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Automated driving

AUTOMATED DRIVING

1. This document, submitted by the Chair of WP.1 Informal Working Group of Experts on Automated Driving (IWG-AD), provides a draft common understanding of the Vienna and Geneva conventions with regard to the use of automated driving functions.
2. Moreover, it aims at answering to the questions which are mentioned in the annotated agenda of the 74th WP 1 session, namely:
 - a. the state-of-the-art of the work progress in the IWG-AD,
 - b. the request of WP1 for IWG-AD to consider automated driving in relation to the precepts of the Geneva and Vienna Conventions, potentially focusing on Article 8 in each one,
 - c. the use of remote control parking, and other automated driving functions
 - d. how to address full automated and/or autonomous vehicles, even driverless vehicles.
3. It is important to note that this informal paper is not intended to become a formal document; it simply sets out the work and thinking of the IWG-AD.

EXPLANATORY INTRODUCTION: WHAT ARE WE TALKING ABOUT?

4. This introduction provides an overview of the various kinds of driver assistance systems and automated driving systems (here called “functions”) available in road vehicles which are already on the market, or imminently coming onto the market.

Advanced Driver Assistance Systems (ADAS)

5. This label is given to any driving function which supports the driver with the dynamic driving task¹, but does not perform the entire driving task (see SAE² Level 1 and Level 2). ADAS are activated by the driver and can be deactivated or overridden at all times. When using these kinds of functions, the driver is engaged in the dynamic driving task at all times and thus must constantly monitor the driving environment and intervene immediately when necessary. Whenever the function reaches its specified limitations, the function’s support ceases and therefore the driver must be engaged at all times in the driving task.
 - a. Examples of Level 1: Adaptive Cruise Control (ACC), Lane Keeping Assistance Systems (LKAS)
 - b. Examples of Level 2: Combinations of ACC and LKAS, Remote Control Parking (RCP)

6. *These functions already exist on the market today.*

Automated Driving Functions (ADF)

7. Automated driving functions are those that still require a driver, whether in the vehicle or outside of it (i.e. a remote driver), to be present. The ADF perform the dynamic driving task upon the driver’s request and will operate only within the use case³ for which they are designed. As with ADAS the driver has the ability to activate or deactivate the system as desired.
8. While active, the ADF may request the driver to take over the dynamic driving task (this is called a ‘transition demand’) with a certain lead time at any point when the function is about to reach the limits of its specification. For some ADF (SAE Level 3 equivalents), the driver is the fall back and must retake control of the driving task in response to a transition demand should the system encounter a situation it cannot deal with. Alternatively, the ADF may be sufficiently advanced (SAE Level 4 equivalents) so as to only require the driver to take over the controls at the end of the use-case, as the system is its own fall back within the use case.
9. The driver does not need to permanently monitor the driving environment, but is required to remain vigilant if or when they have to respond to any transition demand and to acknowledge any vehicle warnings issued by the vehicle.
10. Failing to respond to a takeover demand results in the vehicle performing a minimal risk manoeuvre (i.e. the vehicle slows itself down and/or parks itself at a safe place). In the case of SAE Level 3 functions, where the driver is the fall-back for the function, the minimal risk manoeuvre is initiated. For SAE Level 4 functions, where the system is the fall-back rather than the driver, the minimal risk

¹ “Dynamic Driving Task” is defined by the SAE (Society of Automotive Engineers) as “all of the real-time operational and tactical functions required to *operate* a *vehicle* in on-road traffic, excluding the strategic functions such as *trip* scheduling and selection of destinations and waypoints” and includes a non-exhaustive list of tasks.

² Link to the SAE webpage, where the SAE J3016-paper can be found:
http://standards.sae.org/j3016_201609/

³ Each function is set to operate for a limited period of time and/or in a limited set of circumstances, defined by its specifications. This is called a ‘use case’. For example, a function may only be able to operate on a motorway in acceptable visibility and weather conditions. When it reaches the limits of its specifications, such as reaching the end of the motorway portion of a journey, or encountering difficult weather conditions, this is called ‘reaching the end of the use case’. In such a situation it automatically takes steps intending to ensure the driver reengages with the driving task.

manoeuvre is guaranteed to be fully performed until the vehicle is brought to a standstill, where possible outside of an active lane of traffic. The vehicle will remain there until the driver resumes manual driving.

- a. Examples of Level 3: A Highway-Pilot that keeps to the lane and is able to perform lane changes without confirmation by the driver
- b. Example of Level 4: A highway function that, upon the driver's command, keeps within the lane and is able to perform lane changes without any further confirmation by the driver. The system is active from the point the vehicle enters the highway until the pre-defined highway exit (as determined by the driver), and manages all the situations it encounters in this use-case. Before the pre-defined highway exit, the driver is requested to take over manual driving.

11. *These kinds of functions are expected to enter the market probably before 2020 and are currently in development.*

Autonomous/fully automated Driving Functions (which do not need driver intervention)

12. Autonomous driving functions (SAE Level 5 equivalents), are often called “driverless driving” since they do not require the intervention of a driver who performs the dynamic driving task at all during the entire journey at all, i.e. the vehicle occupants – if any – can be considered to be passengers during the autonomous driving phase, though they may still perform the strategic driving task. These functions perform the entire dynamic driving task and can handle all the driving situations they encounter. Such vehicles could undertake any journey. Some autonomous driving functions may have physical controls so that the vehicle user can activate, deactivate, override the function and hence choose to drive themselves or let the vehicle drive.
13. It is possible that some ADF will only be used within very defined use cases – for example in a campus environment, or a single route – and will not work outside of that environment at all or without human intervention. Given the geographic limitation such examples cannot be considered to be SAE level 5 equivalents.
 - a. Examples: A vehicle that operates from any starting point to any destination within a defined area. The system being able to perform all aspects of the driving task from start to finish of the planned route
 - i. A “City-Taxi” (which operates only in a city), or
 - ii. a “shuttle service” (which operates only on a specific route and never leaves that route).
 - b. Examples of Level 5: A true self driving vehicle capable of undertaking any journey from any starting point to any destination without geographic limitations.

14. *These functions are expected to enter the market around 2020 and/or are currently under research.*

A: THE STATE-OF-THE-ART OF THE WORK PROGRESS IN THE IWG-AD

Background

15. Both the 1949 Geneva, and subsequent 1968 Vienna Conventions on Road Traffic relate to the improvement of road safety and to a certain level of harmonisation to facilitate international road traffic. On-going improvements in road design and construction, vehicle technology (such as collision mitigation), and road use (including safe speeds), have done and will do much to deliver the goals of the Conventions.
16. Driver alert devices, assist features, and advanced driver assistance systems (ADAS), are becoming increasingly commonplace. Their aim is to improve road safety, by assisting the driver in applying the full capabilities of the technology and thus measurably reducing both the number and severity of collisions.

17. ADAS allow the driver to hand varying levels of control to their vehicle, though the driver is required to be attentive, still to be engaged in the driving task and intervene immediately when necessary. True automation of the driving task will go further, and allow the driver to hand full control to the vehicle (for defined periods of time and in specific scenarios). Vehicles with automated driving functions could be available as soon as the early 2020s. Pods and shuttles are already on the market with already higher levels of automation available.
18. Given that over 90% of road traffic collisions involve some form of human error, the advent of increasingly sophisticated ADAS and ADF promises to start making further improvements in terms of reducing collisions and road injuries and fatalities. The benefits could go much further than safety⁴:
 - a. less congestion due to fewer collisions and more efficient use of road space; and
 - b. the democratisation of mobility whereby those who are currently excluded due to age or infirmity, could start to enjoy the advantages that motoring can bring.
19. The World Forum for the Harmonisation of Vehicle Regulations (WP29) elaborates technical regulations for some ADAS systems, and certain functionalities for automated driving (work ongoing especially with respect to “automated”). Once approved, manufacturers are then able to build vehicles that meet these regulations and, once validated (for example, through type approval), legally sell that system in a number of global markets. But the fact that systems are available on the market does not always mean that a driver is allowed to use it on public roads. To ensure that everyone is legally allowed to use, and benefit from, ADAS and ADF, it is necessary to consider how the operation of these systems is in conformity with both Conventions, and how both Conventions can best support or guide their use. Failure to do so would mean foregoing lifesaving/changing benefits.
20. The Road Safety Forum (WP1) has been doing just this: successfully amending the 1968 Vienna Convention to permit the use of some automation technologies, and establishing an Informal Working Group (IWG) at its 71st session in October 2015 to explore options in greater depth.
21. Some of the IWG-AD participants shared the view that, for the longer term, the use of a protocol or an amendment may be necessary. At the same time, IWG members recognized that there was a need for a short term solution to respond to technologies imminently coming to market. The joint contribution of colleagues from UK, NL, ES and FI led to the suggestion that WP1 should issue common guidance to help reduce the risk of fragmentation from variant interpretations of both Conventions as this could be significantly faster than an amendment or protocol. The joint paper also began to explore potential options for these interpretations – notably the nature of control, the role of the driver, and nature of the driver – though it did not attempt to resolve specific issues. In the following debates it was suggested that the amendment to the 1968 Vienna Convention could be seen as a clarification of Article 8 of the 1949 Geneva Convention as well.
22. At this stage, it is worthwhile to recall that the same amendment as the one of the Vienna Convention has been proposed to change the Geneva Convention. Nevertheless, the Geneva Convention has not been amended due to procedural and administrative difficulties.

B: CONSIDERATION OF AUTOMATED DRIVING IN RELATION TO THE PRECEPTS OF THE GENEVA AND VIENNA CONVENTIONS

23. Members of the IWG-AD considered what technologies were ‘covered’ by the amendment to the 1968 Vienna Convention. They basically reached an understanding that functions equivalent to SAE Level 3 and SAE Level 4 (as both still require a driver) are in line with the Conventions as last amended, and

⁴ <https://www.mercatus.org/system/files/mercatus-winston-karpilow-autonomous-vehicles-v1.pdf>
Insurance Institute for Highway Safety, “New Estimates of Benefits of Crash Avoidance Features on Passenger Vehicles,” *Status Report*, Vol. 45, No. 5, May 20, 2010.

some members even regard SAE level 5 as being in line with the Conventions assuming that the driver had the option to take control of the driving task. The IWG-AD participants broadly shared the view that the amendment could be used to explore its implications for particular functionalities which are imminently to come on the market.

24. Delegates recognized that where they have discussed certain topics in detail within the subject matter covered by both Conventions, the consensus they reached on such topics could be considered to stand as a mutually consistent understanding of both Conventions in relation to that topic. In this regard, the use of functions currently being discussed by WP29 are considered to be covered by the both Conventions.
25. Based on several discussions, the IWG-AD has begun to reach a common understanding of both the Geneva and Vienna Conventions, which:
 - a. Firstly, reconfirms that the provisions of Articles 8 of both Conventions state that the driver has to be able to control their vehicle,
 - b. Secondly, confirms that the driver can be assisted in the driving tasks by either driver assistance systems or by automated driving functions, provided that:
 - i. they are included in the Technical Agreements, for instance, those set out by UNECE or when such systems/functions can be overridden or switched off by the driver, *and*
 - ii. there has been agreement within WP1 that the function delivers or does not jeopardise the goals of the Conventions.
 - c. Thirdly, agrees that the driver should continue to drive prudently, or seek to minimize any activity other than the driving task. And, the behaviour of the driver should be considered and adapted in the context of what the ADAS or ADF safely allows. It was recognised that further discussion on what the adapted behaviour means in practice is still needed.
26. In consideration of the third point of the common understanding, on adapting behaviour of the driver, the following overarching principles were suggested:
 - I. Both the Geneva Convention and the Vienna Convention on Road Traffic require that a driver ‘*shall at all times be able to control*’ his vehicle. The Geneva Convention Article 10 requires that a driver ‘*shall at all times ... drive in a reasonable and prudent manner*’, and the Vienna Convention Article 8(5) provides that a driver “*shall at all times be able to control his vehicle or to guide his animals.*” And Article 8(6) ‘*a driver ... shall at all times minimize any activity other than driving*’. Whilst international safety legislation on this may now or in future provide otherwise, the above mentioned Convention provisions of Article 10 and Article 8(5) do not in themselves prohibit drivers from adapting their driving to the automated functions in their vehicle. However, the provision of Article 8(6) seems to prohibit the driver from doing other substantial activities than driving in any case.
 - II. The driver of a vehicle should adapt their behaviour based on the degree to which that vehicle’s automated functions are being used at any given moment according to the designed and given capabilities and limitations of the system. Most IWG-AD members agreed that this adaptation could take place according to the following:
 - A. Where the functions being used in the vehicle require the driver to perform the dynamic driving task, then they should not engage in any activity other than driving. The ‘dynamic driving task’ includes: monitoring and responding to the driving environment, ordering and supervising manoeuvres and maintaining constant control of all driving tasks.
 - B. Where the functions being used in the vehicle do not require the driver/ to perform the dynamic driving task (i.e. they are not needed either to exercise operational control or tactical manoeuvring), but do require him to be available to respond to takeover demands, the Conventions should not prohibit the driver from performing other activities, **so long as** these activities:

- i. do not prevent the driver from responding to takeover demands, and
 - ii. are in line with the intended use of the automated driving function
- C. The application of this principle is however subject to other developing international (for example, through WP29) and domestic regulations where necessary.
- D. Where the functions being used in the vehicle do not require the driver to perform the dynamic driving task (i.e. they are not needed either to exercise operational control or tactical manoeuvring), nor to respond to takeover demands, then the Conventions do not prevent the driver from performing other activities, subject to national/regional safety regulations.

C: THE USE OF PARK ASSIST AND REMOTE CONTROL PARKING, AND OTHER FUNCTIONS

27. Initial discussions on the common understanding and overarching principles have focused on the use of remote control parking on the public road (ACSF Category A), and highway-pilot functions (ACSF Category B2+E). These discussions noted that both Conventions require a driver to be able to control a vehicle (Article 8(1) in both Conventions), and are silent as to the location of the driver, as they are with drivers of animals.
28. They also considered the academic work of John A Michon⁵ which identifies the strategic driving task (e.g. trip planning), and the operational and tactical driving task (proactive and reactive driving while on a trip), and how this may apply in these specific contexts.

Park assist and remote control parking

29. In Park Assist systems, the vehicle does not exceed 10km/h and the driver is in the vehicle. They perform the strategic driving task, by deciding where and when to park, and control elements of the operational and tactical driving task – namely they control the speed of the vehicle, while the park assist system controls steering, but they must stay alert and monitor the environment.
30. In the example of Remote Control Parking (RCP) the driver must be “in close proximity”. In other words, within 6 meters (still to be written and adopted by WP 29), or the system will cease to work. The driver continues to perform the strategic task and elements of the operational and tactical driving tasks. They must continue to monitor, but by continuously pressing a dedicated button of the remote control device, or performing continuous gestures on a smart handheld device, they are able to ‘command’ the RCP function to perform the parking manoeuvre. Should they stop, the car will also stop, so in case of an unexpected event they can stop immediately the car.
31. It is clear that in both cases, the driver must focus their attention on the vehicle and surrounding environment. And, irrespective of the system and the remote device the driver has to be well informed about the way it works.
32. ***Conclusion: The driver retains responsibility, and exercises control of the parking task through a remote control device (e.g. hand held device). Thus the driver complies with the precepts of both Conventions by being ‘at all times able to control his vehicle’ (Article 8, both Conventions).***
33. ***In addition, the Geneva Convention (article 10) requires the driver to “drive in a reasonable and prudent manner”, and the Vienna Convention (article 8.6) also provides that “the driver shall at all times minimize any activity other than driving” and prohibits the use of hand held phones. However, in this specific context, a driver may use a hand-held phone as the remote control, so long as it only used for driving/parking the vehicle in a safe manner.***

⁵ http://jamichon.nl/jam_writings/1985_critical_view.pdf and http://standards.sae.org/j3016_201609/

Highway Pilot (Lane keep and lane change assist)

34. Once activated by the driver, the ADF will keep the vehicle within lane and change lane, without command/confirmation of the driver. Nevertheless, while the function is active, the driver **shall** remain ready, willing, and able to resume the dynamic driving task, in response to a takeover demand.
35. Again, the use of must comply with the following rules:
 - a. The driver must be in their seat, while wearing a seatbelt;
 - b. The vehicle must not exceed the speed limit (though it will be capable of being used at speeds up to 130 km/h);
 - c. The vehicle is on a highway or a road section with a separation of traffic moving in opposite directions.
36. At all times, priority is given to driver action; they can always take over control of the dynamic driving task from the functions. Moreover, function will monitor driver availability (in effect confirming that they are ready able and willing to respond), for example by evaluating driver's activity (e.g. head or eyes movements or any other action on an element in the vehicle).
37. Should the driver be unavailable for 3 minutes, a visual warning will be issued. If the driver fails to respond, the takeover demand is initiated. The takeover demand will be initiated in the following cases:
 - a. Where the function detects a non-acute problem,
 - b. The function reaches the boundaries of its use case,
 - c. If there is an unexpected event or a collision risk.
38. If the driver fails to respond to the takeover demand, the vehicle will initiate a minimal risk manoeuvre.
39. ***Conclusion: The driver shall remain able to control their vehicle and retains the ability to either turn off the system, or countermand it. Therefore, they remain within this requirement of the Conventions.***
40. ***In this case Article 8.6 of the Vienna Convention and Article 8 and 10 of the Geneva Convention continue to apply subject to the considerations set out in section B of this paper, namely paragraph 26 II B.***

D: ADDRESSING THE USE OF FULLY AUTOMATED AND/OR AUTONOMOUS VEHICLES, EVEN DRIVERLESS VEHICLES

41. In line with the request of WP1, many IWG-AD members favour developing a draft common understanding of both Conventions for technologies (ADAS and automated driving functionalities) that are being discussed at WP29. The work that is done in WP1 and WP29 both contribute to road safety, and close cooperation of and interaction between WP1 and WP29 is of great importance for allowing automated vehicles on public roads. This would effectively entail an agile and stepwise approach, and allow debate to focus on technologies that are close to deployment. These debates would focus on how these technologies operate with respect to the Conventions, in the same way has happened with Remote Control Parking (see above).
42. For some members, it is possible that the common understanding could be extended to cover the use of these new technologies. For other members, in the event that this is not possible, it is necessary to consider amending the Conventions. However, there was a strong feeling – indeed it was a ‘red line’ or ‘fil rouge’ – that any solution should apply to both Conventions, so it may be necessary to make it easier to amend legislation because of the constant progress of the state of art in this field.

43. It may be the case that the new technology cannot be included within the conventions at all, even by way of an amendment. In that instance, an entirely new Convention may be required.
 44. It is important to note that IWG-AD has not achieved a consensus on how to proceed at this stage. Some members would, at least initially, prefer to proceed with a continuation of the common understanding approach (though they do not rule out the possibility of a future amendment or protocol), while others would like to consider the potential development of new legislation (amendment/protocol). It is equally important to note that the two approaches do not rule each other out. For example, it was recognised that a common understanding approach, as well as facilitating short and medium term deployment and use, could help deliver information from the real world which could be used to help design a protocol or amendments in the longer term.
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