

**Methodological report****Safety demonstration of automated road transport systems:*****Method for developing interaction scenarios with priority vehicles benefiting from ease of passage and interactions with law enforcement officers*****1. Context and scope of the document**

The design and safety demonstration of automated mobility systems will rely heavily on the use of driving scenarios, making it possible to assess the ability of these systems to respond safely to driving situations encountered in their operational design domain (ODD), and in particular traffic hazards and/or failures of the various components of these systems. The interest of driving scenarios lies in particular in the fact that they focus on the performance of automated road transport systems, independently of the design or the technologies used.

Safety demonstration by driving scenarios has been the subject of a DGITM<sup>1</sup> methodological document<sup>2</sup> presenting a scenario-based approach, based on a structure of descriptors that can help in the search for completeness, which remains the main objective of the approach.

Interaction scenarios with general interest vehicles of a priority nature or benefiting from transit facilities (PV)<sup>3</sup> and interactions with law enforcement officers (LEO) appear as an essential complement to the general scenario-based approach. This document proposes the first methodological principles for describing the interaction scenarios with PVs and LEOs for automated road transport systems (ARTS) covered by the French decree no. 2021-873 of June 29, 2021. This document is intended to facilitate design of driving scenarios.

The scenario-based approach proposed in this document takes up the one presented in the general DGITM methodological document, and adapts it to the generation of interaction scenarios with PVs and LEOs.

It is indeed necessary to take into account the specificities of interaction scenarios with PVs and LEOs:

- in the specific approach to interactions with law enforcement, the objective of a scenario-based approach should, in theory, be to present, in addition to the context of the scenario and triggering elements (orders from law enforcement, approach of a priority vehicle), responses expected from automated systems and to ensure that these responses comply with the requirements (from the police or in terms of priorities); however, in the generic-based approach, the system's response to traffic hazards is a priori "non-standardised", the idea being that its (open) description in the scenario development phase will, in the validation phase, to ensure the relevance of this response;
- in the specific approach to interactions with law enforcement and priority vehicles, the number of triggers (orders from law enforcement, approach of a priority vehicle) is a priori reduced and these elements cannot be qualified as "hazard" (concept which characterizes the generic scenario-based approach);
- the description of interactions with PVs and LEOs is a priori relatively framed (in particular for the gestures of injunctions); conversely, in the generic scenario-based approach, the objective is to be able to describe a variety of traffic hazards, the forms and behaviors of which are hardly standardisable.

---

<sup>1</sup> *Direction Générale des Infrastructures, des Transports et des Mobilités*

<sup>2</sup> Safety demonstration of automated road transport systems: Expected contributions from driving scenarios, DGITM, February 2022

<sup>3</sup> By misuse of language in the rest of the document, the terms "priority vehicle in intervention", to which the abbreviation PV commonly refers, are sometimes preferred to the generic terms "vehicle of general interest with priority in nature or benefiting from transit facilities" which include all of these categories of vehicles.

Overall, the approach adopted to describe the interaction scenarios with PVs and LEOs in this document is inspired by that adopted in the general document: the description of the system responses (i.e. the expected behavior of the vehicle in response to an injunction or a priority) is not detailed, the document concentrates itself, at this stage, on the description of triggering events (injunctions and priorities), driving contexts and hazards which, if necessary, can affect interactions, with a focus on visibility masks in particular. The approach proposed in this document thus makes it possible to take into account the masks attached to routes (static masks), the behavior of other users, or other hazards affecting the perception of injunctions or priority requirements (e.g. loss of connectivity, which could alter the detection of a priority vehicle in intervention or of a law enforcement officer by the system).

This document does not address scenarios that can be considered as "internal" to the vehicle (fires, incivilities between passengers) involving the police or the intervention or emergency services. Nor does it address scenarios in which one of the components comes from failures of the vehicle's automated driving system or of the system (notably of connectivity) in which various vehicles are integrated.

This document was developed from the scenarios provided and proposed by the "Forces de l'ordre" working group led by the *Direction Générale de la Gendarmerie Nationale (DGGN)*, on the basis of scenarios constructed and shared in the methodological document " Safety demonstration of automated road transport systems" of the scenario-based approach. Its purpose is to present an indicative list of scenarios specific to interactions with VPs and LEOs.

This document constitutes an initialization document, complementary to the driving scenarios document, which makes it possible to harmonize certain methodological aspects, which will facilitate the extraction of the relevant scenarios for any system safety demonstration.

This document does not claim to present all interaction scenarios with law enforcement officers and priority vehicles to be taken into account in the design and validation of systems, but to help to generate them from typical situations which are presented. The generation of more complete lists of scenarios will have to be based on combinations of axes of description of the scenarios or quantified parameters, in particular relating to the interaction with vehicles or other users than the couple: vehicle ego – law enforcement officer (respectively priority vehicle).

## **2. *Reminder of the principles of the use of scenarios in the safety demonstration – adaptation of the method to interaction scenarios with priority vehicles and law enforcement officers***

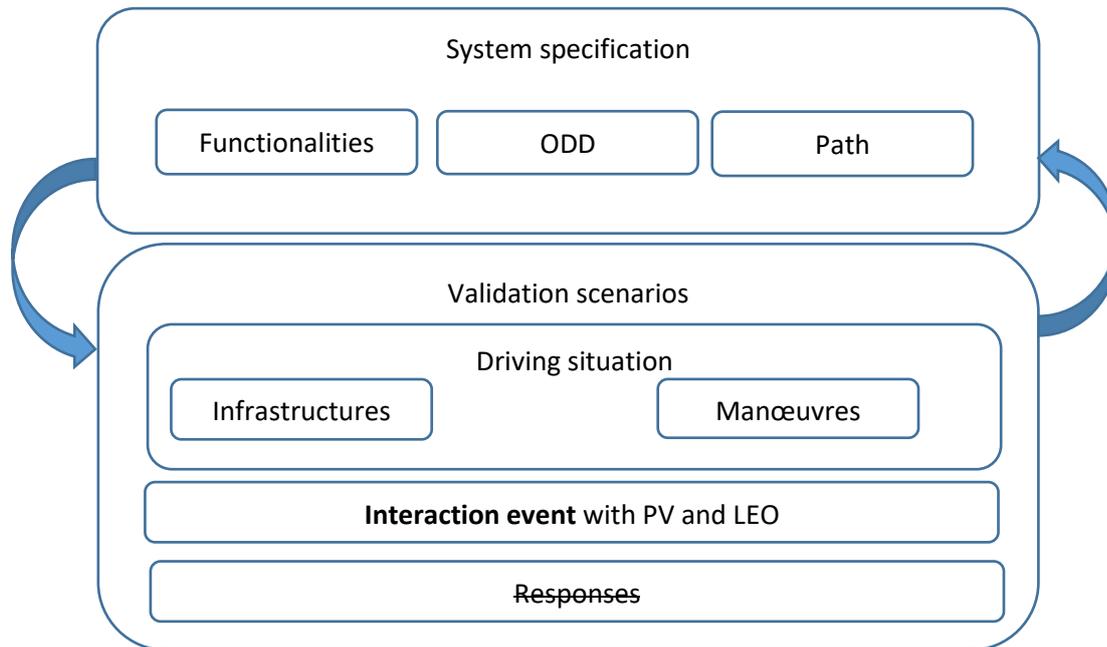
The work of the WP. 29 of the UNECE state that a scenario is *"a description of one or more real driving situations which may occur during a given journey. A scenario can involve many elements, such as the layout of the road, types of road users, objects exhibiting static behaviors or various dynamic behaviors, and various environmental conditions (among other factors)"*.

The work of WP. 29 recall that *"the use of scenarios can be applied to different testing methodologies, such as virtual simulation, test track and real-world testing. Together, these methodologies provide a multifaceted test architecture, with each methodology having specific strengths and weaknesses. Therefore, some scenarios may be more appropriately tested using certain testing methodologies than others"*.

These definitions are quite suitable for specific interaction scenarios with VPs and LEOs.

The main purpose of the safety demonstration based on scenarios is to verify that an automated road transport system, characterized by a set of specifications resulting from its internal design and validation process, is able to behave in a safe manner in the driving situations it may encounter in traffic.

Schematically, scenarios can be used, on the one hand during the **design** of the systems and their “in itinere” validation by the designers; on the other hand in the evaluation of the “ex post” **performance** of the systems, once designed. For the specific case of interactions with PVs and LEOs, the diagram<sup>4</sup> becomes:

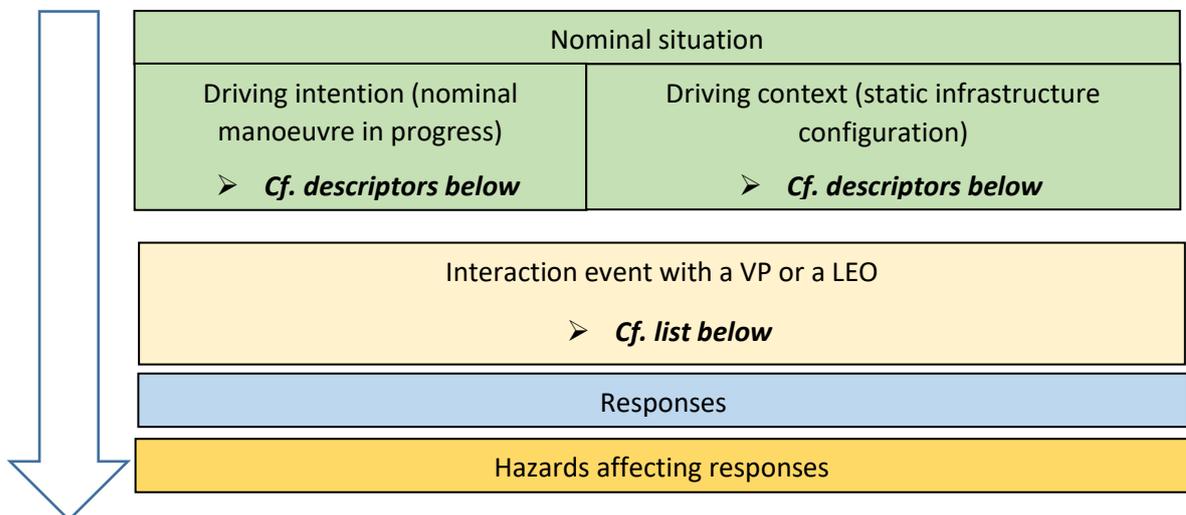


### 3. Proposed definition of scenarios resulting from the scenario-based approach

This part proposes a breakdown into layers for the definition of driving scenarios for the safety demonstration.

#### A. General architecture proposed by the definition of the scenarios

The general architecture proposed, taking into account the elements below, is as follows:



(NB: in the rest of the document, the notion of automated road transport system refers to a set of vehicles and equipment (mainly connectivity); an automated system refers to the automated driving system attached to a vehicle; by misuse of language, a vehicle means an automated vehicle.

<sup>4</sup> This document does not discuss system responses.

This architecture leads to a definition of scenarios in five axes:

1. *Static traffic environment (e.g. geometric configuration of the infrastructure)*
2. *Nominal driving maneuver (“intended maneuver”)*
3. *Events triggering an interaction with law enforcement or a priority vehicle*
4. *System response (not covered in this document)*
5. *Hazards affecting the response (combination of hazards; visibility).*

These axes are detailed below.

**B. Combination of axes and scenario descriptors**

As indicated in the introduction, the "basic" lists of scenarios presented in the rest of the document are mainly derived from the combination of the axes

1 (static driving environment)
*
2 (nominal operation)
*
3 (interaction trigger event)
*
5 (hazard affecting responses, centered on environmental conditions and visibility masks).

*Axis 1: traffic environment – nominal static elements*

The driving environment describes the nominal static elements of the traffic infrastructure. In other approaches, this is what is commonly referred to as ODD analysis to identify characteristics of the operational design domain.

- **Geometry:** The geometry of the infrastructure includes the description in particular of the type of infrastructure, the type of roadway and the specific characteristics thereof (number of lanes, width of the lane, angle of the lanes, radius of curvature, gradient of pavement...). The description of the roadway can be carried out using Part 7 of the *Instructions Interministérielles sur le Signalisation Routières (IISR)*. On the other hand, everything relating to the condition of the road surface is not taken into account at this level but in *hazards affecting the response of the system* (grip, deterioration of the road surface).
- **Signage:** The signage details all the characteristics related to the priority system and respect for the highway code. It may be useful to refer to Parts 2 and 3 of the IISR relating respectively to danger and intersection signs and priority systems.
- **Lisibility (static masks):** This involves taking into account the static masks present on the roadway and which influence the perception of objects.

**Static course descriptors**

<b>Geometric characteristics</b>	<b>Static signage (vertical, horizontal)</b>
Type of infrastructure (roadway, tunnel, bridge)	Priority scheme
Pavement type (divided carriageways, two-way carriageway, one-way)	Danger signs
Number of channels	Limit speeds
Track width	Traffic lights
Intersection geometry: lane angles (intersection, roundabout, level crossing)	Prescription signaling (including access control, limitation of certain areas to certain users)
Radius of curvature	
gradient	

### *Axis 2: Nominal maneuvers (driving intention)*

The description of the nominal maneuvers designates the driving intentions of the ego. These are all the driving situations that the vehicle must be able to manage in a nominal situation. These maneuvers are described assuming no third-party interaction or system failure.

The list of nominal driving maneuvers is detailed below.

<b><i>Nominal maneuver descriptors (driving intentions of the ego vehicle)</i></b>
- Rolling <ul style="list-style-type: none"><li>○ Driving - nominal situation</li><li>○ Crossing (two-way traffic)</li><li>○ Lane change</li><li>○ Overtaking (from the left if not specified)</li></ul>
- Intersections and crossings <ul style="list-style-type: none"><li>○ Crossing a roundabout</li><li>○ Crossing an intersection</li><li>○ Crossing a level crossing</li><li>○ Turn right at an intersection</li><li>○ Turn left at an intersection</li><li>○ U-turn</li></ul>
- Channel inserts and exits <ul style="list-style-type: none"><li>○ Input from insertion / acceleration lane</li><li>○ Exit to exit lane / deceleration</li><li>○ Insertion from lane / private site</li></ul>
- Parking <ul style="list-style-type: none"><li>○ Entering and stopping on a public transport slot</li><li>○ Exit from a public transport slot to the public highway</li><li>○ Stop on track</li><li>○ Post-stop track departure</li><li>○ Parking maneuver on the public road (slot along the lane)</li><li>○ Parking maneuver on public roads (line parking)</li><li>○ Parking maneuver on the public road (herringbone parking)</li><li>○ Exit from parking on public road (slot along lane)</li><li>○ Exit from parking on public road (line parking)</li><li>○ Exit from parking on public road (herringbone parking)</li></ul>

These first two axes are identical to the axes defined in the generic methodological document for driving scenarios.

### *Axis 3: interaction event with a PV or a LEO*

Contrary to hazards which mark the passage from the nominal to the hazard as well as from the pure description to the evaluation of the criticality of the events, this third axis based on interaction events with the PVs and LEOs rather marks the specific treatment of certain situations encountered by the system, which it must know how to manage and to which it must know how to respond in complete safety. Moreover, interaction events with VPs and LEOs are not presented as a list of descriptors, but rather as a specific interaction with a third party to which the system must facilitate the passage or execute orders.

Scenarios are not set in stone but they are much more concrete than the list of hazard descriptors, which can lead to thousands of scenarios.

On the other hand, scenarios built with this approach should then be adapted and evaluated at the level of the course in order to verify the adequacy of the scenario with the path and its specificities.

This layer contains two different notions:

- *Interactions with a vehicle of general interest with priority in nature or benefiting from transit facilities:* for these scenarios, it is a question of combining the first two axes in order to obtain a basic driving scenario in a nominal situation (static configuration of the pathway (geometry and signaling) + intentional maneuver of the ego); then to describe the interaction event between the system and the PV (maneuver + PV behavior (potentially “critical”<sup>5</sup>)). Once again, this document does not present the categorization in two axes from generic to critical in the manner of the methodological document on driving scenarios.
- *Interactions with a law enforcement officer:* for these scenarios, it is a question of combining the first two axes of the generic approach and (static lane configuration + intentional maneuver) with the list of warning gestures law enforcement.

#### *Axis 4: system response maneuvers*

Response maneuvers of the system cannot be standardized a priori, nor the response descriptors insofar as the latter depends both on the environment and its infrastructure, on the precursor event of the response and on the capacities and performances of the system. In the interaction with a PV or a LEO, the integration of the response into the scenario approach raises two specific issues: the fact that responses (ie manoeuvres) must satisfy certain requirements (e.g. stopping place depending on position and gestures of the LEO) and the fact that responses may (legitimately) contravene to traffic rules (eg. crossing a continuous line). At this stage, these issues, i.e. the compliance of responses to injunctions and the possibilities of derogating from traffic rules, are not described in this document, which focuses on the generation of driving scenes involving interactions with PVs and LEOs, without describing responses.

#### *Axis 5: hazards affecting the response of the system*

Hazards affecting the response of the system characterize additional constraints which complicate and modify the response of the system and which are likely to create over-reactions. Several types of hazards are listed in this section.

- Unexpected masks: Unexpected masks designate all the non-static masks that the ego vehicle may encounter, including in particular road users in motion.
- Environmental conditions: Climatic conditions have a temporary impact that complicates the environment and the nominal infrastructure.
- System failures, which when they are considered in axis 5 as a hazard affecting the system's response, would be added to a collision precursor event.
- Adhesion
- Adaptive behaviors of third-party vehicles: other vehicles in the interaction scene do not always have predictable behaviors for the ego vehicle, which complicates and alters its response. The adaptive responses of third parties can lead to collision precursor super-events.

#### *Special case of connectivity*

Connectivity will likely be a component of the systems response to interactions with PVs and LEOs. Given the decision to limit this document to the axes of description of scenarios which are the static driving environment + the nominal maneuver + the visibility + the action of the PV or the LEO), the connectivity is not addressed; it will have to be described (as well as its possible failures), in the description of the answers.

---

<sup>5</sup> A critical behavior of a PV is defined as a driving phase during which the PV overcomes the driving rules which are imposed to non-priority vehicles.

### ***C. Combination of axes and scenario descriptors***

Interaction scenarios with PVs and LEOs are complementary scenarios to the driving scenarios. They are therefore intended to complete the scenario catalog for the validation of the safety demonstration of automated public transport systems. They are presented as a set of minimum scenarios.

The approach proposed in this document, consistent with the generic approach, does not re-specify the hazard layer. Interactions with PVs and LEOs are not considered to be hazards, the system must know how to manage them, these are reasonably foreseeable situations. Nevertheless, this document offers illustrative scenarios of the method but does not present itself as a document covering all reasonably foreseeable situations. The integration of scenarios including several other vehicles and other types of third parties including vulnerable road users will bring additional complexity to the approach and to the generation of scenarios. This is the next stage of the work based on the methodological contributions from the approach by driving scenarios and applied to interaction scenarios with law enforcement officers and priority vehicles or vehicles benefiting from transit facilities. The combinatorial-based approach induced by the methodological support document on the driving scenarios, which aims for the exhaustiveness of scenarios, is thus favorable, and in phase with its adaptation to the specific interaction scenarios with LEOs and PVs.

### ***D. Proposal of lists of scenarios***

This part proposes a minimum illustrative list of scenarios that should give rise to performance evaluations of automated road transport systems in the case of interactions with LEOs and VPs, distinguishing the vehicle, system and route levels. The illustrative list of scenarios resulting from the combinatorial-based approach presented above strongly and voluntarily reduces the possible combination to remain illustrative and in particular on interactions with other road users, as mentioned above. It proposes, for layers that have been retained in the combination, certain possible parameter values in terms of speeds, deceleration and encroachment on the track, for example.

By proposing a list of illustrative scenarios, we voluntarily derogate from the principle of exhaustiveness induced by the combination of all axes, as for the methodological reference document.

- **Interaction scenarios with vehicles of general interest with priority or benefiting from passage facilities in nominal situations**

This section refers on the one hand to reasonably foreseeable situations of interactions with vehicles of general interest having priority or benefiting from transit facilities, named PVs in the rest of the document which could be qualified as nominal situations and on the other hand, situations involving PVs traveling at critical speed and more generally, in situations where the PV does not comply with the rules of conduct which apply to non-priority vehicles because of its priority nature in intervention.

More generally, a critical speed of a priority vehicle benefiting from passage facilities is defined as being:

- a speed higher than the speed limit imposed on non-priority vehicles;
- a speed greater than the speed practiced by the flow of traffic.

Again, this document does not describe ego responses.

	<b>Vehicle (or system *)</b>	<b>Path</b>
<p><i>NB: below, scenarios are indicated subject to the commissioning of the ARTS</i>  <i>NB bis: axes of definition of scenarios below are to be combined (ex: [ I or II ] * [ i or j ] * [ a or b ] )</i>  <i>NB 2bis: scenarios for II are to be combined with those of I because of the path, what is valid for the separated roadway is also valid for two-way traffic</i></p>		
<b>Roulage</b>		
Driving on track	<p>Lane keeping at vehicle speed limits:</p> <p>I) On separate lanes (1; 2; 3 lanes)</p> <ul style="list-style-type: none"> <li>• The PV is stopped on the way or partially blocks the way of the ego</li> <li>• The PV is stopped on the lane adjacent to that of the ego on the right</li> <li>• The PV is stopped on the lane adjacent to that of the ego on the left</li> <li>• The passenger car is stopped in the middle of the road (between two lanes) and blocks the passage</li> <li>• The PV arrives behind the ego in the same way</li> <li>• The PV arrives behind the ego in the adjacent lane on the right</li> <li>• The PV arrives behind the ego in the adjacent lane on the left</li> </ul> <p>II) On bidirectional lane (2*1; 2*2 lanes; 2+1 lanes)</p> <ul style="list-style-type: none"> <li>• The PV is stopped in the way of the ego</li> <li>• The PV is stopped on the lane in the opposite direction of traffic</li> <li>• The PV is stopped in the middle of the road and blocks the passage</li> <li>• The PV comes behind the ego</li> </ul> <p>i) Without a vehicle on the adjacent lane in the same direction</p>	<p>To be linked to the notion of "blank running" over the entire route, without traffic,</p> <p>a) In nominal visibility condition  b) To the limit conditions of visibility of the system ODD</p> <p>Following scenarios should also be declined in a configuration of masks representing that observed on the singular points of the route from the point of view of the masks and the generation of traffic from vulnerable users.</p>

	<p>j) With vehicle of the same speed on the adjacent lane in the same direction</p> <p>a) In a straight line and nominal visibility</p> <p>b) In radius of curvature and visibility at the limits of the vehicle or system ODD</p> <ul style="list-style-type: none"> <li>• The PV travels at a critical speed</li> <li>• The PV crosses a white line</li> <li>• The PV encroaches on the path of the ego</li> </ul>	
<p>Crossing (two-way traffic)</p>	<p>Lane keeping at vehicle speed limits:</p> <p>I) On separate lanes (1; 2; 3 lanes)</p> <ul style="list-style-type: none"> <li>• The PV comes in the opposite direction in front of the ego</li> <li>• The PV arrives in the opposite direction in the adjacent lane on the right</li> <li>• The PV arrives in the opposite direction in the adjacent lane on the left</li> </ul> <p>II) On bidirectional lane (2*1; 2*2 lanes; 2+1 lanes)</p> <ul style="list-style-type: none"> <li>• The PV arrives from the opposite direction of traffic</li> </ul> <p>i) Without a vehicle on the adjacent lane in the same direction</p> <p>j) With vehicle of the same speed on the adjacent lane in the same direction</p> <p>a) In a straight line and nominal visibility</p> <p>b) In radius of curvature and visibility at the limits of the vehicle or system ODD</p> <ul style="list-style-type: none"> <li>• On separate lanes (1; 2; 3 lanes) <ul style="list-style-type: none"> <li>• The PV arrives in the wrong direction against the ego at critical speed</li> <li>• The PV arrives in the opposite direction in front of the ego which must stop</li> <li>• The PV arrives in the opposite direction in the adjacent lane on the right</li> <li>• The PV arrives in the opposite direction in the adjacent lane on the left</li> </ul> </li> <li>• On bidirectional lane (2*1; 2*2 lanes; 2+1 lanes) <ul style="list-style-type: none"> <li>• The PV arrives in the opposite direction of traffic at critical speed</li> <li>• The PV arrives in the opposite direction of traffic facing the ego by crossing a white line</li> <li>• The PV arrives in the opposite direction of traffic facing the ego which must stop</li> </ul> </li> </ul>	<p>To be linked to the notion of "blank running" over the entire route, without traffic,</p> <p>a) In nominal visibility condition</p> <p>b) To the limit conditions of visibility of the system ODD</p> <p>Following scenarios should also be declined in a configuration of masks representing that observed on the singular points of the route from the point of view of the masks and the generation of traffic from vulnerable users.</p>
<p>Lane change / overtaking</p>	<p>Refuse to change lane in the presence of a priority vehicle in the process of changing lanes, overtaking or any movement during which the ego's lane change could be a hindrance.</p> <p>In the event of overtaking of the ego by the PV, the ego must facilitate the insertion or the maneuver undertaken by the PV and not itself undertake any maneuver that would slow down the passage of the PV.</p>	<p>To be linked to the notion of "blank running" over the entire route, without traffic,</p> <p>a) In nominal visibility condition</p> <p>b) To the limit conditions of visibility of the system ODD</p>

	<ul style="list-style-type: none"> <li>• The PV places himself in the path of the ego behind him and wishes to pass</li> <li>• The PV undertakes an overtaking of a vehicle located behind the ego which is on the right lane</li> <li>• The PV undertakes an overtaking of a vehicle located behind the ego which is on the left lane</li> <li>• The PV undertakes an overtaking in the opposite direction of traffic</li> <li>• The PV performs a lane change/overtake at critical speed</li> <li>• The PV performs a lane change / overtaking by crossing a white line</li> </ul> <p>i) Without a vehicle on the adjacent lane in the same direction j) With vehicle of the same speed on the adjacent lane in the same direction</p> <p>a) In a straight line and nominal visibility b) In radius of curvature and visibility at the limits of the vehicle or system ODD</p>	Following scenarios should also be declined in a configuration of masks representing that observed on the singular points of the route from the point of view of the masks and the generation of traffic from vulnerable users.
Road narrowing	<ul style="list-style-type: none"> <li>• The PV arrives opposite and does not have priority over the ego</li> <li>• The PV comes behind the ego</li> <li>• The PV arrives opposite at critical speed</li> <li>• The PV arrives behind the ego at critical speed</li> </ul> <p>a) In a straight line and nominal visibility b) In radius of curvature and visibility at the limits of the vehicle or system ODD</p>	<p>To be linked to the notion of "blank running" over the entire route, without traffic,</p> <p>a) In nominal visibility condition b) To the limit conditions of visibility of the system ODD</p> <p>Following scenarios should also be declined in a configuration of masks representing that observed on the singular points of the route from the point of view of the masks and the generation of traffic from vulnerable users.</p>

*\* NB: application to an automated road transport system: if the system extends the ODD of the vehicle(s): duplication of the Scenarios to the new limits of the system ODD*

<b>Inserts and intersections</b>		
<p><i>NB: below, scenarios are indicated provided that the corresponding nominal maneuver appears in the ODD of the vehicle or the system</i></p> <p><i>NB bis: scenarios must be combined</i></p>		
Crossing a roundabout / roundabout	<p>Crossing a roundabout</p> <ul style="list-style-type: none"> <li>• with 4 inputs</li> <li>• representing the number of vehicle ODD limit inputs</li> <li>• 1 traffic lane in/out</li> <li>• 2 lanes of entry/exit</li> </ul>	<p>To be linked to the notion of "blank running" on all the roundabouts of the route with a control vehicle inserting itself at the various entrances to the roundabouts, from a standstill or from a speed of 30 km/h:</p> <p>a) In nominal visibility condition b) To the limit conditions of visibility of the system ODD</p>

	<ul style="list-style-type: none"> <li>• In nominal visibility condition</li> <li>• To the visibility limit conditions of the vehicle or system ODD</li>   <li>• The PV is stopped on the roundabout</li> <li>• The PV drives on the roundabout behind the ego</li> <li>• The PV is to the right of the entrance in front of which the ego is about to pass</li> <li>• The PV arrives behind the ego at one of the entrances to the roundabout</li> <li>• The PV travels in the opposite direction on the roundabout</li> <li>• The PV drives on the roundabout behind the ego at critical speed</li> <li>• The PV inserts himself in front of the ego and takes priority</li> <li>• The PV arrives at critical speed at the right of the entrance in front of which the ego is about to pass</li> <li>• The PV arrives behind the ego at critical speed at the right of one of the roundabout entrances</li> </ul>	<p>Specific scenario representing the roundabouts of the route presenting significant visibility masks, respectively in heavy traffic conditions and with a passenger car entering the roundabout at critical speed.</p>
<p>Crossing an intersection</p>	<p>Crossing an intersection</p> <p>I. with lights</p> <ul style="list-style-type: none"> <li>• The PV enters the intersection in the face of the ego which goes straight ahead and does not know its intentions</li> <li>• The PV arrives behind the ego stopped at the red light at the intersection</li> <li>• The PV is stopped in the intersection and blocks the passage</li> <li>• The PV crosses the intersection at critical speed and does not respect the priorities</li> <li>• The PV turns red and enters the intersection facing the ego which has green and goes straight</li> <li>• The PV arrives behind the ego at critical speed</li> </ul> <p>II. with specific priority scheme</p> <ul style="list-style-type: none"> <li>• The PV arrives behind the ego on the right of a “give way” or priority on the right</li> <li>• The PV arrives at the right of a “give way” in front of the ego traveling on the priority lane</li> <li>• The PV arrives at critical speed in front of a “give way” in front of the ego traveling on the priority lane</li> <li>• The PV arrives at a priority on the right in front of the priority ego</li> <li>• The PV arrives at critical speed to the right of a priority on the right in front of the priority ego</li> <li>• The PV arrives behind the ego to the right of a priority on the right where a user presents himself</li> </ul>	<p>To be linked to the notion of "white running" on all the intersections of the route with a witness vehicle entering, from a standstill or from the maximum speed authorized on the adjacent lane:</p> <ol style="list-style-type: none"> <li>a) In nominal visibility condition</li> <li>b) To the limit conditions of visibility of the system ODD</li> </ol> <p>Specific scenario representing the intersections of the route presenting significant visibility masks, respectively in heavy traffic conditions and with a control vehicle approaching the intersection at critical speed.</p>

	<ul style="list-style-type: none"> <li>The PV turns left from main lane in front of ego going straight</li> </ul> <p>III. without specific priority scheme</p> <p>a) In nominal visibility condition</p> <p>b) To the visibility limit conditions of the vehicle or system ODD</p>	
Crossing a level crossing	<p>Stop in accordance with the signaling of a level crossing:</p> <p>a) In a straight line and nominal visibility</p> <p>b) In radius of curvature and visibility at the limits of the vehicle or system ODD</p> <ul style="list-style-type: none"> <li>The PV arrives behind the ego at the level crossing and the light is red</li> <li>The PV arrives behind the ego at the level crossing and the barriers are lowered</li> </ul>	Stop in accordance with the signs on all the level crossings encountered on the route
Turn right at an intersection	<p>Turn right at an intersection</p> <p>I. with lights</p> <ul style="list-style-type: none"> <li>The PV enters the intersection facing the ego which turns right and does not know its intentions</li> </ul> <p>II. with specific priority scheme</p> <ul style="list-style-type: none"> <li>The PV turns left from main lane in front of ego turning right</li> </ul> <p>III. without specific priority scheme</p> <p>a) In nominal visibility condition</p> <p>b) To the visibility limit conditions of the vehicle or system ODD</p> <ul style="list-style-type: none"> <li>The PV turns red and enters the intersection facing the ego which has green and turns right</li> <li>The PV turns red at critical speed and enters the intersection facing the ego which has green and turns right</li> </ul>	<p>To be linked to the concept of "blank running" on all the right turns of the course with a control vehicle entering, from a standstill or at a speed equal to a fixed percentage of the maximum speed authorized on the lane adjacent, from the lane towards which the ego vehicle enters or from the front lane (by turning left):</p> <p>a) In nominal visibility condition</p> <p>b) To the limit conditions of visibility of the system ODD</p> <p>Specific scenario representing right turns of the route with significant visibility masks, respectively in heavy traffic conditions and with a passenger car approaching the intersection at critical speed.</p>
Turn left at an intersection	<p>Turn left at an intersection</p> <p>I. with lights</p> <ul style="list-style-type: none"> <li>The PV enters the intersection facing the ego which turns left and does not know its intentions</li> </ul> <p>II. with specific priority scheme</p> <p>III. without specific priority scheme</p> <p>a) In nominal visibility condition</p> <p>b) To the visibility limit conditions of the vehicle or system ODD</p>	<p>To be linked to the notion of "blank running" on all left turns of the route with a control vehicle entering, from a standstill or at a speed equal to a fixed percentage of the maximum speed authorized on the lane adjacent, from the lane towards which the ego vehicle enters or from the front lane (by turning right):</p> <p>a) In nominal visibility condition</p> <p>b) To the limit conditions of visibility of the system ODD</p> <p>Specific scenario representing left turns of the route with significant visibility masks, respectively in heavy</p>

	<ul style="list-style-type: none"> <li>The PV turns red and enters the intersection facing the ego which has green and turns left</li> <li>The PV turns red at critical speed and enters the intersection facing the ego which has green and turns left</li> </ul>	traffic conditions and with a passenger car approaching the intersection at excessive speed.
Input from insertion/acceleration lane	<p>Track insertion</p> <p>I. On separate lanes (1; 2; 3 lanes)</p> <p>II. On bidirectional lane (2*1; 2*2 lanes; 2+1 lanes)</p> <p>i) with lights</p> <p>ii) with specific priority scheme</p> <p>iii) without specific priority scheme</p> <ul style="list-style-type: none"> <li>The PV enters from a non-priority lane, the ego gives way</li> <li>The ego enters from a priority lane, the PV arrives on the main lane</li> <li>The PV enters at critical speed from a non-priority lane, the ego must slow down in its lane</li> <li>The PV enters at critical speed from a non-priority lane, the ego must change lanes</li> </ul> <p>a) In a straight line and in nominal visibility conditions</p> <p>b) On bends and at the limit visibility conditions of the vehicle or system ODD</p>	<p>To be linked to the concept of "blank running" on all the insertions of the route with a control vehicle traveling on the lane targeted by the insertion at the maximum speed authorized on this lane:</p> <p>a) In nominal visibility condition</p> <p>b) To the limit conditions of visibility of the system ODD</p> <p>Specific scenario representing route insertion configurations with significant visibility masks, respectively in heavy traffic conditions and with a passenger car approaching the intersection at critical speed.</p>
Exit to exit lane / deceleration	<p>Assumed covered by lane change scenarios in nominal situations</p> <p>Deceleration behavior on approach and on the exit lane, from the maximum speed allowed in the ODD of the vehicle / system, in a situation of blocking the exit lane beyond the end of the deceleration lane</p> <ul style="list-style-type: none"> <li>The VP is behind the ego and is approaching at critical speed</li> </ul> <p>a) In nominal visibility condition</p> <p>In a curve on the exit lane and within the visibility limit conditions of the vehicle or system ODD</p>	<p>To be linked to the concept of "blank running" on all the insertions of the route with a control vehicle traveling on the lane targeted by the insertion at the maximum speed authorized on this lane:</p> <p>a) In nominal visibility condition</p> <p>b) To the limit conditions of visibility of the system ODD</p> <p>Specific scenario representing exit configurations towards the deceleration lane of the route presenting significant visibility masks, respectively in heavy traffic conditions and with a passenger car approaching the exit at critical speed.</p>
Public transport stop	<p>Deceleration and stopping behavior on a stop (in line, in advance, in notch) obstructed by awkward parking of a passenger car</p> <ul style="list-style-type: none"> <li>partially: reduction of the nominal parking length by less than 5 m</li> <li>strongly: parking length less than the length of the vehicle + 5 m</li> </ul> <p>from an initial running speed equal to the maximum authorized speed</p>	The scenarios opposite should also be declined in the configurations of stopping place presenting a significant risk of reduction of the parking length of more than 5 m by awkward parking.

	<ul style="list-style-type: none"> <li>a) in nominal visibility conditions</li> <li>b) to the visibility limit conditions of the vehicle or system ODD</li> </ul>	
Public transport stop output	<p>Insertion into traffic from the stop (in line, in advance, in notch), free to park over the entire nominal length</p> <ul style="list-style-type: none"> <li>• the PV arrives behind the ego who wants to get out of the stop</li> <li>• the PV arrives in front of the ego which wishes to exit the stop</li> <li>• with a PV traveling at critical speed on the lane targeted by the insertion (+ 20 km/h and + 50 km/h compared to the maximum authorized speed) and not respecting the priorities</li> <li>• with a PV parked on the lane targeted by the insertion</li> <li>• with a PV stopped on the lane targeted by the insertion</li> </ul> <ul style="list-style-type: none"> <li>a) in nominal visibility conditions</li> <li>b) to the visibility limit conditions of the vehicle or system ODD</li> </ul>	<p>To be linked to the concept of "blank running" on all the insertions of the route with a control vehicle traveling on the lane targeted by the insertion at the maximum speed authorized on this lane:</p> <ul style="list-style-type: none"> <li>a) In nominal visibility condition</li> <li>b) To the limit conditions of visibility of the system ODD</li> </ul> <p>Following scenarios should also be declined in a configuration of masks representing that observed on the critical parking exits of the route from the point of view of the masks.</p>
Departure post-stop on track ( <i>separate scenarios from stop to line stop</i> )	<ul style="list-style-type: none"> <li>• The PV arrives behind the rebooting ego</li> <li>• The PV arrives in front of the ego which restarts</li> </ul> <p>Insertion into traffic from the stop</p> <ul style="list-style-type: none"> <li>• the PV arrives behind the ego which restarts</li> <li>• the PV arrives in front of the ego which restarts</li> <li>• with a PV traveling at critical speed on the lane targeted by the insertion (+ 20 km/h and + 50 km/h compared to the maximum authorized speed) and not respecting the priorities</li> <li>• with a PV parked on the lane targeted by the insertion</li> <li>• with a PV stopped on the lane targeted by the insertion</li> </ul> <ul style="list-style-type: none"> <li>a) in nominal visibility conditions</li> <li>b) to the visibility limit conditions of the vehicle or system ODD</li> </ul>	<p>To be linked to the notion of "blank running" on all the planned stops of the ego vehicle on the route, free of third-party parking lots:</p> <ul style="list-style-type: none"> <li>a) In nominal visibility condition</li> <li>b) To the limit conditions of visibility of the system ODD</li> </ul>

(NB: stops on the road corresponding to minimal risk manoeuvres or emergency manoeuvres are dealt with in the responses to critical hazards below)

- **Scenario interactions with law enforcement officers (indications / warnings / order from LEO)**

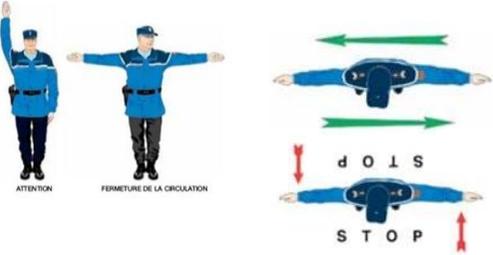
The regulatory actions below derive directly or almost directly from the documents drawn up by the law enforcement working group led by the DGGN. Adjustments will have to be made for certain situations described or potentially adapted to the scenarios in question (for example the gestures listed in 1.7).

The completeness of the interaction scenarios with law enforcement officers is enabled by the combination of the first two layers of the SDG description with the list of regulatory gestures below.

For example, the straight-line scenario on a dual carriageway (1; 2; 3 lanes), without a vehicle on the adjacent lane in the same direction with nominal visibility (first scenario resulting from the methodological document on the scenarios) must be object of a series of scenarios to verify the responses of the ego to the following regulatory gestures. Thus, multiplying the number of scenarios with the number of regulatory actions listed below produces an initial non-exhaustive list of situations to which the ARTS must be able to respond.

Finally, the notion of specificity due to the route and the hazards affecting the response must be taken into account in the detection of law enforcement agents. This is what the last column “hazards affecting the response” conveys.

<i>LEO order</i>		<i>Operational contexts</i>	<i>LE process</i>	<i>Illustration</i>	<i>Hazards affecting the response</i>
1.1	Stopping a vehicle on the roadside	Road check (following the observation of an infraction / blood alcohol control / narcotics control / fight against delinquency - article 78-2-2 CPP)	1 - On the side of the road, face the vehicle to be stopped 2 - Attention signal: raise your right arm vertically 3 Stare at and point at the driver with the index finger of the left hand extended in the extension of the arm 4 - Extend your left arm in the direction of the vehicle parking space. Then bring the right forearm up to chest level and make wide outside circles.		LEO in civilian clothes with an armband, other road users who create a mask between the User and the LEO, pedestrian who makes a similar gesture, unfavorable weather conditions

1.2	Recirculation	Following a traffic check.	<p>1 - Wait for the controlled driver to pay attention.  2 - Check that there is no traffic on the return lane.  back into traffic.  3 - Take position on the road, parallel to the traffic lane, and by repeated gestures of the right arm, confirm to the driver concerned the indication to start moving.</p>		
1.3	Stopping a vehicle on the road	Implementation of alternating traffic, closure of a traffic lane (following an accident, a public event, a sporting event, etc.)	<p>1 - Face the flow of vehicles to be stopped.  2 - Signal for attention: raise your right arm vertically.  3 - Raise both arms horizontally, palms towards the vehicle flow.</p>		LEO in civilian clothes with an armband, other road users who create a mask between the User and the LEO, pedestrian who makes a similar gesture, unfavorable weather conditions
1.4	Slow down	When approaching a dangerous or sensitive area (accident, intervention of emergency services, intervention of law enforcement, etc.)	Extend the arm on the side of the traffic flow, palm towards the ground and operate a broad and slow movement from top to bottom.		LEO in civilian clothes with an armband, other road users who create a mask between the User and the LEO, pedestrian who makes a similar gesture, unfavorable weather conditions.

1.5	Circulate, speed up	Regulation of traffic around a dangerous or sensitive area (accident, intervention of emergency services, intervention of law enforcement, etc.)	Extend the arm in the direction to follow and with the other arm, operate a circular oscillating movement with the forearm.		LEO in civilian clothes with an armband, other road users who create a mask between the User and the LEO, pedestrian who makes a similar gesture, unfavorable weather conditions
1.6	Injunction to ask a User to turn right or left on the roadway	When approaching a dangerous or sensitive area (accident, intervention of the emergency services, intervention of the police, etc.)	Extend the arm on the side of the circulation flow, palm vertical, and operate a piston movement, wide and slow.		LEO in civilian clothes with an armband, other road users who create a mask between the User and the LEO, pedestrian who makes a similar gesture, unfavorable weather conditions
1.7	Other type of injunction, not standardized (for example: back off, etc.).	<i>TO INFORM</i>	<i>TO INFORM</i>	<i>TO INFORM</i>	LEO in civilian clothes with an armband, other road users who create a mask between the User and the LEO, pedestrian who makes a similar gesture, unfavorable weather conditions

2.1	Stop	Escort, traffic regulation.	Raise the arm vertically, open hand forward.		LEO in civilian clothes with an armband with an unmarked vehicle, other road users who create a mask between the User and the LEO, motorcyclist who makes a similar gesture, unfavorable weather conditions
2.2	Slow down	Escort, traffic regulation.	Arm outstretched laterally, slow alternating movements, ample from top to bottom (right arm for users traveling in the same direction, left arm for those traveling in the opposite direction).		LEO in civilian clothes with an armband with an unmarked vehicle, other road users who create a mask between the User and the LEO, motorcyclist who makes a similar gesture, unfavorable weather conditions
2.3	Overtake, accelerate	Escort, traffic regulation.	Left arm outstretched alongside the body, sweeping back and forth movements, open hand forward.		LEO in civilian clothes with an armband with an unmarked vehicle, other road users who create a mask between the User and the LEO, motorcyclist who makes a similar gesture, unfavorable weather conditions

2.4	Tighten up	Escort, traffic regulation.	Arm flexed, hand at shoulder height, slow, ample piston movements to finish with arm extended horizontally.		LEO in civilian clothes with an armband with an unmarked vehicle, other road users who create a mask between the User and the LEO, motorcyclist who makes a similar gesture, unfavorable weather conditions
2.5	Follow me	Vehicle interception.	Arm stretched along the body, ample circular movements in the direction of clockwise.		LEO in civilian clothes with an armband with an unmarked vehicle, other road users who create a mask between the User and the LEO, motorcyclist who makes a similar gesture, unfavorable weather conditions
3.1	Injunction to ask the User to <b>follow the LEO</b>	Vehicle interception.	<ol style="list-style-type: none"> <li>1. The LE vehicle uses its light and sound signaling means when approaching the User</li> <li>2. It positions itself in front of the user and uses its light signals</li> </ol>		LEO in civilian clothes with an armband with an unmarked vehicle, other road users who create a mask between the User and the LEO, motorist who makes a similar gesture, unfavorable weather conditions