automatically, earliest 10 s after the start of the transition demand".

From our understanding, the 10 s requirement is the minimum requirement for the transition phase (i.e. duration). Is this correct? Also, can you please inform us how the 10 s requirement was established.