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Automated driving
Situations when a driver operates a vehicle from the outside of the vehicle

The (driver) matrix

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This document aims at contributing to WP.1 defining the scope of work towards addressing the situations when a driver is envisaged to operate a vehicle from the outside of the vehicle.

I. Background

1. Due to automation, the role of the driver is continually evolving. A baseline for vehicle-automation is described in J3016 (SAE, September 2016), indicating the different SAE levels of automation and the corresponding characteristics. It's a taxonomy and set of definitions for terms related to driving automation systems for on-road motor vehicles. It describes the interaction between driver and vehicle automation. While it does not specify the (physical) position of the driver, it does highlight potentials where the strategic aspects of driving could be undertaken by a person outside the vehicle (eg a dispatcher). Although the Vienna/Geneva Conventions are related to the role of the driver, the position of the driver is not defined perhaps because it needed to remain flexible as there were several options: the driver of a motor vehicle was supposed to be **in** their vehicle, the driver of a horse-drawn coach was supposed to be **on** their coach or **on** the horse (the 'engine') pulling it, the "driver" of a flock was supposed to be **outside** but near their flock. With the introduction of new technologies, the position of the driver for a vehicle continues to need careful consideration. This article will propose a way to do this.

II. Position of the driver

2. Nowadays it is possible that in some situations the driver could be outside of the vehicle. In the 75th UNECE/WP 1 session, Contracting Parties delegates of either the Geneva Convention (1949) or of the Vienna Convention (1968) deemed that a remote-control parking device used by a driver outside of their car "does not endanger road safety", provided the system is in conformity with the UNECE technical regulations. .

3. Bearing in mind that this situation, i.e. the use of remote control parking device by a driver outside of the vehicle is accepted, does it mean that any case where the driver would not be in the vehicle is accepted as well? The answer is clearly: "NO". In terms of high-level principle, if a 'remote' system can be demonstrated and independently (potentially via WP29) verified as safe (technically usable for the designated purpose) , WP1 should consider if that system can safely be used. The first analysis which follows below has to be considered as a very first draft on the issue proposed to colleagues for reflection.

4. Let's start with the conventional vehicle, having the driver behind the control instruments within the car. The 'conventional driver' must be able to perform the strategic, tactical, and operational driving functions. Imagine that all instruments for operating the vehicle remain intact, but we provide the driver with a Virtual Reality viewer which provides them with the same information as they would have had without this viewer. This could be achieved by cameras on the vehicle, combined with augmented reality. We could then call the driver a 'Virtual Driver'. If the virtual driver is provided with the same information with as without this viewer, there would be no argument to prohibit the driver to drive the vehicle. The next step in this thought-experiment would be to shift the driver outside the vehicle and provide them with the same set of instruments to be able to control the vehicle as he would have had inside the vehicle, albeit from a distance. The driver could now be considered to be a 'Remote Driver'. In principle, the remote driver would still be able to perform his driving functions in a safe manner, fulfilling all the requirements from Article 8 of the Vienna Convention.

5. Now let's go one step further: imagine that the view of the driver is restricted (ie more restricted than they would have if they were in a vehicle), then they should not drive (even if they are conventional, virtual, or remote) as they could not safely meet the requirements of article 8 of the Vienna or Geneva Convention. Conversely, If the restricted view were compensated for by sensors in the vehicle which take over the object and event

detection and response (OEDR) the driver (even a remote or virtual one) would still be able to control the vehicle and this would be allowed.

6. We now need to consider the thought experiment in the context of the SAE levels.

7. Regardless of the level of automation, the conventional, virtual, or remote driver is 'allowed' to drive the vehicle if:

- they exercise dynamic control (DC) directly; and
- they have an unrestricted view or such a view can be achieved by technical means.

8. If either of these two conditions are not met, then conventional, remote, or virtual driver will not be able any longer to drive safely or fulfill the requirements of article 8 of the GC/VC. Therefore, this option should not be allowed on public roads.

9. In SAE levels 3, 4 and 5 the vehicle is fitted with an automated driving system (ADS) that can exercise dynamic control for sustained periods (ie the OEDR). This leaves the conventional, virtual, or remote driver to exercise strategic control (SC).

10. In SAE level 3, the driver is the fall back ready user (ie they must be able to exercise dynamic control upon a takeover demand). Therefore, if the conventional, virtual, or remote driver has a restricted view, they could not resume proper dynamic control of the vehicle.

11. In SAE level 4 and 5 the conventional, virtual or remote driver does not have to respond to a system takeover demand. Nor would they have to have an unrestricted view, as the ADS would exercise dynamic control and compensate for the restricted view while active. For level 4 vehicles it is important to note that the ADS can only work within a specified operational design domain (ODD), and the conventional, virtual, or remote driver must be able to exercise dynamic control to get to that specified ODD.

A summary of the possible situations can be found in the matrix below:

SAE level (See J3016 sept16)	*0*	*1*	*2*	*3*	*4*	*5*
Conventional driver in car	+	+	+	+	+	+
Virtual driver in car	+	+	+	+	+	+
Remote driver, with unrestricted view, exercising DC	+	+	+	+	+	+
Remote driver, with restricted view, ADS engaged	X	X	X	X	+ ODD SC only	+ SC only
Remote driver, with restricted view, ADS not engaged (or incomplete vehicle OEDR)	X	X	X	X	X	X

Note: this description does not take into account other (inter)national requirements like being able to identify yourself as the (remote) driver or being present at the spot in case of an accident. These and other requirements will have to be fulfilled as well, although here again new technologies may provide new alternatives to meet the objective behind the requirement.

III. Conclusion

12. The Conventions do not, *per se*, hinder the possibility of a remote driver in the following situations:

- A driver is outside the vehicle and they:
    - have a clear view of the driving environment or they are provided with the same or similar view by technical means; and
    - are able to exercise dynamic control to the same extent that they would have if inside the vehicle.
- A driver is outside the vehicle and:
    - the vehicle safely exercises dynamic control without the need for driver intervention

13. Importantly, this high-level principle does ***not*** automatically enable drivers to be remote from the vehicle. The reliability and accuracy of the remote systems, and where necessary automated driving systems, must be demonstrated and independently verified to provide reassurance that they work. Indeed, for remote-control parking, WP.1 could reach a conclusion because WP.29 had established a way of verifying the efficacy of the remote-control parking system (in the form of an amendment to R79). As remote technology, and automated driving technologies, continue to develop, WP1 will need similar reassurances before being able to decide if other remote applications are not prevented by the Conventions.