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Convention on Road Traffic (1968):
Remote activities related to driving

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Remote activities related to driving

Submitted by Finland, Germany and the United Kingdom

This paper follows and replaces two documents on remote driving and remote management of automated vehicles (Informal document No. 1/Rev.2 (September 2021) and Informal document No. 16 (March 2023)).

- ## **Safety considerations for remote management of automated vehicles which do not require a human driver inside the vehicle.**

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I.   Introduction

WP.1 has been discussing situations when a driver operates a vehicle from the outside of the vehicle since its 78th session. This paper follows and replaces two discrete papers on remote driving and remote management of automated vehicles, tabled as informal papers at the 86th session of WP.1 (Informal document No. 1/Rev.2 (September 2021) and Informal document No. 16).

Automated vehicles which do not require a human driver inside the vehicle, will need to be overseen and managed remotely. Remote management refers to the activities undertaken beyond line of sight to manage one or more automated vehicles without a responsible human inside, carrying only passengers and/ or goods. Remote management could be considered as a top level term that may cover various types of remote human oversight in the operation of automated vehicles in traffic, ranging from oversight to remote driving. These will be needed to support safety, ensure traffic flow or provide a means of communication with passengers. A common understanding of the requirements of remote oversight within UNECE would therefore help contracting parties as the technologies develop and commercialisation continues.

Use of automated vehicles in road traffic should fulfil the requirements set out in the 2018 resolution on the deployment of highly and fully automated vehicles in road traffic. So far, further guidelines have only been provided on the operation of automated vehicles which issue transition demands; in the 2022 resolution on safety considerations for activities other than driving undertaken by drivers when automated driving systems issuing transition demands exercise dynamic control.

Remote management brings a distinct set of opportunities and challenges to road traffic, their regulators, drivers and other road users. This paper seeks to explore the safety challenges posed by remote management to support its development and safe deployment in road traffic.

II.   Scope

The scope of this paper concerns situations where automated vehicles are operated with no responsible humans inside them, and what considerations are needed by contracting parties to ensure road traffic safety. Automated vehicles are vehicles equipped with an Automated Driving System.

We acknowledge that there may be difficulty in separating the various forms of remote management, and whether distinguishing between these is useful for contracting parties. Roles may overlap and one remote management agent could perform more than one role.

However, there is a clear distinction between remote driving and the other forms of remote management in terms of roles and responsibilities. The remote management agent becomes a remote driver and takes on the associated responsibilities when they perform dynamic control or when they monitor the road environment with a view to immediate intervention. The principles covered in this paper on remote driving will also apply to situations where the vehicle is not automated.

It is possible that the vehicle or system manufacturers may allow only certain forms of remote management, meaning that some automated vehicles may not be remotely driven.

III.   Definitions

The terminology for various forms of remote management is proposed as follows. Remote management can consist of measures of remote assistance and remote driving.

1.   Remote assistance includes measures to support safety inside and outside the vehicle whilst the ADS has the dynamic control. Remote assistance can include the following measures:
    a.   General vehicle status monitoring, including the location of the vehicle at all times, with no requirement for full situational awareness;
    b.   General monitoring of the inside of the vehicle, especially passenger and cargo status;
    c.   Summoning assistance when needed and managing technical incidents and breakdowns;

      d.   Providing the strategic elements of the driving task;

      e.   Instructing an ADS to perform specific manoeuvres or to approve manoeuvres proposed by the ADS; and

      f.   Communication with the authorities, first responders and other road users.

2.   Remote driving means situations where a person outside the automated vehicle exercises all or part of the dynamic control of that vehicle, including monitoring its behaviour on the road with a view to immediate and safety-critical intervention. Where they do so, they are considered to be the driver and bear sole responsibility for the dynamic control of the automated vehicle.

It is also proposed here that the entity organising remote management operations (envisaged to be a company) would be called the "remote management provider" and the individual human acting on behalf of the entity would be called "remote management agent".

IV.   Recommendations for remote systems

The technological aspects of the systems implemented shall not be considered here. However, they may be touched upon for clarification purposes, and must be able to support the role of the remote management agent. Automated vehicles without a responsible human inside and their remote management workstations should:

1.   Ensure that the remote management agent can perform their required role through an intuitive human machine interface.

2.   Minimize the effects of latency on the remote management agent.

3.   Have sufficient capability to ensure road safety at all times, either by bringing the vehicle to a safe condition, or having a remote management agent safely take over the dynamic driving task to continue the journey. The safe condition which the vehicle reaches should be compatible with the safety case.

4.   Be designed to be foundationally IT-secure.

V.   Recommendations for remote management providers (companies)

The remote management provider should:

1.   General Responsibilities
      a.   Ensure adequate staffing and support and supervise the remote management agent to meet the requirements imposed on them set out in Part VI below.
          Bear responsibility for the actions of the vehicle where these are due to a failure in operating the system as specified by the manufacturer.
          Consider the appropriateness of health checks for remote management providers, where this is required by their role such as in remote driving, as is the case already for other safety critical shift work.
          Ensure that the number of passengers / vehicle load on the vehicle does not exceed its limit.

2.   Agent Management
      a.   Ensure that the attention of the remote management agent is managed safely, and that adequate breaks are built into their schedules.
      b.   Ensure that the workload of the remote management agent is managed appropriately, including through the allocation of tasks.
      c.   Ensure safe transfer of management between remote management agents, e.g. through planned and careful execution of transfers of control where handovers occur at break times and at the end of shifts.
      d.   Have a clear identification of who is remotely managing the vehicle at any given time, particularly where remote driving may be undertaken.

3.   Training and Licensing
      a.   Ensure that all remote management agents are adequately trained (in compliance with domestic requirements where applicable) to undertake their role under the specific system and conditions used.

   b. Ensure that remote management agents hold the appropriate qualifications (for example a valid licence for the territory in which the vehicle will be deployed, particularly where remote driving may be undertaken).
4. Vehicle and Workstation Maintenance
   a. Ensure the technology and machinery used are properly maintained, including ensuring that the vehicle is roadworthy.
5. Inclusivity and Accessibility
   a. Address the diverse needs of vehicle occupants, including those who are disabled, by ensuring that the service is provided inclusively, including complying with domestic accessibility requirements, and incorporating features on vehicles to mitigate the absence of staff providing direct assistance.
6. System Management
   a. Ensure adequate communications networks connections and IT-security of their operations.
   b. Maintain a record that enables verifying the events relating to remote management activities.
   c. Consider how to safely address system failures, including those relating to connectivity and connection to the remote management workstation.
   d. Consider the need for a safety case which covers each specific application of remote management.
   e. Consider the need for a back-up connection system.
7. Remote Management Workstation
   a. Enable the remote management agent to adjust the workstation appropriately, to ensure it is comfortable and adapted to their needs.
   b. Have strategies to support the remote management agent such as limiting the effects of motion sickness, information overload and change blindness (where that remote management agent may fail to detect relatively large changes in visual scene).
   c. Ensure that the remote workstation supports the role of the remote management agent, e.g. by providing appropriate situational awareness and control over the vehicle for remote driving.
8. Passenger Communication
   a. Provide passengers with solutions for them to request emergency stops as well as regular stop requests.
   b. Provide the ability to properly communicate any unexpected events, including any remote management-agent-initiated trip interruptions, to avoid passenger confusion.
   c. Provide human-machine interface (HMI) solutions and protocols between passengers and remote management agents to support communication and interaction for both daily and emergency operation. These should be designed inclusively, including for people who cannot see a visual display screen or hear audible announcements, for people with limited dexterity or reach, and for those with impaired cognition.
   d. Prevent passengers from interfering with vehicle controls while the remote driving function is activated; except for the use of emergency systems (such as emergency stop).
   e. Have procedures and facilities to deal with medical emergencies and crashes involving the remotely driven vehicle, as these pose the most serious safety concern, are time critical, require accurate perception, comprehension, and an effective response. These incidents will require stopping, securing the vehicle, attending the injured, coordinating passenger emergency exit and on-board communication with dispatch and emergency crew. This complex coordinated response may require the input of multiple personnel. This should apply even when passengers are not in the remotely driven vehicle itself, for example in instances where the vehicle injures another road user.
9. Communicating with authorities
   a. Ensure that remote management agents can communicate clearly and effectively with relevant authorities including the police, where requested to or required by traffic rules in the jurisdiction of operation.

VI. Recommendations for remote management agents (individuals)

The role of a remote management agent enables the safe operation of automated vehicles without a human driver inside but poses new challenges. Further specific training is required to perform remote management

including remote driving, either to maintain appropriate situational awareness when remote driving or to determine the appropriate course of actions when alerted to a traffic situation by the automated vehicle.

Remote management agents should:
1. Have the physical and mental capabilities, and the competence, to perform remote management in all applicable scenarios and those set in domestic legislation and rules (including the possibility of health checks and special licence for remote driving (if required in domestic legislation).
2. Ensure that their physical detachment from the vehicle does not result in a decreased sense of risk, urgency, or a lack of empathy and sensitivity towards the vehicle surroundings, its occupants, and other road users.
3. Hold the appropriate qualification and training to use and operate the vehicle, in the country where the vehicle is driven, and required in domestic legislation a special licence for remote driving where it is undertaken.
4. Be ready and able to provide remote management when required, and where remote driving is undertaken, minimise any other activity that would restrict or impair their ability to take dynamic control.

To safeguard the transport of passengers or goods in an automated vehicle, the remote management agent should:

5. Be aware of any passengers inside the vehicle which they are operating. This includes how many passengers and if any children are on board.
6. Ensure that the vehicle is a safe environment for its passengers, including monitoring the vehicle to prevent its theft.
7. Ensure passenger safety when boarding or leaving the vehicle, such as ensuring that all waiting passengers have boarded before closing the doors, or otherwise verify that the doors have been closed.
8. Ensure that passengers are in an appropriate standing position (where the vehicle allows, for example on buses), or safely seated and wearing seat belts where legally required, before the vehicle is moving.
9. Support disabled passengers to use the vehicle confidently, comfortably, and safely, including by operating accessibility equipment, providing remote assistance, and by communicating audibly and visibly to passengers waiting for and travelling on the vehicle regarding its route and location.
10. Be adequately trained and able to communicate with passengers, other road users and the emergency services following an incident.
11. Monitor cargo, luggage and mobility devices, such as wheelchairs and strollers, to ensure that they are secured appropriately to prevent them from coming loose and posing a safety risk.
12. Comply with any other relevant domestic and international rules, including those related to the transport of passengers and goods.

In addition, when remote driving, the agent should:
13. Comply with all relevant road traffic rules such as ensuring that the vehicle speed and driving style are appropriate for the vehicle and its load.

VII. Recommendations for manufacturers

To safeguard road safety, the developer or manufacturer of automated vehicles which do not require a responsible human inside, and their workstations should:

1. Bear responsibility for the system to comply with the requirements set out in relevant parts of this paper and those set in domestic legislation and rules.
2. Ensure that the system enables a competent remote driver to exercise safe dynamic control of the vehicle in road traffic, where required.
3. Ensure that the design of the human-machine interface is based on a proper assessment of human needs and limitations, including enabling the necessary situational awareness.
4. Ensure appropriate software updates are made available to the system as required to maintain safety and security.
5. Consider the need for mechanisms to monitor remote management agent attentiveness and performance.

6. Consider the need for public and consumer awareness and understanding of remote management in automated vehicles without a responsible human inside, including the accurate depiction of the capabilities and limitations of the technology in system marketing.

7. Specify the requirements for safe operation of the system.

The responsibilities mentioned here and under part V should be clarified between the remote management provider and manufacturer when they are jointly responsible for safe operation.

VIII. Recommendations for contracting parties

Noting that further discussion and research is required in this area, contracting parties should:

1. Consider how the location of the remote management agent, and whether they physically operate inside or outside of the jurisdiction in which the vehicle is driven, will impact on the enforcement of traffic laws against those performing the dynamic driving task for a part of a journey.

2. Consider how authorities will be able to access information on the responsible remote management provider, including contact details and a means to communicate with the responsible agents without delay.

3. Consider how authorities will be able to access information on the current health state of the remote driver (for example under the influence of alcohol or drugs, fatigue etc.) and how to control and enforce any applicable legal requirements.

4. Consider the cognitive demands of the different types of remote management, where it is envisaged that remote support could be provided to more than one vehicle but remote driving can only be undertaken on a single vehicle.

5. Consider the need for domestic legislation concerning the contents of this paper, including for the system, and licensing requirements for both the remote management provider and agent (noting that the required training will differ by type of remote management).

IX. Final provisions

This paper will be periodically reviewed and updated to address technological and/or regulatory developments concerning remotely driven vehicles, and automated driving systems which require remote management.

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