Automated road transport systems:

elements for characterizing remote intervention functions

Methodological document

Preamble

Remote intervention constitutes one of the functions contributing to the safe operation of an automated road transport system deployed on its predefined route or zone.

If the the system relies on remote intervention to operate safely, it must be integrated in the safety demonstration of the system, in which the use of driving scenarios that may be encountered by the system plays a central role.

This document, of a methodological nature, proposes first methodological elements prior to taking into account the different conditions of the remote intervention, or functions related to it, in the scenario-based approach:

- It presents a taxonomy of the different concepts underlying the notion of interaction between the automated driving system and the human actor, whether he has an action on the system or whether he acts in support of operation;
- It returns to the definition of remote intervention functions, attempting to articulate the functions described in the regulatory framework (national and European) on automated road transport systems, and functions that could be described as "related", some of which nevertheless present significant safety issues;
- It then addresses the question of the role of the remote operator for these "related" tasks, from the angle of sharing (or not) tasks between several agents within the same supervision center.

These elements will feed future work toi integrate the remote intervention in the scenario-based approach, especially in the description axes introduced in the sceanrio-description and -generation method.

Furthermore, this work on remote intervention could contribute to further discussions on skills and qualifications of remote intervention operators.

This document, of a methodological nature, has no binding purpose and does not commit, at this stage, a position of the French Ministry for Transportation (DGITM) on the connection of the different functions identified below, to the concept of remote intervention and to the regulatory requirements attached to it.

Contents

1. Definition of remote intervention: references

National regulatory framework

Decree No. 2021-873 (automated road transport system – called ARTS) defines remote intervention as: action carried out by the authorized person mentioned in article L. 3151-3, located outside the vehicle, as part of an automated road transport system:

a) To activate or deactivate the system, to give instructions to perform, modify, interrupt a maneuver, or to acknowledge maneuvers proposed by the system;
b) To instruct the navigation system operating on the system to choose or modify the planning of a route or stopping points for users;

Furthermore, Ordinance No. 2021-443 provides that "any remote intervention can only be carried out by an authorized person, holder of the driving license corresponding to the category of vehicle in question". The decree of August 2, 2022 specifies the provisions relating to the authorization of remote operators. This decree notably recalls the notion of remote intervention as defined in the transport code, while distinguishing two roles for these functions:

- operator responsible for carrying out remote intervention missions, in application of the system's procedures and operating methods;
- supervisor exercising responsibility for verifying the implementation of remote intervention procedures and operating methods.

- European framework: EU regulation – ADS

European regulation 2022/1426 on the type-approval of fully automated vehicles equipped with an automated driving system includes elements of definition and safety requirements for remote intervention.

Article 2 introduces the notion of remote intervention and proposes the following definitions:

- "remote intervention operator" means, where applicable to the ADS safety concept, person(s) located outside the fully automated vehicle who may remotely achieve the tasks of the on-board operator provided it is safe to do so. The remote intervention operator shall not drive the fully automated vehicle and the ADS shall continue to perform the dynamic driving task;
- "remote capabilities" mean capabilities specifically designed to support remote intervention.

Under the requirements for describing the ADS system in Annex I, the regulation covers:

- conditions for triggering a request [….] to the remote intervention operator;
- concept of human/machine interaction with the remote intervention operator;
- expected role of the remote intervention operator;
- operational measures of the remote intervention operator;
- instructions for the remote intervention operator in the event of a failure and request to the ADS;
- links and ADS interface with other vehicle systems, off-board hardware/software and remote capabilities;
- for the operating mode with partial efficiency (= partial performance), the warning strategy of the operator, of the remote operator;
- for each failure condition [….], the warning signal to be given to the remote operator.

With regards to safety requirements related to the performance of the system in Annex II, the regulation provides that:

- the vehicle control strategy in case of hazards includes remote intervention;
- in the event of a traffic accident, the ADS resuming normal operation shall not be possible until the safe operational state of the fully automated vehicles has been confirmed by self-checks of the ADS or/and the on- board operator (if applicable) or the remote intervention operator (if applicable);
- when the ADS reaches the ODD boundaries, it shall perform a MRM to reach a MRC and shall warn the on board operator (if applicable)/remote operator accordingly (if applicable);
- upon detection, the ADS system reports major faults and the resulting operational status to the vehicle occupants, the on-board operator (if applicable) or the remote intervention operator (if applicable). applicable) [….] ;
- the fully automated vehicle shall only leave the MRC after confirmation by self-checks of the ADS or/and by the on-board operator (if applicable) or remote intervention operator (if applicable) that the cause(s) of the MRM is no longer present;
- if a remote intervention operator is part of the safety concept of the ADS:
    - the fully automated vehicle shall provide means for vehicle occupants to call a remote intervention operator through an audiovisual interface in the fully automated vehicle and unambiguous signs shall be used for the audiovisual interface;
    - fully automated vehicle shall provide vision systems of the occupant space inside the vehicle and of the surrounding of the vehicle to allow the remote intervention operator to assess the situation inside and outside of the vehicle;
    - it shall be possible for the remote intervention operator to open the power operated service door remotely;
- event data recorder shall record:
    - requests sent by the ADS to the remote intervention operator (if applicable);
    - requests/input sent by the remote intervention operator (if applicable);
- the operating manual, given to the remote intervention operator, guarantees the safe use of the fully automated vehicle by means of detailed instructions addressed […] to the remote intervention operator and includes technical measures […] for example, presence of a remote intervention operator; instructions intended […] to the remote intervention operator (if applicable) […] in the event of failures and requests from the ADS.

Under Annex III which details the requirements on compliance assessment, the regulation stipulates that:

- scenarios should include:
    - failures and traffic hazards stemming from the corresponding remote capabilities when ADS capabilities depend on those capabilities;
    - remote capability issues, for example, absence of the remote intervention operator;
- the tests shall include:
    - scenarios whereby the ADS is overridden by the remote intervention operator (if applicable);
    - aspects that may have an impact on vehicle controllability and user information (HMI aspects e.g. interaction with the operator/remote operator);
- the type-approval authority must carry out an assessment of the application of the analytical approach(es), which must cover […]

    - unreasonable risks due to operational disruptions (including misunderstanding of the reaction of the remote intervention operator);
    - errors or misunderstandings of the remote operator;
    - aspects relating to operational security […] in relation to the non-vehicle support infrastructure and the remote intervention operator, loss of connectivity;
- incident reports (= "occurrences") must cover [….]:
    - interactions with remote operator (if applicable) related to major ADS or vehicle failures
    - occurrences related ADS failure resulting in a request to intervene to the operator or the remote intervention operator

Some etymological references

The term intervention comes from the Latin verb *intervenere*, and is defined as follows in the dictionary of the French language (about a thing):

- *the fact of acting, of having a determining role (among other elements, other factors); synonyms: action, role*
- *action of occurring during an evolution; etymology: action of intervening, fact of occurring*

The Littré definition brings the notion of mediation or superiority of intervention (action by which one intervenes either as a mediator or as a superior). The definition in the Encyclopedia (1751) specifies that intervention can take place either at first instance or on appeal.

Thus, sticking to the French definitions of the term "intervention", remote intervention is characterized by an action, carried out remotely in support (mediation) or forced (superior), in first instance or in recall, on an element (system).

We can also note that supervision has a close, but different, meaning: its Latin root is broken down into two parts:

- super: over
- videre: to see, to witness, to judge, to examine

In English, the legal definition put forward is "*Ongoing process performed by a supervisor who monitors the performance of the person supervised and provides regular, documented individual consultation, guidance and instruction with respect to the skills and competencies of the person supervised*".

These definitions converge towards the notion of remote intervention as the action of exercising control (idea of superiority during the action) by the person who supervises, in order to unbind a situation observed from above (overlooking vision, surveillance).

2. Typologies of human-machine interactions: summary taxonomy

Remote intervention, as provided for by the regulatory framework, is part of a broader range of methods of interaction between humans and an automated road transport system. The literature uses these different concepts under the generic term of teleoperation (from the Greek têle, meaning "far away, at a distance"). Various contributions attempt to establish a taxonomy of these concepts[1].

Different notions are in fact combined in the typology of these interaction modalities, which can be summarized as follows:

- remote "vision" (without action): in this case, the human has no direct vision of his vehicle or his driving environment (the notion of "remote" is then opposed to the notions of "on board" or "nearby");
- remote intervention on an automated system (covered by the national regulatory framework, subject of this document);
- remote driving: as opposed to system automation characterized by the performance of the entire dynamic driving task by the automated driving system, remote driving is characterized by the performance of the driving task by a human remotely, a priori without "naked eye" vision of the vehicle and its environment;
- the distinction between action (intervention) on the vehicle and its driving on one hand, and relations with users on the other hand;
- the notion of "direct vicinity" (which is therefore different from the "remote" position by the fact that the human has a direct vision of the vehicle and its environment: this concept was introduced by the European ADS regulation[2], establishing the concept of vicinity at less than 10 m from the vehicle);
- the notion of "toe-heel": this concept, put forward by operators, with reference to the railway world, consists of bringing a vehicle from its storage to its commercial route (or vice versa) or any other non-commercial movement on the network; we note that this notion is orthogonal to the definition of actions on the vehicle (manual driving, remote driving, nearby driving, remote intervention, direct vicinity intervention);
- the notion of "lending a hand": this concept covers the idea, after an automated system has been secured, that a human "provides assistance" to the vehicle so that it resumes his service; this concept is characterized in particular by its limited scope in terms of maneuver (distance, speed); as above, this notion is a priori orthogonal to the definition of actions on the vehicle (manual driving, remote driving, nearby driving, remote intervention, nearby intervention).

As the objective of this document is not to deal with these concepts in details (in particular not remote driving), this document is limited to the brief characterizations above. Despite its succinct nature, this articulation of concepts nevertheless seems useful for analyzing the greater or lesser proximity of a given

[1] Cf. among others, the taxonomy proposed by SAE in appendix 1.

[2] Driving in the vicinity of the vehicle is introduced and allowed by the (EU) 2022/1426 regulation in the following conditions :

- for the purpose of maintenance or to take over after a minimal risk manœuvre,
- the vehicle is intended to be driven at speeds higher than 6 km/h,
- it is not necessary for the driver to stay within the fully automated vehicle,
- the control can be performed via a remote control located in the vicinity of the vehicle provided that the vehicles stays in the direct line of sight of the driver, at a maximal distance that not exceeds 10 m.

In application, the regulation introduces two distincts situations in which the manual driving in the vicinity of the vehicle is allowed, via a remote control and at low speed :

- moving the vehicle outside of commercial use for the purppose of maintenance or toe-heel of this vehicle, to the first passenger pick-up point or from the last passenger pick-up point;
- conveying passengers between two pick-up points between two routes.

function with the notion of remote intervention (or, conversely, with other notions cited above, in particular remote viewing).

This analysis of the different functions with regard to the regulatory definition of remote intervention is the subject of the following parts of this document.

3. Analysis of the functions attached to remote intervention

The definition of remote intervention, as mentioned in the previous part, includes actions not relating to driving (execution of the dynamic driving task) and participating in safety, carried out by a remote operator.

In this sense and in complementarity with what has been described previously, the notion of a boundary between the performance of the system and that of the human operator no longer exists, since the driving task is entirely carried out by the automated driving system. .

As described above, actions attributed to the remote intervention operator are as follows:

a) *To activate or deactivate the system, to give instructions to perform, modify, interrupt a maneuver, or to acknowledge maneuvers proposed by the system;*
b) *To instruct the navigation system operating on the system to choose or modify the planning of a route or stopping points for users;*

3.1. "Macro" approach: characteristic elements of remote intervention

The definition of remote intervention from the national regulatory framework refers to different notions.

As explained previously, the notion of intervention includes the notion of response provided by an operator to a situation encountered by the system.

The notion of maneuver refers to any action which contributes to the dynamic control of the vehicle as defined in R. 311-1-1 of the Transport Code. This notion is by nature quite broad and can integrate different configurations that the document tends to explore.

The notion of "giving instructions to" is to be distinguished from pure command in the sense that it means taking the instruction into account by the system, which must be used to carry out the requested action while assuring people's safety, and maintaining the responsibility for carrying out the requested maneuver. This same principle applies to modifying and interrupting a maneuver.

In the case of acknowledgment of a maneuver proposed by the system, it is also important to remember that it is the system which retains responsibility for carrying out the maneuver that it has proposed, if it is acquitted.

The notion of instruction given to the navigation system concerns planning, whether it is the spatial planning of the route or its temporal planning. For example, modifications made to travel times following a change in operating mode requested by the operator can be linked to this notion. Itinerary planning or real-time service modification may follow the occurrence of an element on the route likely to degrade the level of integrity of passengers or third parties (fire, unplanned event).

It seems important to specify that the remote operator may be required to carry out actions that do not fall under remote intervention, but present a security issue. These actions then fall under "safety tasks" as mentioned in article R. 3152-19 of the Transport Code.

These actions, their conditions of implementation and the quality of the operator who carries them out, are part of the safety demonstration.

Even if this operator is not necessarily the authorized person mentioned in article L. 3151-3 of the Transport Code, he must nevertheless be authorized according to the terms set by the operational safety management system, which is an integral part of the system and the safety demonstration.

3.2. Detailed approach: remote intervention and related functions

This part offers initial elements of analysis of the range of actions that can be carried out remotely on the vehicle and its environment, in order to better understand how they enter into the definition of remote intervention or relate to it.

It is first important to remind a fundamental regulatory notion in the definition of remote intervention: this intervention only concerns the automated driving system of the vehicle, for the purposes of exercising an action on it, without replacing the action of this system on the dynamic driving task. In this definition, the fact that a remote intervention action prevails over an action coming from the system does not mean that the remote operator takes control of the dynamic driving task; at any time, the automated driving system fully carries out the dynamic driving task.

Conversely, if no action is taken on the automated driving system or if the action concerns a component that is not the automated driving system, it is not a priori a remote intervention.

The paragraphs below attempt to apply these general elements to a list of detailed functions in order to identify the extent to which a certain number of functions can be considered not to fall strictly within the definition of the remote intervention, but can constitute tools or levers (“enablers”) in certain hazardous situations (or “scenarios”).

The list of functions below corresponds to the initialization state of this document. It may be enriched later.

a. Commercial operation of the service and vehicle missions

We are talking about route decisions, services, stops, timetables, waiting times, passenger pick-up.

It is appropriate here to distinguish these functions with regard to the time constant which characterizes them:

- When these decisions are made "ex ante" in relation to the automated driving mode (e.g.: planned timetables, or choices taken at the opening for services of the day, or choices of stops or itineraries carried out at the time of the start of the mission), we go beyond the scope which seems to be covered by the regulatory definition;
- When this type of decision occurs in the shorter term, but is not linked to the operation of the automated system or to the hazards it encounters (for example giving up serving a stop given that no user requests it), we also understands that it does not fall within the definition of remote intervention (we can then speak of a commercial operating decision);
- When the decision concerns an instruction given to the automated system to modify, in the short term, its route or stops, in response to a hazard (OEDR approach), we are then more clearly in the scope covered by the definition of remote intervention in the regulation. We can try to clarify matters by referring to the notion of dynamic driving task defined in the European framework[3], which distinguishes between:
  - strategic functions such as trip planning and selection of destinations and route points;
  - tactical functions, including maneuver planning and functions operating on a time constant of seconds and including tasks such as lane selection, gap acceptance and overtaking.

  The perimeter targeted by the regulatory definition therefore appears close to the “tactical” layer of the dynamic driving task: for example, deciding to turn at the first available intersection or to forgo stopping at the last moment, to avoid an identified hazard (by the system or the remote operator): we understand that these are decisions whose time step is counted in seconds (i.e., in anticipation distance, of the order of a hundred meters for 10 seconds of warning in traffic at 30 to 50 km/h). It seems reasonable to make a distinction between the tactical component of the dynamic driving task, which would then fall under remote intervention, and the strategic component (independent of hazards or a time step greater than one or two tens of seconds), which would not come under it (even if intermediate situations between these two notions remain possible and should be subject to a more detailed analysis). Concretely, we can cite here two examples which seem to clearly illustrate the difference between the two notions:
  - ordering to branch off to avoid a traffic hazard potentially affecting safety, while the nominal maneuver in progress consisted of going straight (and provided that this branching remains within the ODD), would fall within the scope of the remote intervention;

[3] Cf. (EU) 2022/1426 (ADS Regulation) :

4) ‘dynamic driving task (‘DDT’)’ means all real time operational functions and tactical functions required to operate the vehicle, excluding strategic functions such as trip scheduling and selection of destinations and waypoints and including without limitation the following subtasks:

(a) Lateral vehicle motion control via steering (operational);

(b) Longitudinal vehicle motion control via acceleration and deceleration (operational);

(c) Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical);

(d) Object and event response execution (operational and tactical);

(e) Manoeuvre planning (tactical);

(f) Enhancing conspicuity via lighting, sounding the horn, signalling, gesturing, etc. (tactical).

5) ‘operational functions’ of the DDT means functions delivered over a time constant of milliseconds and which include tasks such as steering inputs to keep within a lane or braking to avoid an emerging hazard.

6) ‘tactical functions’ of the DDT means functions delivered over a time constant of seconds and including tasks such as lane choice, gap acceptance and overtaking.

- giving up, at the start of the mission or during the mission, but without safety reasons (OEDR) to serve a stop, would not fall under remote intervention.

b. Driving environment monitoring and enhanced perception through remote intervention

Generally speaking, monitoring the route or the driving environment in a nominal traffic situation was not designed as part of remote intervention, even if it constitutes support (it can for example make it possible to identify traffic difficulties or hazards, leading to a remote intervention consisting of modifying the route or ordering an MRM if necessary)[4].

The question nevertheless arises of the action consisting, during a response sequence to a hazard in which remote intervention is activated (ie via instructions or acknowledgments of maneuvers), in targeting or increasing the surveillance of the vehicle to allow these remote intervention modalities (for example: zooming in on a bulky object; rotating the angles of the sensors to target a particular vision area; increasing the power, range or resolution of certain sensors).

These "enhanced monitoring" actions, which can in theory take place in upstream, downstream situations or during a hazard scenario, raise questions since the remote operator may be required to modify the functions of certain components which are part of the automated driving system (in particular by modifying the perception functions of the system: see camera angle, zoom). This form of handling of perception functions by the operator, with the aim of supplementing the perception of the vehicle in order to enable it continuing to perform the dynamic driving task, would mean that the operator, through his action, modifies the detection or perception capabilities of the system.

Intervention on these organs of the automated driving system appears critical to the extent that the operator can make a modification to the perceived environment and, if necessary, can create a perception bias that could affect safety.

The above elements would lead us to consider that remote action aimed at modifying the perception of the vehicle, during a response sequence to hazards, is part of remote intervention.

However, on closer inspection, if we consider that enhanced perception is akin to giving instructions to the automated driving system (to increase its vision), and acknowledge its proposals (in the sense of taking into account the enhanced vision offered by the system), this meaning does not correspond exactly to the definition of the decree which mentions instructions and acknowledgments of ***maneuvers*** given by the remote operator.

In addition, the concept of remote intervention was originally designed to provide a response to situations that the system would not be able to manage (e.g. leaving the operational design domain – ODD or after a minimum risk maneuver - MRM), without carrying out the dynamic driving task.

However, ***perception is part of the dynamic driving task***, as defined by the regulation and, during remote intervention, the system is supposed to maintain the dynamic driving task:

- The ARTS decree indicates in particular: *Dynamic control: execution of all real-time operational and tactical functions that are necessary for the movement of the vehicle. These include lateral and longitudinal control of the vehicle,* ***road environment monitoring****, road traffic event reaction and maneuvers preparation and reporting;*
- The EU ADS Regulation states: *'dynamic driving task ('DDT')' means all real time operational functions and tactical functions required to operate the vehicle, excluding strategic functions such as trip scheduling and selection of destinations and waypoints and including without limitation the following*

[4] The industrialists consider these functionalities as not operationally available at the current stage.

subtasks: […] ***monitoring the driving environment via object and event detection, recognition, classification****, and response preparation (operational and tactical).*

To solve these apparent definitional gaps, one possibility would be to consider that, when a remote operator has an action on the automated driving system to modify the perception, he can only do so in the absence of any maneuver, i.e. post-MRM shutdown and/or before system activation. And, during the period of time in which it modifies the perception capabilities, the automated driving system is not active, it only becomes active again when the perception capabilities have returned to the level decided by the automated driving system itself.

This separation of tasks would lead to say that the action of enhancing the perception does not constitute remote intervention (since the dynamic driving task is not active during these periods of time). However, the action decided by the operator on the basis of this enhanced vision, consisting of giving an instruction or acknowledgment of a maneuver, would remain an integral part of the remote intervention.

If the enhanced vision system of the vehicle used by the operator is separate and redundant from the perception system attached to the automated system itself, which would result in the presence of a set of cameras (and other possible perception devices) separate from those used by the automated driving system and of which a change of angle or zoom carried out by the remote intervention operator would not have an impact on the dynamic driving task of the automated driving system, then there is nothing to prevent operator's actions occurring during maneuvers, and they are not considered as remote intervention, whether in a nominal situation or as part of a hazard response.

c. Managing a change in operating mode

An automated road transport system can, in certain cases, be designed to define different automated functions depending on the operational domain (for example: turning left is not permitted in certain environmental conditions). Leaving one ODD to move to another ODD then leads to what can be described as a "change in automation mode". By extension, this concept covers the exit of ODD, which must then cause the system to exit the automated mode (if necessary via a safety maneuver).

These mode changes (between different automation functions or towards non-automated mode) occurring at the same time than an ODD change, may request a remote intervention, even if the principle according to which the system should be capable of recognizing its ODD boundaries should be fulfilled, therefore, by extension, if it crosses the border between an ODD A and an ODD B.

If the system is designed to request an acknowledgment when switching from automation mode A to automation mode B when switching from ODD A to ODD B, or to order a switch from automation mode A to automation mode B (for example if the assessment of the boundaries between ODD A and ODD B by a person outside the vehicle must complement the assessment by the vehicle system), then these functions fall under the concept of remote intervention, in the sense that they are intermediate between the system activation / deactivation function and the acknowledgment/operation order function, both covered by the regulatory definition of remote intervention.

d. Vehicle state monitoring

The question of whether or not monitoring the vehicle's condition involves remote intervention should be analyzed, as for the perception of the driving environment, with regard to the regulatory definitions of automation, and particularly the dynamic driving task.

The European regulation does not appear to include vehicle state monitoring in the dynamic driving task, even though such monitoring is part of the safety requirements. Likewise, the national framework only refers to orders and acknowledgments of maneuvers.

As a result, “nominal” monitoring of the vehicle state, carried out by an supervisor, does not a priori constitute a form of remote intervention.

Regarding cases of failure or malfunction, reported by the system to the operator or identified by the operator, and which may result in an action on the automated driving system (MRM, shutdown), we can say that, even in this case, the notion of surveillance is assimilated to a complement or a necessary building block for a remote intervention action, but cannot be considered as a remote intervention action stricto-sensu.

Concerning possible "enhanced" monitoring of the vehicle's components, following a hazard (for example: checking the state of a sensor that may have been damaged during a hazard), we can consider, at given the regulatory definitions, it does not constitute a remote intervention component. If “enhanced” monitoring actions are carried out by the remote operator, and affect the monitoring of the automated driving devices controlled by the ADS, these actions should, by analogy with the enhanced perception actions, only be possible outside of the maneuvers conducted by the automated system, unless the enhanced monitoring system is complementary / redundant to that used by the automated driving system when activated. In the latter case, these actions can be considered independent of automation, and can be carried out when the automated system is activated; they do not, in any case, fall under remote intervention.

e. Intervention on non-automated functions and components of the vehicle

We are interested here in functions such as interior lighting, temperature adjustment, door opening. A priori, these functions, even automated (e.g. thermostat; light sensors), are not part of the dynamic driving task. Any remote intervention on these functions or any action on their possibly automated version would therefore not constitute remote intervention.

On the other hand, it is important to remember that the dynamic driving task covers, in the definition of the EU ADS regulation: […] *“Enhancing conspicuity via lighting, sounding the horn, signalling, gesturing, etc. (tactical).”* If the operator gives instructions or accepts proposals for action on these functions, this then constitutes remote intervention.

Likewise, if the vehicle has automated loading-unloading functions: e.g. goods, equipment for disabled people, etc. – those functions are not considered driving automation functions. However, they participate in the automated road mobility service and deserve special attention; they are discussed below.

f. Intervention on automated loading-unloading functions

As indicated above, if loading-unloading functions are part of the on-board automated driving system (which will possibly be the case in an automated freight and logistics service), these functions cannot ex ante be considered as driving automation functions and the analysis requires a case-by-case approach. In any case, safety issues related to those functions justify to integrate them into the safety demonstration, in particular through the development of suitable scenarios. Part 5 of this document offers initial thoughts in this direction, which will be explored in depth as part of the development of the regulatory framework for automated freight and logistics.

In particular, the question of the articulation of those functions with remote intervention arises when:

- certain loading-unloading functions are strongly linked to automated driving functions (including perception), or vice versa (e.g.: conditioning system activation and/or specific maneuvers, to the loading-unloading state ; automatic uncoupling of a trailer);
- the same remote action acts simultaneously on ADS maneuvers and on loading-unloading or coupling-uncoupling actions of a trailer;
- a remote action acts simultaneously on the automated driving system perception functions for the purposes of steering loading-unloading or similar actions (e.g. zooming or shifting on certain sensors towards the sidewalls or loading-unloading zones).

In case where certain automated driving functions or maneuvers are subject to loading-unloading-coupling-uncoupling tasks, two sub-cases are a priori possible:

- the automated loading-unloading-coupling-uncoupling functions have been designed as part of the ADS, and we should then consider that intervening on the loading-unloading functions is remote intervention;
- the automated loading-unloading-coupling-uncoupling functions were designed as not part of the ADS: in this case, formally, it seems that we should not consider that intervening on the loading functions -unloading involves remote intervention; however, if an instruction or acknowledgment on a loading-unloading-coupling-uncoupling maneuver results, via the control, in a maneuver instruction or acknowledgment, the action appears to fall within the regulatory definition of the remote intervention; not to consider this type of intervention as remote intervention, it would be appropriate that, in those situations, the instruction and acknowledgment sequences be split, i.e. associated to the driving on the one hand, the loading-unloading-coupling-uncoupling functions on the other hand; this leading to deactivating servo-controls during remote intervention.

If an intervention on loading-unloading-coupling-uncoupling tasks involves and modifies the automated driving perception functions, it seems that we can apply the analysis developed above for enhanced driving environment perception or vehicle's components diligent monitoring: if "enhanced" monitoring actions attached to loading-unloading-coupling-uncoupling are carried out by the remote operator, and affect the monitoring of the automated driving devices controlled by the ADS, it should only be possible outside of the maneuvers carried out by the automated system, unless the augmented loading-unloading monitoring system is additional to that used by the automated driving system when activated.

g. Intervention on connectivity elements and remote capabilities of the ADS system

We are interested here in technical devices or functions provided from the infrastructure or more broadly from the outside of the vehicle, contributing to the safety of the automated system. Among these devices, we can cite connected lights or elements for the closing / opening access to reserved lanes or sites, extended vision elements settled on the infrastructure, which can be defined as part of the perception system of the ADS, and more generally, the connectivity elements to which the automated driving system is linked.

Any action on these devices or functions may, with regard to the definition of remote intervention in the EU regulation, be considered as remote intervention since these devices or functions are designed as part of the ADS. With regard to the national definition (STRA decree) of remote intervention (which does not explicitly mention the ADS perimeter), we could also consider that any action on a connectivity component and/or remote component on the infrastructure, which participates in the execution of an automated maneuver (to be ordered or acknowledged), is part of the remote intervention, except possibly to demonstrate that this connectivity component and/or remote component on the infrastructure is redundant in relation to the ADS perception system at the time of the performed maneuver.

The particular case of failures of these connectivity or remote component should also be analyzed:

- if a failure or functional insufficiency of these devices is noted by a supervisor, which leads him to block or replace the connectivity, we can consider that, if he modifies (admittedly for safety reasons), the perception functions of the system, then this action is presumed to fall under remote intervention, if at least one of the two criteria below is met:
    - this device is part of the ADS system (EU approach to the definition of remote intervention)
    - this action takes place during a maneuver or at the time of an instruction or acknowledgment of a maneuver (FR approach to the definition of remote intervention);
- if the system identifies a failure or functional insufficiency of these devices and requests a possible remote acknowledgment to substitute, modify or disconnect these devices or to undertake a maneuver, the qualification with regard to remote intervention meets the same logic as above: it falls under remote

intervention if these devices are part of the ADS's design or if the action takes place during a maneuver, an instruction or an acknowledgment;

- in the extreme case where it is the connectivity supporting remote intervention which presents failures or functional insufficiency, whether noted by the operator or by the system, the above reasoning applies: remote intervention is part of the ADS system when it is active, modifying its connectivity support (example: changing connectivity mode) therefore also falls under remote intervention; in any case, a failure or functional insufficiency of the connectivity support between the automated driving system and the remote operator, affecting its ability to complete the missions (maneuver instructions and acknowledgments, changes of stops and routes) , constitutes a serious failure requiring a safety action.

The regulatory qualification proposed above, which argues for considering actions on connectivity and remote functions as remote intervention, does not involve any consideration of the opportunity to multiply these remote intervention actions on the management of interfaces with off-board elements: these participate in the safety of the automated driving system, the multiplication of possible interventions presents in particular, in addition to the cognitive load issues for the operator, specific cybersecurity risks.

h. Communication with intervention, first responders and law enforcement officers

The question of the status of interactions with law enforcement officers and priority vehicles or those benefiting from ease of passage with regard to remote intervention arises. In the work carried out to date, interactions with law enforcement have been considered in the system's response (see axes for describing traffic scenarios) to an event, constituted by an injunction or a priority. In this way, the driving system, as soon as it is subject to an interaction with a law enforcement officer or a priority vehicle (first responder), should be able to detect it, to recognize it and to react in such a way as to either respond to the injunction received (law enforcement), or move aside and give way to the vehicle, or facilitate their passage.

To the extent that law enforcement officers and/or priority vehicles do not have a direct link to the vehicle or its automated driving system, they cannot be considered part of the remote intervention: they do not exert any action on the system.

When, to facilitate interactions between the system and the situations involving these specific third parties, a link is established between the remote intervention center and in particular the operator and the law enforcement officers, this communication can result in an action by the remote operator on the system; but in this case, remote intervention is the responsibility of the operator and not of law enforcement officers or of the priority vehicle.

Likewise, when a priority vehicle or a law enforcement officer sends a connectivity message signaling its presence or including a request or injunction to perform a maneuver, this interaction does not fall under the concept of remote intervention: in fact:

- either the ADS alone interprets this information for its maneuvering decisions, and in this case, there is no remote intervention;
- or the ADS requests an acknowledgment or even a maneuver instruction from the remote operator, who remains alone in charge of giving the acknowledgment or instruction, without the sender of the original information (law enforcement or priority vehicle) being considered as part of the remote intervention.

To this extent, interactions with law enforcement and priority vehicles (or those benefiting from ease of passage, also called first responders) are not intended to be considered as remote intervention.

i. Communication with third-party infrastructure operators

We are interested here in interactions with actors such as road managers, parking lot managers or multimodal hubs, which do not involve direct interventions on traffic management elements, but pass

through human operators in traffic operation. This may involve, for example, requests for authorization to enter an enclosure, to raise barriers, to act on traffic lights, to activate variable message signs, etc.

A priori, these interactions do not affect, through the action of the operator himself, the functions of the ADS, so they can be considered as not being part of the remote intervention.

j. Communication, alert and passenger assistance

Communication, and, where appropriate, issuing alerts or providing assistance to passengers, constitute key elements of passenger transport system's safety. These functions inherently require remote actions.

The EU ADS Regulation states that the obligations to "*provides assistance in duly identified situations to the passengers of the fully automated vehicle*", apply to the on-board operator on board and that the remote intervention operator can perform this task *"where applicable to the ADS safety concept […], provided it is safe to do so".*

The national regulatory framework (ARTS decree) does not mention communication and assistance to passengers among remote intervention functions.

However, the question arises of the qualification of the various forms of communication or passenger assistance alert with regard to remote intervention definition.

We can already note that the different types of responses to communications or alerts sent by passengers fall, schematically, into five categories:

i. Remote intervention action within the meaning of the ARTS decree
ii. Mission of on-board human assistance
iii. Action on non-automated vehicle components (e.g. temperature)
iv. Automated action on non-ADS functions (e.g. opening doors)
v. Action on technical off-board capabilities to the infrastructure forming part of the ADS
vi. Action to remove doubt or deepen the situation which was the subject of the alert

This categorization of responses leads to the following elements of analysis:

i. Responses relating to instructions or acknowledgment of maneuvers; modification of routes and stopping points following the hazard causing the alert constitute, in themselves, remote intervention, when activated by the operator;

ii. Delivering on-site human assistance (including the intervention of law enforcement or emergency services) is not part of the remote intervention functions, even if this action may follow a remote intervention action (such as the request for an MRM or a detour for example);

iii. Action on non-automated vehicle components, as indicated above, does not fall under remote intervention;

iv. The particular case of ADS driving actions triggered automatically by passenger action must be analyzed closely. We can refer here to requirements on the automatic stop functions provided for in the drafted "urban shuttle" decree: this command, called *"passenger safety stop request system",* can be activated by a push-button or a specific and dedicated operable handle inside the vehicle.

- *The passenger safety stop request should be sent to the operator, who should be able to identify the vehicle in which it was activated,*
- *The passenger safety stop request should be maintained until the operator acknowledges it (inhibition),*
- *The passenger safety stop request activation automatically leads to vehicle stop in the following conditions:*

- *if the vehicle is in the station or leaves the station: immediately;*
- *if the vehicle is outside a station:*
    - *as soon as it is possible to carry out a minimum risk maneuver, unless the passenger safety stop request is acknowledge by the operator before the MRM is carried out,*
    - *at a maximum of 30 seconds after its activation, unless the passenger safety stop request is acknowledged by the operator before this period.*

v. The action on connectivity elements and remote capabilities possibly functionally integrated into the ADS seems to have to be examined according to the criteria proposed above: the fact that this action is triggered in response to a communication or an alert initiated by passengers does not modify the action's status with respect to remote intervention;

vi. The particular case of removing doubts should be examined in the same way as actions for vehicle or traffic state monitoring: it is not a question of remote intervention, modulo a more in-depth examination of two sub-cases:

a. When perception devices used by the ADS could be affected by the remote action, which assumes that they are at standstill or that they can be considered redundant within the ADS system;
b. When the raise of doubt involves a maneuver instruction or a request followed by a maneuver acknowledgment (for example to check the state of the vehicle's environment or one of its components).

In particular, automated urban shuttles are equipped with a control command allowing direct communication with the operator when there is an emergency requiring action on the vehicle's automated driving system.

We can also assume that a passenger can communicate with the operator and more generally the intervention center in order to report an internal hazard (traveler discomfort, fire, on-board vehicle incident, etc.), a external hazard that informs the operator of an external danger that requires the operator to make a decision and take an action.

k. Traceability of system actions and generation of alerts

The traceability of system actions seems to present a major issue in the context of monitoring and audits carried out of the system in operation. The collection of a certain number of operating indicators and interactions between remote intervention and the system is a traceability tool. Among these indicators could be considered, for example, alerts reported by the system or requests for remote intervention asked by the system.

The question of managing iterations of alerts in the context of remote intervention monitoring is particularly linked to the definition of these reports. The choice of data to record and send and their characteristics is particularly decisive in this regard.

The question may arise about the status, with regard to remote intervention, of an action by a human located outside the vehicle, to modify the system's alert reporting criteria (for example modification of the number of alerts per unit of time) or to act on the system parameters defining how alerts are prioritized relative to each other in the event of overlapping alerts in a degraded situation. This may involve, for example, asking the system to be more or less discriminating (i.e. more or less restrictive) in the alerts produced, for example depending on the level of perceived risk or cognitive load of the human located remotely.

Even if the management of alerts directly characterizes the interactions between the remote intervention operator and the automated driving system, the action on the reporting of these alerts and their

parametrization does not appear to fall under the scope of remote intervention in that it is not manageable in real-time for the purposes of issuing a command or a response to the system.

The management of alert reporting appears in fact to be a system update functionality not operationally linked to remote intervention itself, not the subject of the document.

Furthermore, the action of the operator on operating alerts, independently of the alerts reported by the vehicle on its state, on detection and perception elements linked to its operation, can be considered as a function of the remote intervention allowing to define the level of relevance of alerts, which can affect the type of action required in response to these alerts in operation. They thus participate in the decision-making process for the operator's responses, and appear to be closely linked to remote intervention tasks.

3.3. Summary

The table below summarizes the analysis of the links between functions related to remote intervention and remote intervention itself.

Task	Specific points related to remote intervention functions
Commercial service and vehicle missions (route modification and stopping following an accident are excluded)	Only traffic modifications due to traffic hazards or system failures are covered by remote intervention; mission modifications for commercial reasons (fluctuations in demand or traffic) are not a priori covered by remote intervention.
Driving environment monitoring and perception enhanced by the intervention	Monitoring the driving environment falls under the regulatory functions of the ADS. (The question arises of prescribing that acting remotely on these functions (for example to increase or modify the vision of an event), would only be possible at standstill, the ADS only resuming the maneuver when the perception functions have returned to the level used by the ADS, free from actions by the remote operator). The possibility of splitting the system's perception components for the benefit of control actions by the remote intervention operator without impact on the perception of the system would not fall under remote intervention.
Management of an operating mode / ODD shift (or degraded traffic conditions)	If the design of the system integrates the possibility of an extrernal action to the ADS for the acknowledgment or even the shifting instruction from one ODD to another, then this function is considered as remote intervention. By extension, if the system design includes the possibility of degraded operation, the transition from a so-called nominal to degraded operating mode, and that external intervention is possible to acknowledge or order this transition, then this function falls under the remote intervention.
Vehicle state monitoring	A priori, the ADS should be able to identify failures that affect its operation. This function therefore does not a priori fall under remote intervention. If remote intervention acts remotely on these functions (for example to increase or modify vision of a failure), the question should be asked of prescribing that this is only possible at standstill, the ADS system resuming the maneuver only when the monitoring functions have returned to the level used by the ADS, free from actions by the remote operator.
Intervention on non-automated vehicle functions and components	A priori, does not fall under remote intervention.
Intervention on connectivity elements or remote capabilities on the infrastructure	A priori falls under remote intervention since either these elements have been declared as part of the ADS (see European definition), or are mobilized by the system for a maneuver (see national definition).
Intervention on automated loading/unloading functions	Only comes under remote intervention if the driving delegation functions are subject to them and if the loading/unloading functions have been declared as part of the ADS (see European definition), or are mobilized by the system to a maneuver (see national definition).
Communication with intervention, first responders and law enforcement officers	A priori, does not fall under remote intervention
Communication with third-party infrastructure operators	A priori, does not fall under remote intervention
Communication and assistance to passengers	Does not fall under remote intervention; if core functions of the system are affected as part of these actions (e.g. use of the vehicle's perception capabilities to remove doubts or facilitate assistance), the question should be asked of prescribing that this couldn’t be done outside of maneuvering.
Traceability of system actions and remote intervention	The ability of the remote operator to act on the recording of system alerts in real-time does not seem to be operationally possible, which would tend to exclude these functions from remote intervention.

4. Articulation of remote intervention functions and related tasks between different agents

This part offers first considerations regarding the articulation of roles around the different tasks identified in the previous part. It addresses in particular the question of the uniqueness of the person responsible for remote intervention stricto-sensu and of certain tasks which are closely linked to it (or, conversely, the need to divide tasks between those, central, devolved to the operator, and others, sufficiently distant to be carried out by other actors). One of the issues of this analysis concerns the extent of the obligation to hold the driving license of the vehicle, for certain tasks, as it is defined by the order of April 14, 2021 (article L. 3151-3 of the Transport Code) provides that "*Any remote intervention as defined by regulations, can only be carried out by an authorized person, holder of the driving license corresponding to the category of vehicle in question*".

In general, it appears that certain functions "related" to remote intervention have strong connections with it, especially during decision-making by the remote intervention operator on a particular vehicle in a hazard situation. The criteria for analyzing these "adhesions" undoubtedly deserve to be refined.

- A first family of criteria could be deduced from an approach in which we evaluate, in the situation as close as possible to that of a driver, ***the information which he should have at his disposal concomitantly during a decision to react to a danger*** (which can be estimated, on average, at 1 second).
- A second family of criteria could be to consider, again from the perspective of driving (even if remote intervention does not fall under remote driving), ***the levers of action that it should have at its disposal concomitantly during a decision to react to danger.***

This approach amounts to considering that, in these situations, the duplication of these functions between two people could generate risks of inconsisten decision. This reasoning would nevertheless not apply to remote intervention on two separate vehicles, which can a priori be separated more easily between two operators, including in a hazard situation, since there is no direct short-range interaction between the two vehicles.

The table below provides a first qualitative application of these criteria to the different tasks and sub-tasks related to remote intervention.

Task	Subtask particularly relevant to remote intervention functions during reaction to a danger
Commercial service and vehicle missions (route modification and stopping following an accident are excluded)	None: this task does not appear to relate to a driving reaction time in the face of danger.
Driving environment monitoring and perception enhanced by the intervention	Reading the results of enhanced perception (+++) Action to enhance perception (++)
Management of an operating mode / ODD shift (or degraded traffic conditions)	Acknowledgment of the switchover request by the system
Vehicle state monitoring	A priori none: the automated system should normally identify failures preventing it from continuing in activated mode, the management (action / reading) of this type of information does not appear to be considered as part of the decision-making process of the operator in the case of a danger.
Intervention on non-automated vehicle functions and components	None
Intervention on connectivity elements or remote capabilities on the infrastructure	A priori, the segmentation proposed above (capabilities integrated into the ADS or action during a maneuver = remote intervention), should be sufficient to define the tasks really adhering to (in fact, included) remote intervention.
Intervention on automated loading/unloading functions	A priori, these functions concern the immediate driving environment of the vehicle (traffic management operators driving around the vehicle) and could justify that the person in charge of remote intervention manages them; nevertheless, certain viewing angles can be specific (interior of the vehicle) and we can assume that these interventions are carried out at standstill, which then allows us to consider the “duplication” of remote intervention stricto-sensu. These tasks are probably the trickiest given the possible duplication between remote intervention operator / other supervision operator. It can be noted that, in traditional public transport, the driver remains responsible for the safety of passengers, including during boarding/disembarking.
Communication with intervention, first responders and law enforcement officers	None: this task does not appear to relate to a driving reaction time in the event of a danger; moreover, the cognitive load of interaction with these actors does not appear to be of the same nature as that relating to driving.
Communication with third-party infrastructure operators	None: this task does not appear to relate to a driving reaction time in the event of a danger; moreover, the cognitive load of interaction with these actors does not appear to be of the same nature as that relating to driving.
Communication and assistance to passengers	A priori, this task does not appear to relate to a driving reaction time in the event of a danger. The cognitive load of interpreting and removing doubts regarding internal events does not appear to be of the same nature as that relating to driving.
Traceability of system actions and remote intervention	None: this task does not appear to be remote intervention because it is difficult to manage in real-time and is not within the scope of system operation with regard to remote intervention

5. First steps towards integrating remote intervention into the scenario-based approach

The scenario-based approach is intended to help characterize all traffic situations the system may encounter, in a reasonably foreseeable way, in its operational design domain. This approach is intended to integrate scenarios in which remote intervention contributes to the system response, and/or contributes to hazards (failures or functional unsufficiencies).

The aim of the work that will lead to this downstream integration is to be able to generate scenario types taking into account the different functions of remote intervention, but also the related functions listed above, from which we see that they are closely linked to remote intervention in safety management, even if they do not fall under remote intervention within the meaning of the European and national regulatory definitions.

This part outlines ways for combining the specific features of remote intervention with scenario descriptors already proposed in the DGITM methodological documents[5]. It does not aim to present a list of all remote intervention scenarios but to initiate a step-by-step increase of these scenarios, whether for situations that could lead to a remote intervention, situations in which remote intervention is a source of hazards, and situations in which the functions related to remote intervention listed in part 3 participate in the response or generation of the hazard.

In this approach, it is proposed not to cover remote intervention outside of the operation of the automated system on its route or in the predefined area. In particular, the approach route and/or possible remote driving, if it is not part of the automated system and its predefined route or zone, are not intended to be integrated into this approach.

This part is limited to remote intervention stricto-sensu, excluding the related functions analyzed in part 3 above.

In this context, remote intervention can be integrated into the scenario layers of the generation methodology proposed by the DGITM:

- As a response to a traffic hazard, a failure or a functional insufficiency;
- As a source of failure or functional insufficiency:
  - In response to a hazard;
  - In a nominal situation: this category can, generally speaking, be considered theoretical, as the sustained absence of traffic hazards being very unlikely; on the other hand, this situation can make sense in the context of remote intervention, as it theoretically reflects those sitautions in the ODD where remote intervention is not requested in the response to hazards;

Furthermore, it is probably appropriate (which is confirmed by the above analysis of the functions related to remote intervention), to distinguish the situations in which the action of the operator is carried out on the system either at the stop or during driving.

When remote intervention is analyzed as a response to a hazard, it appears useful for the scenario to be characterized, in addition to the state of the system, by the primary entity which requested it, i.e. the one which reported the hazard. From this angle, a remote intervention, whether carried out during traffic or post-stop, can be initiated:

- by the system itself which detects an imminent exit from its ODD and/or its capabilities;
- by the remote operator who considers that the system needs his intervention;
- by a passenger to report any hazard or request assistance.

[5] See https://www.ecologie.gouv.fr/en/automated-vehicles for more information.

Combining these characteristics of remote intervention scenarios requires us to define the links between the description attributes.

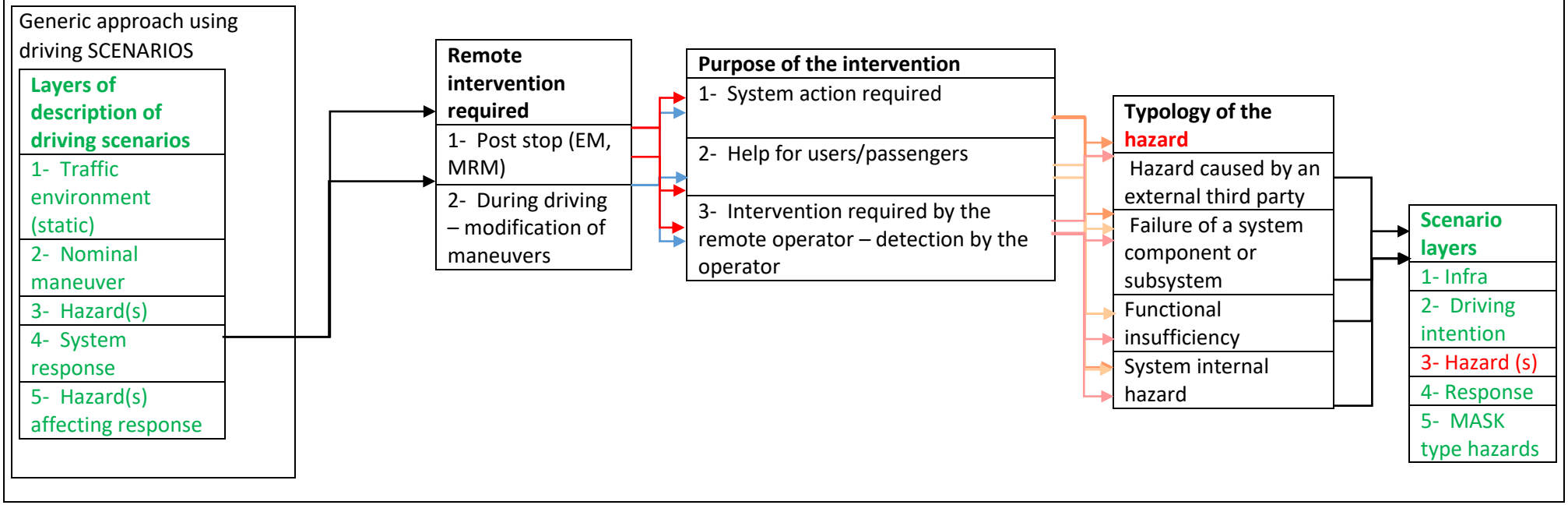
In particular, the actions reported by the passengers are limited. The only action ordered directly by passengers is passenger safety stop request, reserved for emergency cases (see above).

The following table summarizes all the possible categories to characterize remote intervention by scenarios, regardless of the seriousness of the remote intervention requests.

Dynamic	Required by	Due to
Post stop	The system	External hazard (third party user)
		Technical failure
		Fonctional insufficiency
		Internal hazard (passenger)
	A passenger	External hazard (third party user)
		Internal hazard (passenger)
	The authorized remote operator	External hazard (third party user)
		Technical failure
		Functional insufficiency
		Internal hazard (passenger)
During driving	The system	External hazard (third party user)
		Technical failure
		Functional insufficiency
		Internal hazard (passenger)
	A passenger	External hazard (third party user)
		Internal hazard (passenger)
	The authorized remote operator	External hazard (third party user)
		Technical failure
		Functional insufficiency
		Internal hazard (passenger)

In order to specify the types of remote intervention, whether they come from the system or from the operator himself or from a passenger, taking into consideration that the type of request must make it possible to prioritize dependencies between remote intervention requests.

Tree structure of the scenario-based approach applied to the construction of remote intervention scenarios



Appendix 1: taxonomy of remote functionality concepts by the SAE[6] and link with French concepts

Executive summary

Vehicle automation is based on the assumption that vehicles are capable of carrying out the entire driving task in a specific and defined operational design domain. Within the limits of this operational design domin, the system should be capable of bringing the vehicle to a state of minimal risk and may require human intervention located in a remote center.

This human intervention (remote assistance) is characterized by a set of suggestions, recommendations and orders sent to the system from a remote center in order to improve system capabilities as well as its overall performance, without direct control of the vehicle.

The design of a system integrating remote intervention functionalities requires ensuring their adequacy with safety concepts and demonstrating their safety. In particular, the functions of remote intervention must describe the scope, limits and capabilities permitted by an external human actions on the system.

The document includes the definition of the types of events that can trigger a remote intervention. Furthermore, the logical reasoning concerning the on-board modules and decision-making is not addressed. The recommendations remain agnostic of vehicles, automated driving systems as well as functional architecture and commercial use cases.

The concept of remote intervention is described as applicable in the case of the driving of vehicles equipped with automated driving systems and does not concern manual driving, vehicle fleet management and operating supports for passengers or other road users.

1. Definitions

Fleet operations: activities that support the management of a fleet of ADS-equipped vehicles in driverless operation, which may include, without limitation:

- ensuring operational readiness, dispatching ADS-equipped vehicles in driverless operation (i.e., engaging the ADSs prior to placing the vehicles in service on public roads),
- authorizing each trip (e.g., payment, trip route selection),
- providing fleet asset management services to vehicles while in use (e.g., managing emergencies, summoning, or providing remote assistance as needed, responding to customer requests and breakdowns),
- **s**erving as the responsible agent vis-á-vis law enforcement, emergency responders, and other authorities for vehicles while in use,
- disengaging the ADS at the end of service,
- performing vehicle repair and maintenance as needed.

Customer support: customer support function entails delivering assistance, guidance, and solutions to customers prior to, during, and after their interaction with an ADS-equipped vehicle.

“Dispatch”: to place an ADS-equipped vehicle into service in driverless operation by engaging the ADS.

Monitoring: continual oversight of vehicle operation from beyond line of sight.

[6] Automated Vehicle Safety Consortium. 2023. AVSC Best Practice for ADS Remote Assistance Use Case. SAE Industry Technologies Consortia.

Remote assistance: event-driven provision, by a remotely located human, of information or advice to an ADS-equipped vehicle in driverless operation to facilitate trip continuation when the ADS encounters a situation it cannot manage.

Remote assistance does not include real-time DDT or fallback performance by a remote driver. The RA function does not include providing strategic instruction regarding selection of destinations or trip initiation timing (i.e., dispatch functions).

Examples of remote assistance (intervention) functions:

- Confirming or changing tactical behavior/maneuver plans,
- Confirmation or changing trajectory plans,
- Confirmation/augmenting object classification (assigning a classification to an unknown object, give context for movement modeling),
- Temporary modifying specific driving policies,
- Temporary changing zones (temporarily closed area following an emergency intervention).

Remote driving: real-time performance of part or all of the DDT and/or DDT fallback (including real-time braking, steering, acceleration, and transmission shifting), by a remote driver.

A remote driver is not the same as a driverless operation “dispatcher”.

Remote operations: monitoring, assistance, and/or driving of vehicles using remote technology.

Situational attention: perception of elements in the environment, the comprehension of their meaning, and the projection of their status in the future.

Strategic attention: strategic functions involving the planning stages of a trip, incorporating the determination of trip goal, route and vehicle choice, and evaluation of the costs and risks involved.

Tactical functions: functions delivered over a time constant of seconds and including tasks, such as lane choice, gap acceptance, and overtaking.

Operational functions: functions delivered over a time constant of milliseconds and which include tasks, such as steering inputs to keep within a lane or braking to avoid an emerging hazard.

Tactical behavior: execution by an ADS of near-term tasks, such as maneuvers and their compositions, which are selected to achieve a higher goal (route plan) within the context of the perceived world model.

Trigger: event or condition that prompts an ADS-DV to seek additional support from human operators or remote assistants. Triggers are predefined thresholds or situations set by ADS developers for such events.

2. Objectives and functions of remote assistance

The goal of remote assistance (remote intervention) is to complement the capabilities of the automated driving system and increase the overall performance of the system by providing guidance, suggestions on scenarios that extend the capabilities of the design.

Remote intervention is one of the features of remote operations.

Box: parallel with the French framework

The definitions presented in the SAE document are consistent with the concepts presented in the methodological document on remote intervention.

The table below shows the correspondence of terms.

SAE 2023 concepts (SAE diagram)		**DGITM 2024 methodological document (typologies of human-machine interactions – summary taxonomy)**	**Defined Actions (SAE)**
Interactions with vehicle and fleet			
Remote operations = set of functionalities carried out remotely			Behavioral awareness
Remote monitoring	vision control of the vehicle environment and its condition (performance) of vehicles	Remote viewing (no action)	Situational awareness
	response to technical vehicle anomalies	*Action following vehicle state monitoring*	
Dispatching = assigning vehicles on the route and planning of their routes		*Operations planning*	Strategic awareness
Remote assistance = provides real-time commands and information to vehicles in specific scenarios without support for the dynamic driving task		Remote intervention (regulatory definition)	Tactical functions
Remote driving = performance of all or part of the dynamic driving task by a remote driver		Remote driving	Operational functions
Interactions with a human			
Customer support = assistance to passengers (e.g. a passenger forgets their keys in the vehicle)		*Part of the operation not considered in pure remote intervention:* • *passenger assistance service during and after the fact* • *link with authorities and emergency services* • *link with other road users*	Not applicable
Authorities interactions = interactions with authorities and priority vehicles (law enforcement and emergency services) in the event of an accident involving an ADS			
Other road users supports = e.g. a road user is blocked by a parked vehicle and contacts remote support			

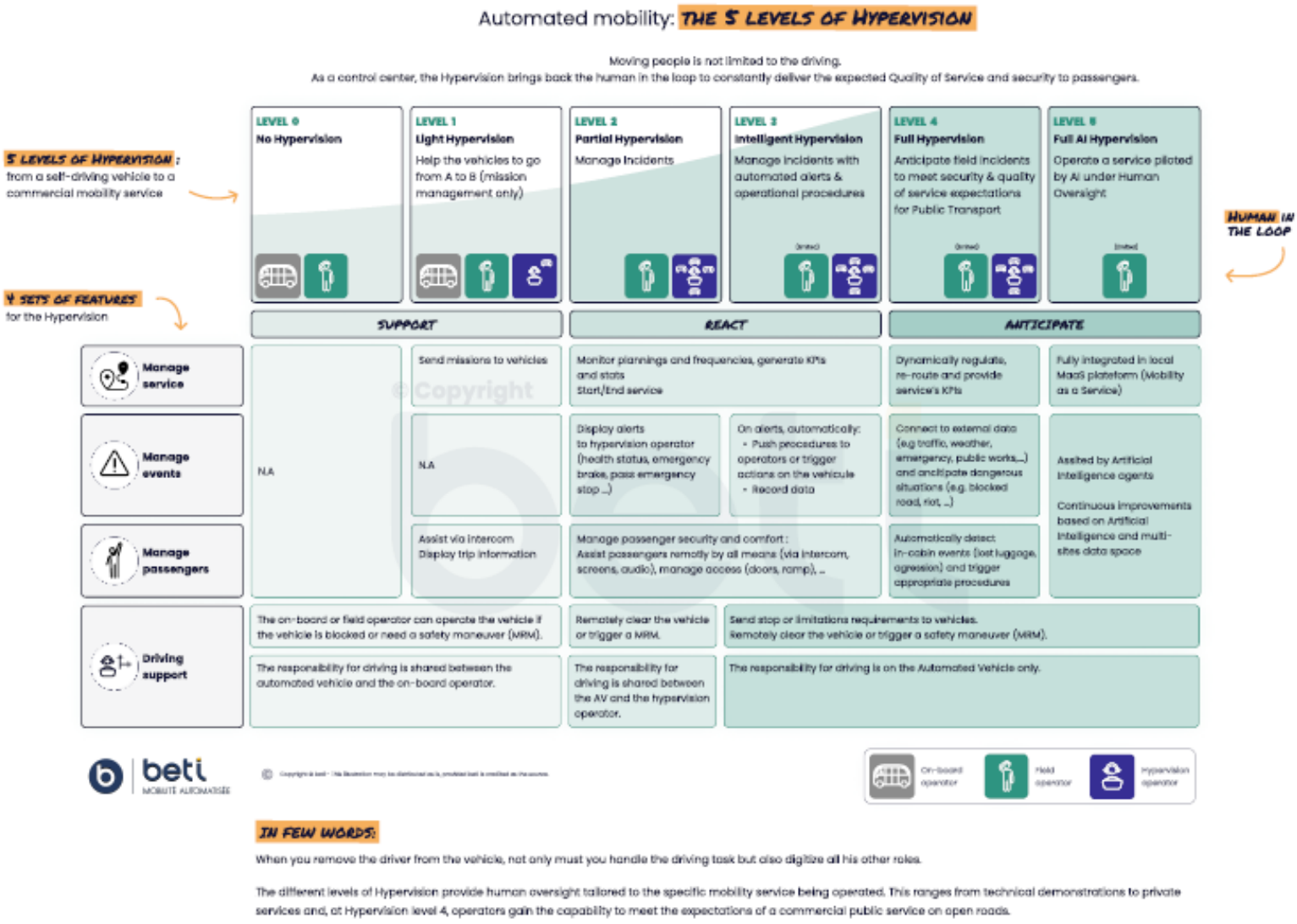
Remote intervention training

Remote intervention operators should be trained to have a deep understanding of the operational aspects of ADS and the intricacies of remote intervention interface systems.

Examples of considerations to take into account for training:

- Remote assistants receive both conceptual insights and hands-on experience concerning ADS functionalities and Remote assistance interface systems,
- Training process that may involve a blend of self-guided learning and instructor-led activities,
- Training guidance that covers all inputs that a remote assistant is expected to utilize, encompassing the entire spectrum of tasks they need to perform,
- Specific attention on understanding ADS behaviors and elements of the ODD, enabling operators to effectively navigate through situations that exceed ADS design capabilities,
- Remote assistant awareness of rules and regulations specific to the jurisdiction(s) within which the ADS-DV is operating,
- Specialized training may also allow remote assistants to specialize in specific competencies, enhancing their proficiency in certain aspects of remote assistance operations.

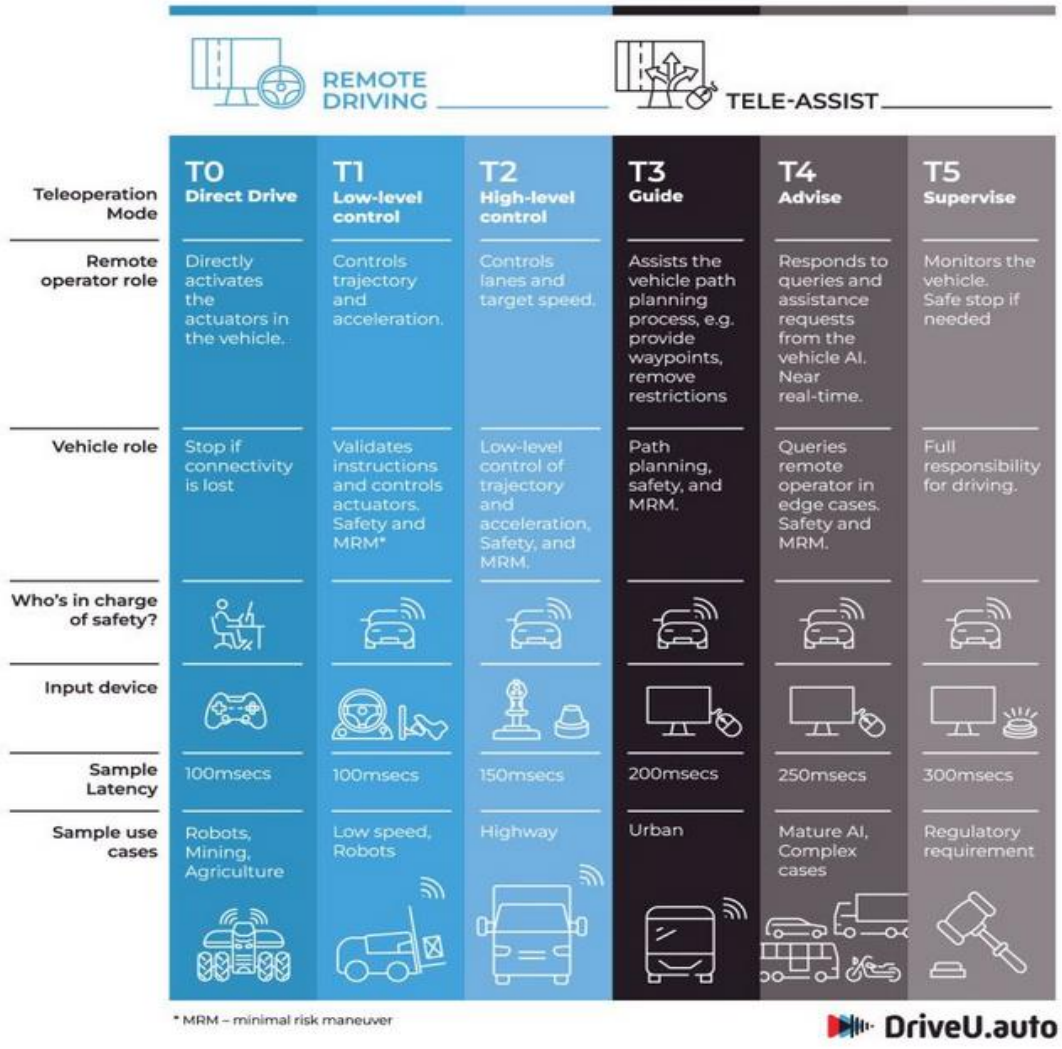
Appendix 2: taxonomy of the "hypervision" concept proposed by beti



Built on the model of SAE automation levels, this diagram offers levels of remote intervention linked to the operation of a fleet as part of a service.

Appendix 3: taxonomy of remote tasks proposed by DriveU.auto

The diagram below, published by DriveU.auto, which is developing a connected supervision platform for the operation of automated vehicle fleets:



Built on the model of SAE automation levels, this diagram offers levels of remote intervention based on the capacities allocated to the remote operator.