

# Safety demonstration of automated road transport systems: contribution of driving scenarios

## Deliverable 1. Generation, feeding and enrichment of scenarios

Version of June 29, 2022

*Methodological working document*

### Preamble

This document deals with the methodology for generating, feeding and enriching driving scenarios that can be used to demonstrate the safety of automated road transport systems (ARTS). It is part of a set of deliverables intended to cover different aspects of the use of scenarios:

- Generation, feeding and enrichment of scenarios
- Prioritization of scenarios
- Use of scenarios by different validation tools, at different design stages and by different actors

This document was written within the framework of the working group on scenarios co-led by the DGITM and the SystemX Technological Research Institute (hereinafter IRT SystemX). It deepens and completes the DGITM methodological document on driving scenarios [1] and its main objective is to propose an approach to bring to life the first list of descriptors presented by this initial document.

The definitions and concepts presented in this deliverable have been discussed in working groups between the administrations and the sector. In particular, the definitions are taken from Decree No. 2021-873 of June 29, 2021 implementing Ordinance No. 2021-443 of April 14, 2021 relating to the criminal liability regime applicable in the event of the circulation of a delegated driving vehicle and its conditions of use.

First of all, this deliverable complements the DGITM methodological document [1] on terminology issues in order to make the link with other work carried out in parallel on the safety demonstration, and to ensure consistency with the models of scenario description, developed at IRT SystemX. Secondly, this deliverable proposes approaches to complete the list of descriptors presented in the DGITM methodological guide and proposes a process to continue enriching descriptors and scenarios. This list of descriptors constitutes a useful tool to build, by appropriate combinations, the relevant risk scenarios for the safety demonstration of automated systems. The challenge of the scenario approach is indeed that these can be enriched over time, based on feedback. This progressive enrichment must be accompanied by an enrichment of the descriptors.

This document is organized into three parts:

- resumption of terminology;
- possible contributions of different sources to enrichment;
- scenario enrichment approach, illustrated by an initial confrontation with a sample of scenarios and enrichment proposal based on this initial confrontation work.

The iterative nature of the scenario enrichment process proposed in this document could lead to regular updates of the descriptors and possibly of the indicative lists of scenarios, on the basis of mobilization of scenario sources.

Thus, this deliverable is intended to be kept up to date regularly and to benefit from the updating of the lists of descriptors, reported by the stakeholders (for example the designers of the system, service organizers, operators), or by updating scenario sources, for example via traffic data or detailed studies of observed accidents. At this stage, this deliverable does not predict the future development of prescriptive documents on the use of this or that scenario for the validation of an STRA.

## Acronyms

AEBS	Advanced Emergency Braking System
ALKS	Automated Lane Keeping System
APD	Preliminary Hazard Analysis
APR	Preliminary Risk Analysis
ASAM	Association for Standardization of Automation and Measuring systems
ASFA	Association of French Motorway Companies
ASP	Safety Analysis of the Route
BAAC	Traffic Accident Analysis Bulletin ( <i>Bulletin d'Analyse des Accidents de la Circulation</i> )
CEESAR	European Center for Security Studies and Risk Analysis
Cerema	Center for Studies and Expertise on Risks, Environment, Mobility and Planning
DGITM	Directorate General for Infrastructure, Transport and Mobility
EDA	Detailed Accident Study
EDP-M	Personal Mobility Device (Motorized)
EM	Emergency Maneuver
ER	Feared event
GAME	Overall At Least Equivalent
GIDAS	German In Depth Accident Study
HDV	Heavy duty vehicle
IGLAD	Initiative for the GLocal harmonization of Accident Data
IISR	Interministerial Instruction on Road Signs
ISO	International Standardization Office
IRT	Technological Research Institute
LAB	Accidentology and biomechanics laboratory
LV	Light vehicle
MOSAR	Methods and Tools for Safety and Robustness Analysis of Automated Vehicles
MRM	Minimal Risk Maneuver
NATM	New Assessment Test Method
NHTSA	National Highway Traffic Safety Administration
ODDs	Operational Design Domain , umbrella term for <ul style="list-style-type: none"> <li>• Functional Design Domain, of the automated driving system</li> <li>• Technical Design Domain of the technical system</li> <li>• Operational Design Domain of the ARTS</li> </ul>
OEDR	Object and event detection and response
ONISR	National Interministerial Road Safety Observatory
PFA	French Automotive Industry Platform
STRA (ARTS)	Automated Road Transport System
STRMTG	Technical Service for Cableways and Guided Transport
SOTIF	Safety Of The Intended Functionality
VOIESUR	Vehicule Occupant Infrastructure Etudes de la Sécurité des Usagers de la Route
VRU	Vulnerable Road User
WG	Working group

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## Introduction

The use of scenarios for the design and validation of automated driving systems and automated road transport systems (ARTS) is unanimous in the ecosystem of the automated vehicle.

All of the regulatory work now refers to a scenario-based approach (for example the EU ADS regulation currently being published [15], the UN R157 regulations known as ALKS [14], UN R152 AEBS [24], the NATM framework document [13], ...) which was included in the French regulatory framework linked to decree no. 2021-873 of June 29, 2021 [26]. The need to standardize certain notions has therefore appeared, a need which is reflected in particular by the creation of a new international working group at the UNECE dedicated to the harmonization of technical regulations for the development of vehicles equipped with automated driving systems (WP. 29 / GRVA). A similar group has also emerged at ISO (cf. [5], [6], [7], [8]) in the Road Vehicles Technical Committee (TC 22), and the Vehicle Dynamics Sub-Committee (SC 33) on scenarios for the design and validation of automated vehicles<sup>1</sup>.

The various works contribute to the establishment of a classification of the elements composing a scene in the form of layers or axes. In the remainder of the document, the term "layer" will preferably be used. The different layers of description cover all elements, from static to dynamic.

This document takes into account these various works, which nevertheless result in differences in the choice and ordering of the scenarios' axes of description. Faced with these differences, the DGTIM methodological document of February 2022 [1] has taken the decision to recommend a reduced number of independent layers from the point of view of descriptors, in order to facilitate the combination of risk factors in scenarios, which appears suitable to a large generation of scenarios.

In accordance with this document, this deliverable is technology agnostic and does not address technical failure of the system or cybersecurity aspects. Similarly, at this stage, scenarios involving remote intervention are not addressed in this document, ie. scenarios in which a remote intervention feature is the cause of the dangerous situation. However, this document covers scenarios in which remote intervention can contribute to the response.

This document first takes up elements of terminology in order to ensure the consistency of terms between the different frameworks.

This document then describes the different sources of scenarios that can be used to create lists of scenarios that can be used to validate the safety of systems.

This document then proposes an approach to broaden descriptors and/or the values of certain descriptors by confronting existing descriptors with various scenario databases, and by developing combinations of scenario descriptors. In application of this approach, this document proposes a first enrichment of this list of scenarios and its descriptors by using a selection of risky scenarios from accident databases as well as from the IRT SystemX databases.

This methodological document is not intended to be a guide, but to enrich and complete the DGITM methodological document of February 2022 [1]. This document and the proposed approaches will be updated regularly, in particular to ensure consistency with works on ODD description and on safety analysis of routes, which could enrich scenario descriptors.

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<sup>1</sup> The notions of scenario and ODD having many similarities, and the two feeding each other, the group also deals with the standardization of ODD description (it should be noted that for the digital tools part, ASAM standardizes in coherence with this ISO group, ways of describing the scenarios and the ODD within the framework of these activities named OpenSCENARIO and OpenODD).

# I. Terminology and principles for defining scenarios

This part completes and clarifies certain notions of the DGITM methodological document published in February 2022 on the scenario-based approach in order to ensure the consistency of the vocabulary used in the French ecosystem and various international works.

Given the diversity of reference works on driving scenarios, and the multitude of terms used, it seems useful to define without ambiguity the main terms of the scenario-based approach used in this document.

In this part, definitions from the DGITM methodological document are used, and the reference to terms used in the guides relating to the globally at least equivalent approach (GAME) is provided, as well as the reference to other works if necessary. As they have not yet been published, the definitions provided from the GAME approach could be modified. They are given in a footnote in the same way as other definitions potentially from other repositories. When the definition is not taken directly from the DGITM methodological document [1], it comes from the application guide for the GAME principle which will soon be published.

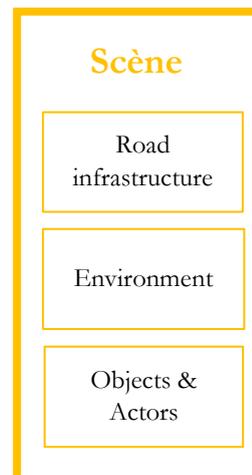
In the rest of the document, the term “system” will be used for the technical system or the automated road transport system. These make use of automated vehicles called “ego vehicles”, with the understanding that scenarios describe the situation at a given location and time in the traffic system, which includes vehicles, infrastructure and users concerned. With this in mind, notions relating to the operational design domain (ODD) and the response to event and object detection (OEDR) relates to the ego vehicle.

## i. The scenario and its elements

Ulbricht & al [3] define a scene intuitively “A scene describes a snapshot of the environment including the scenery and dynamic elements, as well as all actors' and observers'”. Based on this definition, the following definitions are proposed later in this deliverable.

Scene: description at a given moment of the system and its environment (objects and actors, road infrastructure, environmental conditions)<sup>2</sup>.

Figure 1: Illustration of the components of a scene



Initial scene: initial state in which the system and its environment find themselves to start a scenario.

Final scene: final state in which the system and its environment are to complete a scenario.

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<sup>2</sup> The GAME group has given the following definition, consistent with this first definition: “Given state of the considered system and its environment (objects, actors, road infrastructure, climate, etc.) at a chosen or observed time t. It defines the static (scenography) and dynamic set of elements, as well as the actors of the scenario by their specifying parameters and their values”.

Scenario: sequence of scenes and events and/or actions. A scenario is the temporal development of scenes. A scenario consists of at least an initial scene, an event or an action and a final scene.

Event: modification of the external environment of the ego vehicle or of the system<sup>3</sup>.

Action: modification of the state of the ego vehicle or of the system<sup>4</sup>.

## ii. Use cases and test cases

The notions of use case and test case initially come from systems engineering, particularly from the software world. The following definitions come from this field and have been applied to the scenario-based approach for automated driving systems.

Use case (in the context of the scenario-based approach): consisting of a scenario and/or i. an area of operation, ii. expected behavior, iii. operating limits<sup>5</sup>.

Test case: the test case is derived from a use case, it is a concrete scenario (see below), in other words an instantiated logical scenario with precise values, a requirement and a recipe criterion<sup>6</sup>.

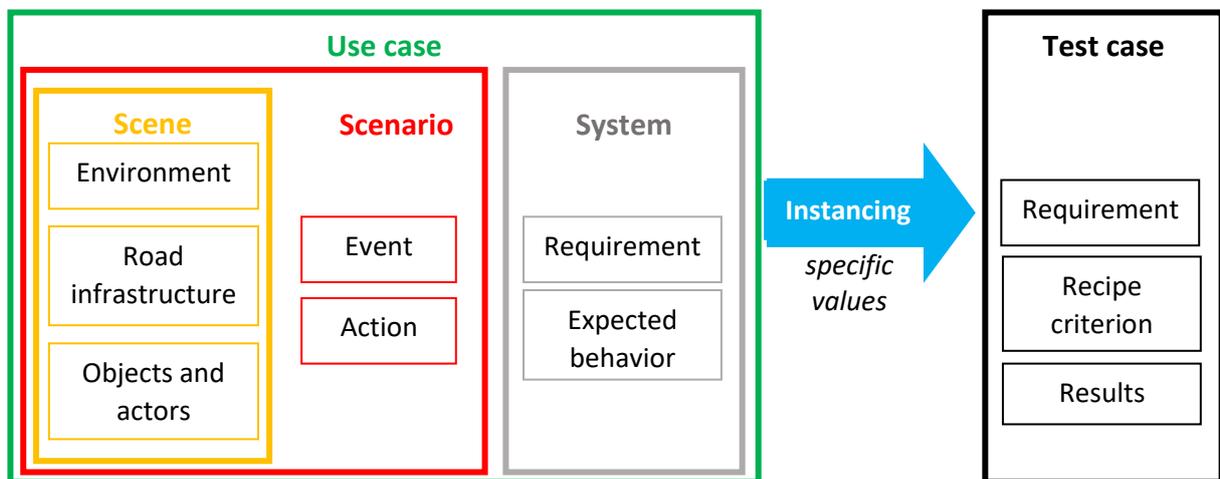


Figure 2: A use case is made up of one or more scenarios, allowing the specification or illustration of a design requirement, an operating limit, and an expected behavior of a system. A test case derives from a use case and instantiates it.

<sup>3</sup> According to the GAME group: modification of the external environment or failure of the system considered (e.g. ego vehicle), at a given moment, which can be characterized, and which must be taken into account for a decision.

<sup>4</sup> According to the GAME group: all of the operations carried out on the ego vehicle or on the system (braking, acceleration, lane change, request to take over, turn signal activation, etc.).

<sup>5</sup> According to the GAME group: specification of a design domain, possibly including the following system information: one or more scenarios, its field of operation, its expected behavior, its operating limits.

<sup>6</sup> According to the GAME group: a test case includes a concrete scenario, i.e. instantiated logic with precise values + a requirement + an acceptance criterion.

### iii. Scenario abstraction levels

There are typically 3 levels of abstraction of scenarios:



Figure 3: Levels of abstraction of scenarios from the most abstract (on the left) to the most concrete (on the right)

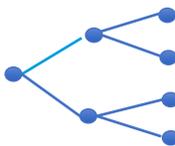
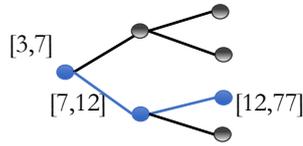
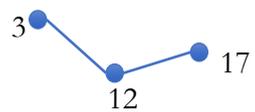
**Functional scenario:** scenario class, family grouped under a common name.

*Nota Bene:* It can be class or family of functional or logical scenarios.

**Logical scenario:** presents the flow logic (with, if necessary, ranges of values and logical distributions). The logical scenario is the generic level<sup>7</sup>.

**Concrete scenario:** the sequence of events is fully defined, each value is specified and all specificities are defined. The concrete scenario is the maximum instantiation level, and can be used to define a test case<sup>8</sup>.

These three levels can also be presented by a top-down approach, starting from a definition of a functional scenario as a "typical maneuver scenario" (for example overtaking, without necessarily a parametric value), then declined with a logic of sequence of scenes, events and/or actions defined (with ranges of parametric values), and then specified by precise quantitative parameters (for example speed of 72 km/h, visibility at 50 m). The table below presents the particularities of the three scenario abstraction levels, as well as their possible uses.

Script	Functional	Logical	Concrete
	Description of a class, a family of scenarios under a common name. 	A possibility of evolution of the functional scenario 	Fully defined, instantiated sequence. 
<b>Use</b>	High level specification. Set of scenarios used to describe a use case.	Scenario in the sense of systems engineering. General definition of test specifications	Definition of a <i>test case</i> . Driving or simulation data capture
<b>Parameters</b>	Approximate (if defined)	Range of values with occurrence probability distribution	Instantiated Parameters

<sup>7</sup>According to the GAME group: Scenario whose sequence of events is defined, i.e. the sequence of scenes and actions & events is completely defined from the initial scene to the final scene. For each specifying parameter of the scenario, a variation interval is given.

<sup>8</sup>According to the GAME group: Scenario for which the set of numerical values of the parameters specifying the logical scenario is defined.

The diagram below is intended in particular to integrate the principles of filiation, refinement, and generation of scenarios in connection with the levels of abstraction of scenarios and the number of associated scenarios. The lower the level of abstraction and the more precise the parameters of the scenarios, the greater and increasing their number.

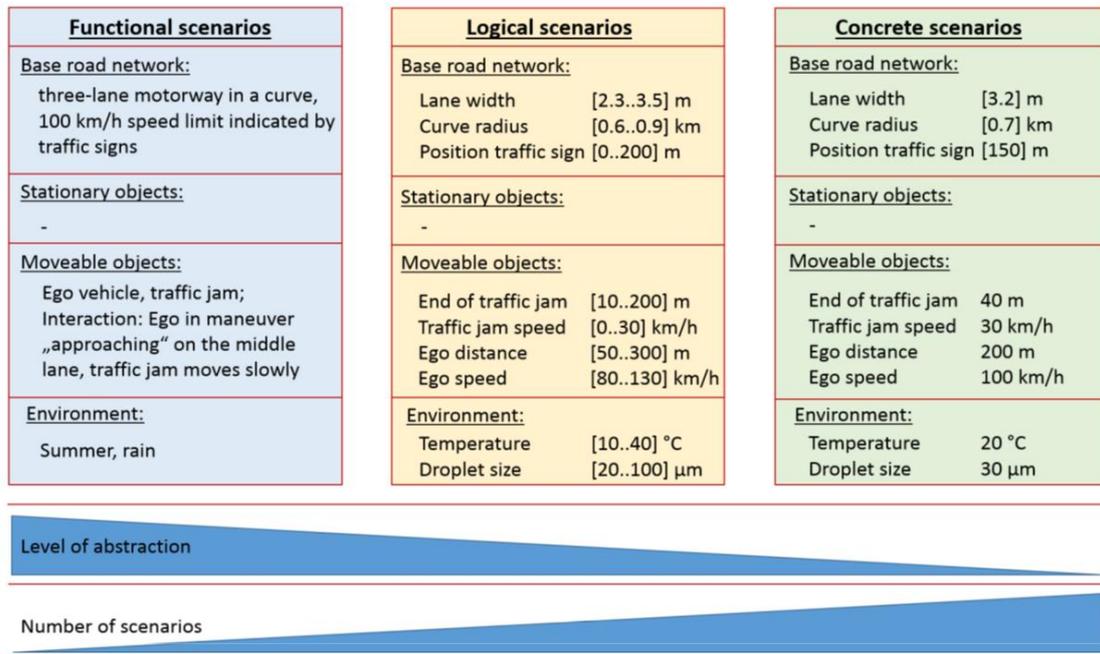


Figure 4: Three levels of scenario description (figure taken from the NATM document [13])

#### iv. Types of events

**Feared event:** undesirable event that can cause a dangerous situation, and under certain conditions, an accident.

*NB 1: The term feared traffic event is a feared event external to the system, caused or generated by a third party user.*

*NB 2: Feared events include feared traffic events (attributable to third parties) as well as those resulting from system malfunction(s).*

**Precursor event of collision or traffic hazard:** cf. feared traffic event.

**Accident:** unexpected event or series of events leading to damage that could jeopardize the safety of users. An accident therefore designates both bodily injury accidents and material accidents.

*NB 1 according to BAAC ONISR Guide [28]: A road traffic injury accident is defined as an accident which:*

- Causes at least one victim, i.e. a user who has required medical treatment;
- Occurs on a road open to public traffic;
- Involves at least one vehicle.

**Near accident:** dangerous situation that did not result in an accident due to the absence of the conditions of realization or due to an action of the system or of third parties.

**Malfunction:** *inadequate* response of the system in two possible cases, either during a failure, or during the occurrence of operating conditions that are not correctly managed due to the functional characteristics of the system, which may be functional limitations or insufficiencies.

**Failure:** cessation of the ability of a functional unit to perform a required function or to operate [nominally].

## II. Scenario feeding method: sources overview

This part proposes to make the link between different sources of scenarios and the type of scenarios that they can generate preferentially.

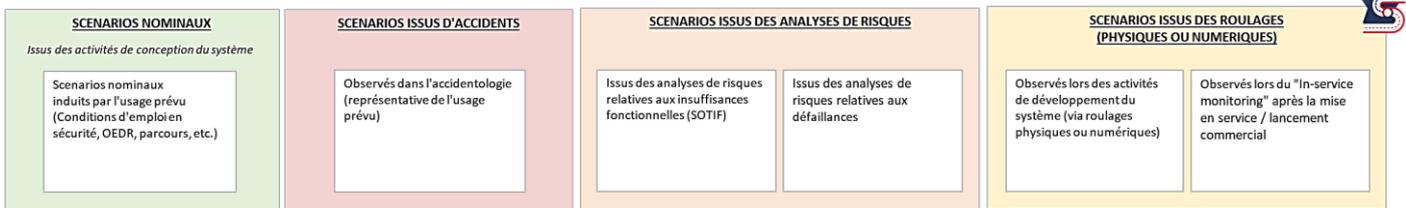
The French approach, presented in this document, recommends considering four categories of scenarios:

- ✓ **Nominal scenarios**, resulting from system design activities, induced by the intended use (operational design domain, OEDR, route, etc.).
- ✓ **Scenarios resulting from accidents**, observed in the accidentology representative of the intended use.
- ✓ **Scenarios resulting from risk analysis** relating to the functional insufficiencies<sup>9</sup>.
- ✓ **Scenarios resulting from driving (physical or digital)**, which have two objectives:
  - Scenarios often called “*Edge case*” or “*Black swan*” or notable scenarios (rare, unknown and dangerous, from area 3 of SOTIF).
  - “Near accidents” or accidents avoided by interaction between driver and users, likely to become accident scenarios in automated driving.

The capitalization of scenarios resulting from driving starts from the design phase, and then continues after commissioning.

These four categories are the basis of all scenarios to be taken into account, including with regard to the combinations and deemed to cover the reasonably foreseeable.

Table 1: 4 categories of scenario sources - \*as mentioned above, failure scenarios are not addressed at this stage.



This typology of scenario feeder modes should be compared with the three categories of scenarios that emerge from European and international pre-regulatory work [15]:

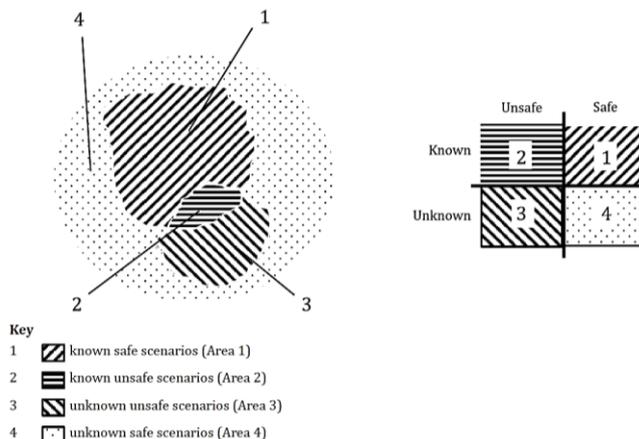
- 1 *Nominal scenarios*
- 2 *Critical scenarios*
- 3 *Failure scenarios (not covered at this stage)*

To cover the risks of functional deficiencies, the ISO 26262 – ISO PAS 21448 (known as SOTIF) standards are taken as a reference. To completely cover the identification, and treatment of known hazardous scenarios required by area 2 of ISO 21448 presented in Figure 5, accident scenarios in and at the edge of the ODD will be collected. ISO 21448 also requires setting up a process for detecting, capitalizing on and processing potentially dangerous scenarios that were not known when the system was designed. The state-of-the-art process for this type of scenario is to carry out driving campaigns in order to detect these scenarios which are quite rare today, called “*edge cases*” or “*black swans*”.

Figure 5 recalls the definition of the different “*areas*” of the ISO 21448 standard, called SOTIF.

<sup>9</sup> Scenarios resulting from failures are not addressed at this stage.

Figure 5: Definition of SOTIF areas



In Appendix 1, illustrative applications are available from two existing databases:

- the IRT SystemX MOSAR tool;
- the ONISR database.

## 1. Scenarios resulting from the system design process

- Sources:** from the system design process, and in particular the systems engineering use cases used to describe the nominal behavior of the system and used in the ODD definition process, and the OEDR, the first step of which consists in identifying in the system design files the tactical maneuvers, here called nominal maneuvers, contextualized in a nominal scenario.
- Coverage:** for each system use case, at least one functional scenario allows its description and recipe. Use cases shall at least cover the different types of road infrastructure, maneuvers of other vehicles, the main relevant events, and demonstrate compliance with traffic rules (Highway Code, etiquette, etc.) applicable to the place and as it circulates. Nominal scenarios shall be completely representative of the intended use and of the use studied.

In order to ensure the correct representativeness of the intended use, nominal scenarios are defined using the following input data:

- service description;
- route description (typical or real);
- system description (including functions, maneuvers, etc.);
- ODD description;
- OEDR definition.

These are the scenarios today derived from systems engineering design process used to describe use cases or operational view of the system. They make it possible to describe in a simple and understandable visual way for all, the behavior of the system in and at the limit of its ODD or its path or its predefined zone.

These nominal scenarios also include the list of scenarios proving that the automated system that controls the dynamic driving task respects the Highway Code in its ODD. They are very frequent and a priori have a low level of risk, which is partly why the notion of relevant scenarios is often used in the literature to mean scenarios to be capitalized on and not critical scenarios (in the dangerous sense).

The list of nominal scenarios can be very long, due to the variability and possible combination of the elements describing the intended use (types of infrastructure, types of objects, etc.).

The content of the list of nominal scenarios contributes to the good coverage of the global validation activities of the system studied. These scenarios participate in characterizing system performances, in and at the limit of the ODD, which contributes to address the SOTIF.

## 2. Accident scenarios

- a. Source: scenarios resulting from detailed analysis of bodily injury and material accidents, representative and relevant to the automation functionality to be validated. Among the possible reference databases, let us mention the French database resulting from the VOIESUR project (made available in 2015, resulting from accidents of 2011). We can also cite the ONISR database and the annual reports of the STRMTG. Foreign bases recognized as GIDAS, IGLAD or NHTSA can be considered.
- b. Coverage: accident scenarios, defined taking into account the intended use of the system studied, are linked to the ODD and the predefined route or zone, the OEDR.

Entities presenting an automated system for marketing or putting it into service must have a documented process for evaluating, testing and validating their road accident avoidance capabilities and their design choices. Based on its ODD or predefined traffic route or zone, the system must be able to deal with reasonably foreseeable accident scenarios, whatever their causes.

Accident scenarios can be collected from the functional level to the concrete level. Often collected scenarios are described rather in a functional way (e.g. NHTSA, ASFA) with little information, and it is possible to deduce logical and concrete scenarios.

To promote the readability and comparability of accident scenarios, it is advisable to use logics of grouping into functional, logical and concrete scenarios and to use a recognized classification in pictograms such as that proposed by the VOIESUR project (cf. Appendix 4). On the other hand, this database is representative for scenarios in typical motorway environments (divided carriageways) but is less representative of accident rates in urban areas where the omnipresence of vulnerable road users (VRUs) brings other accident configurations.

Accident scenarios can be used to identify dangerous behaviors of the system studied, which can lead to dangerous situations (including those having led to proven accidents in particular contexts, recorded in accidentality).

Accident scenarios contribute:

- Firstly, to the construction of safety by promoting exhaustiveness in risk analysis (i.e. avoiding omissions);
- Then, to the definition of the expected results of the system (to avoid the accident or to mitigate its consequences), following the expression of the safety requirements covering safe behaviors.

## 3. Scenarios from risk analysis studies

- a. Source: dangerous scenarios are taken from risk analysis linked to the system studied, in order to define safety concepts necessary to cover all reasonably foreseeable risks with regard to the intended use (preliminary danger analysis, preliminary risk analysis and route safety analysis, threats and attacks, ...).
- b. Coverage: "covering scenarios" are scenarios necessary to define security concepts, notably by combining deductive and inductive approaches aimed at favoring the exhaustiveness of risk identification. A safety concept defined for a "covering scenario" can make it possible to cover the risk associated with several nominal scenarios, or several accident or "black swans / edge cases" scenarios. Safety concepts defined on the basis of "covering scenarios" shall cover all the risks of dysfunctional causes (failure and SOTIF functional insufficiencies).

In addition to the inductive (Preliminary Risk Analysis) and deductive (Preliminary Hazard Analysis) methods, the French ARTS ecosystem recommends carrying out a safety analysis of the route at the ARTS level or ODD/OEDR at the automated driving system level, to exhaustively identify new potentially dangerous scenarios particularly linked to a driving context. The safety analysis of the route or the ODD which allows possible new scenarios of dangerous situations linked to the particularities of the route (i.e. the specific characteristics of the route which generate or amplify the possibility of accidents, or which require a particular response of the system).

This theoretical study is supplemented by driving (see category 4 of scenarios) in the selected operational context, making it possible to validate it and make it robust if necessary when new rare scenarios, until then unknown are detected and analyzed.

It should be noted that dangerous situations and safety requirements specified in safety analyzes can be linked to the scenarios concerned.

#### 4. Scenarios resulting from driving (or “notable scenarios”)

These are scenarios of dangerous situations, but unknown, that is to say not identified in other categories of scenarios, i.e. nominal scenarios, accident scenarios, and scenarios of dangerous situations resulting from the risk analysis. These complementary scenarios are observable through development activities that may include physical or digital runs, and through ARTS runs once in service.

*Please note: This is a regulatory (NATM / ADS Act) and normative (SOTIF) requirement.*

- a. **Sources:** they come from driving (physical or digital) in the development phase (possibly on routes other than the ARTS predefined routes), or after marketing or commissioning. The challenge of these activities is to track down rare and unknown dangerous scenarios known as “black swans” or “edge cases”.
- b. **Coverage:** the validation strategy must define the minimum modalities of these validation activities to minimize the occurrence of dangerous and unknown scenarios (cf. area 3 SOTIF). In SOTIF, the criterion for stopping validations is defined via the “acceptance criteria”, and the “validation targets”.

Among these scenarios, we find all scenarios and information relating to in-service safety required by the various regulatory texts (R157 (ALKS) and the LOM Law [26]).

**Conclusion:**

In summary, the chapter up to now has presented four categories of scenario sources (see Table 2), relevant to consider in order to promote the completeness of the base of scenarios to be presented for the commissioning authorization of the ARTSs.

		Power Sources			
		Scenarios from system design	Scenarios from accidents	Scenarios resulting from risk analyzes	Scenarios from driving
<b>Categories of scenarios taken into account in pre-regulatory work (NATM, EU ADS ACT)</b>	<i>Nominal Scenarios</i>	X			
	<i>Critical Scenarios</i>	Accident		X	
		To analyse			X
		Validation			
		In-service monitoring			
<i>Failure scenarios<sup>10</sup></i>	Analysis of failures		X	X	

Table 2: Link between the four categories of scenarios in the document and the categories of scenarios internationally requested <sup>11</sup>

<sup>10</sup> Not detailed below.

<sup>11</sup> The European Commission ADS Regulation defines nominal, critical and failure scenarios as follows:

- 'nominal traffic scenarios' means reasonably foreseeable situations encountered by the ADS when operating within its ODD. These scenarios, often referred to as 'traffic scenarios', represent the non-critical interactions of the ADS with other traffic participants and generate normal operation of the ADS.

The first three categories of scenarios above can be supplemented by “expert opinion” scenarios. These can be defined taking into account technical solution (for example: to contribute to accident scenarios and associated severity, human behavior experts, road behavior experts).

As part of the DGITM methodological document [1], a methodology to identify a list of minimum scenarios to consider has been presented. This methodology is based in particular on a logic of combining “layers” or axes of description.

This so-called combined-based approach is developed in the section below, highlighting its benefits in completing the lists of scenarios, when combined with the accumulation of scenarios from previous approaches (system design, accidents, risk analyses, driving).

- 
- 'critical scenarios' means scenarios related to edge-cases (eg unexpected conditions with an exceptionally low probability of occurrence) and operational insufficiencies, not limited to traffic conditions but also including environmental conditions (eg heavy rain or low sunlight glaring cameras), human factors , connectivity and miscommunication leading to emergency operation of the ADS.
  - 'failure scenarios' means the scenarios related to ADS and/or vehicle components failure which may lead to normal or emergency operation of the ADS depending on whether or not the minimum safety level is preserved.

### III. Scenario enrichment process: use of sources and descriptor combination

#### 1. General approach

In addition to the input from the sources listed above, the purpose of this section is to present an approach to enrich the list of scenarios based on the following logic:

- the comparison of scenario descriptors with different sources is likely to reveal:
  - the need for new axes of description: a scenario taken from the sources turns out to be non-describable due to the lack of one or more lines of description
  - values of the description parameters: a scenario taken from the sources modifies the field of “reasonably foreseeable”
- the combination of scenario description axes, enriched by new axes, then generates more scenarios, limiting the risk of scenario omissions (nominal or critical).

In turn, this enrichment of scenarios makes it possible to improve the mobilization of sources, for example by deepening risk analysis or by collecting traffic or accident data reflecting the new types of scenarios generated by the combination. This enrichment also makes it possible, if necessary, to ensure that nominal scenarios have not been omitted in the design of the system and its ODD.

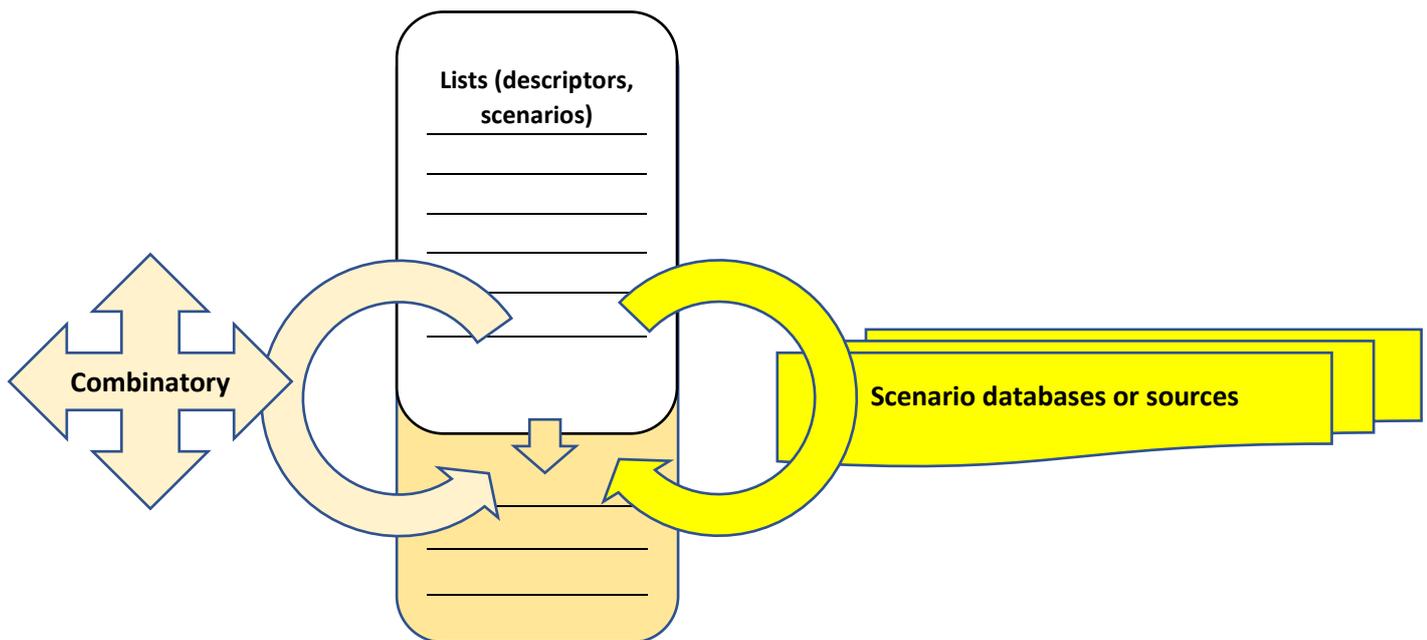


Figure 6: Process of enriching scenarios by comparing them with databases or sources and combining the axes of description

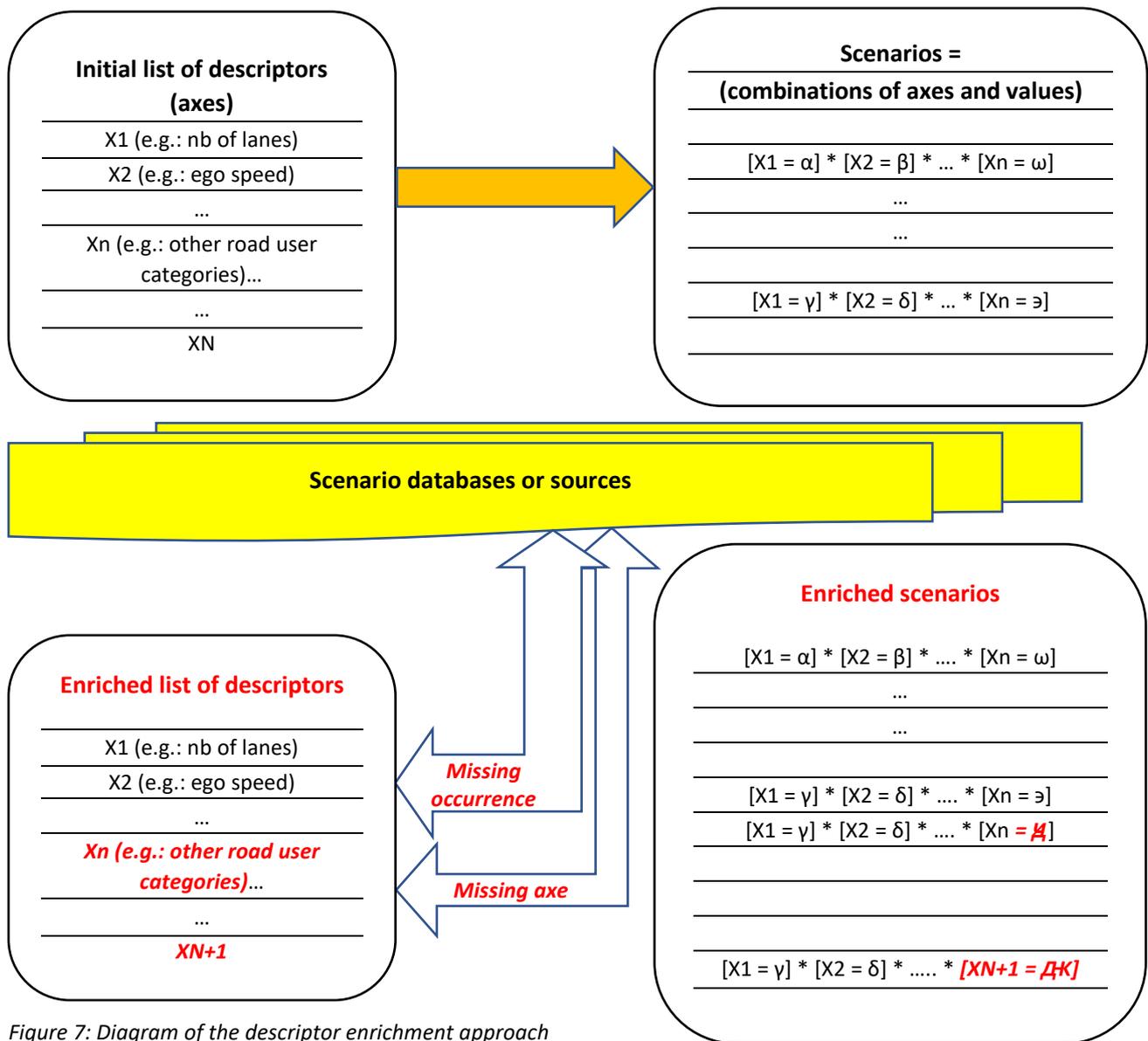
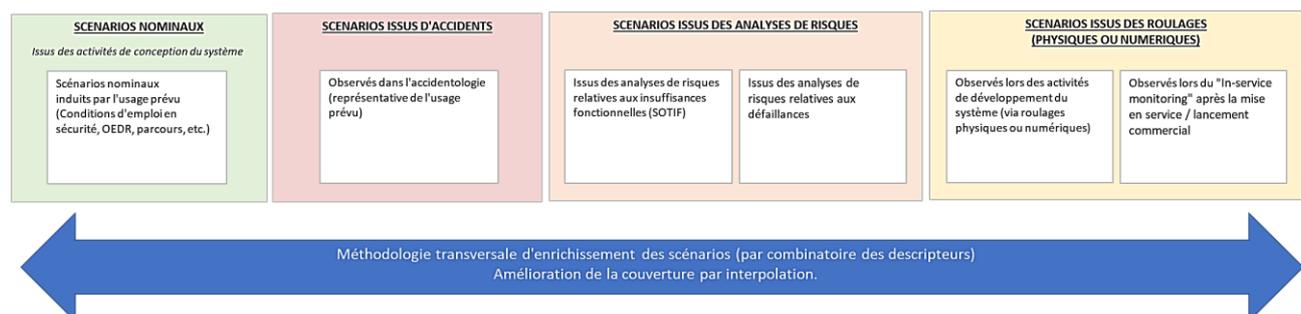


Figure 7: Diagram of the descriptor enrichment approach

The combinatorial approach, inspired by a logic of fault trees, as proposed in this document aims to facilitate the continuous enrichment of the lists of scenarios in support of the objective of the most complete coverage of the scenario space. Combined with a confrontation with scenarios from the sources described in chapter II, it ensures that the combination is robust and documented.

Table 3: Link between the four categories of scenarios in the document (see Table 1) and the cross-cutting combinatorial approach to these four categories.



## 2. Examples of enrichment of scenario descriptors

This chapter proposes an initial update of the list of descriptors presented in the DGITM methodological document of February 2022 based on initial comparisons with existing databases or works.

The search for new descriptors is done by refining the layers proposed in the global scenario-based approach. The use and confrontation with “new” scenarios has the virtue to lead to new lines of descriptors, which themselves lead to new parameters. The sources of confrontation are used at different levels in order to increase the number of descriptors for each of the layers.

The top-down, nested approach to enrich descriptors is shown in the table below. It presents the list of descriptors and occurrences added by the first enrichment.

Descriptors	Occurrences
<b>Layer 1: traffic environments – nominal static elements</b>	
Traffic regime (with lanes with variable allocation) Zone adjacent to the lane of the ego (Hard shoulder or hardened lane, Absence of shoulder, Barriers – guardrails, sidewalks, street furniture, adjacent parking lot, railway line, central island) Longitudinal variation of the cross section (chicane, road narrowing, reduction in the number of lanes, end of lane) Type of intersection (non-intersection, in X, in T, in Y, with more than 4 legs) Pavement surface (asphalt, concrete, gravel, paving stones, dirt/sand) Longitudinal profile (top of coast, bottom of coast) Plan view (right or left hand radius of curvature, variation of the radius of curvature) Ground marking (continuous lines, dotted lines, prohibited area or surface, pedestrian crossing, cycle path, cycle lock) Traffic signs (danger, intersection, prescription, indication) Landmarks and fixed positioning and approach markers	Regulatory use of lanes Infrastructure design (underground, bridge, interchange ramp, cycle path, cycle lane, toll area, pedestrian area, meeting area, construction site) Longitudinal delta (speed bumps, breaks, pothole, deformed level crossings)
<b>Layer 3: traffic hazards</b>	
Nature (guided transport, special vehicle) Vehicle category (according to the Highway Code) Travel speed / acceleration / lateral position / longitudinal position	Number / density / mass Respect of safety distances? Contextual elements that are presumed to require attention (EDP-M on sidewalk, EDP-M at the right of an intersection)
<b>Layer 5: hazards affecting the system response</b>	
Climatic or weather conditions (precipitation, snow, hail, wind, fog) Airborne particles (smoke, dust, salt) Lighting-related visibility (glare, dusk, night without public lighting, night with public lighting off, night with public lighting on) Grip (wet road, puddles, flooded, snowy, mud, ice, grease)	Traffic information (day of the week, time of day, incident/accident present on the route)

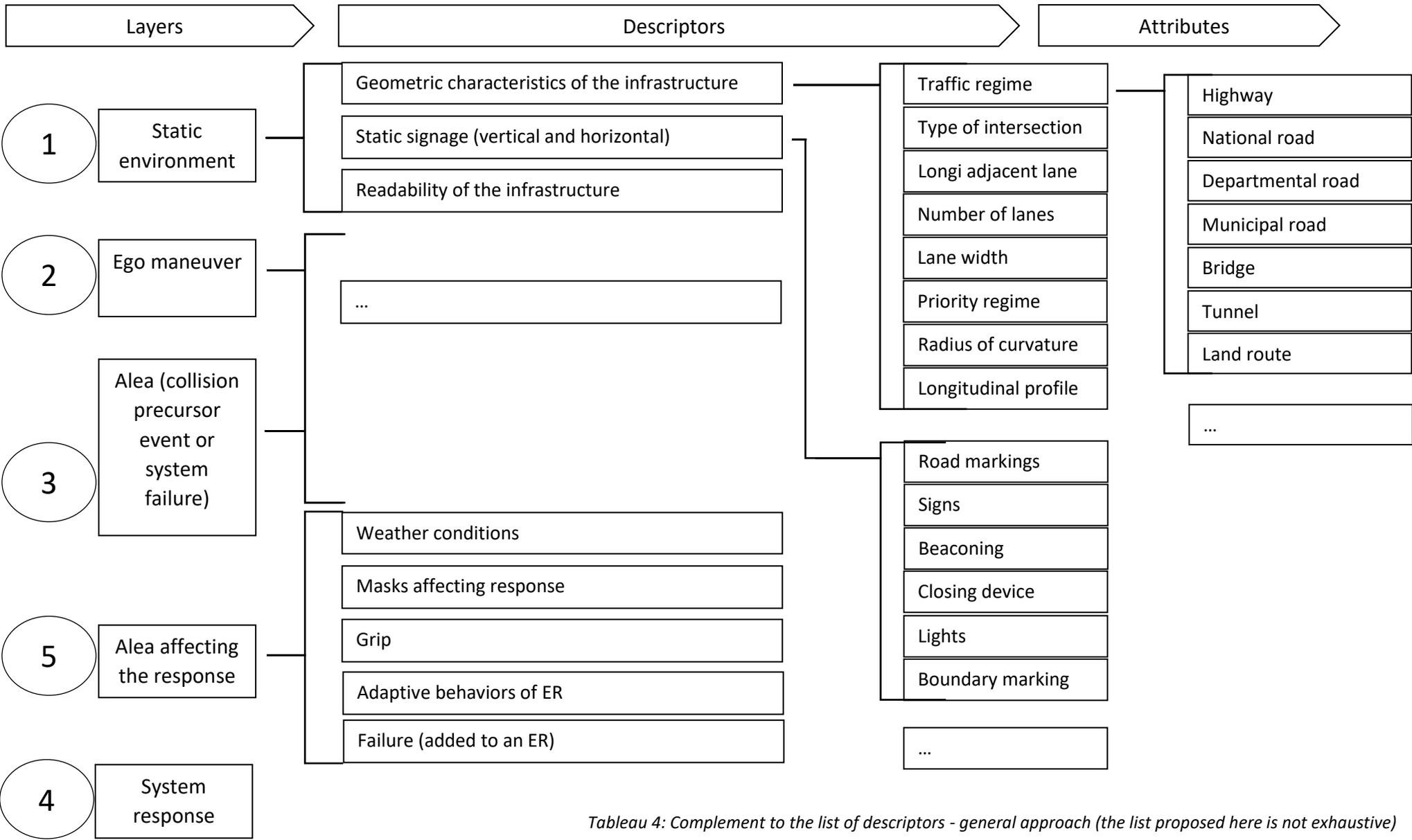


Tableau 4: Complement to the list of descriptors - general approach (the list proposed here is not exhaustive)

The following part presents the evolution of the list of descriptors from the illustrative applications presented in Appendices 1, 2 and 3.

### A. Descriptors identified ab initio

The lists of descriptors identified ab initio, i.e. in the DGITM methodological document of February 2022 [1] are as follows.

#### i. Static course descriptors

<b>Geometric characteristics</b>	<b>Static signage (vertical, horizontal)</b>
Type of infrastructure (roadway, tunnel, bridge)	Priority regime
Type of roadway (dual carriageway, two-way, one-way)	"Danger" signage
Number of lanes	Speed limits
Lane width	Traffic lights
Geometry of the intersection: lane angles (intersection, roundabout, level crossing)	Prescription signage (including access control, limiting certain areas to certain users)
Radius of curvature	
Declivity	

#### ii. Nominal maneuver descriptors

<b>Nominal manoeuvre descriptors (driving intentions of the ego vehicle)</b>
- Rolling <ul style="list-style-type: none"> <li>o Rolling - nominal situation / following lane or vehicle in its lane</li> <li>o Crossing (two-way traffic)</li> <li>o Lane change</li> <li>o Overtaking (from the left if not specified)</li> </ul>
- Intersections and crossings <ul style="list-style-type: none"> <li>o Crossing a roundabout</li> <li>o Crossing an intersection</li> <li>o Crossing a level crossing</li> <li>o Turning right at an intersection</li> <li>o Turning left at an intersection</li> <li>o U-turn</li> </ul>
- Entering and leaving a lane <ul style="list-style-type: none"> <li>o Entering from insertion lane / acceleration</li> <li>o Exit to exit lane / deceleration</li> <li>o Insertion from lane / private site</li> </ul>
- Parking <ul style="list-style-type: none"> <li>o Entering and stopping on a CT slot</li> <li>o Exit from CT slot to public road</li> <li>o Stop on track</li> <li>o Post-stop departure from track</li> <li>o Parking maneuver on the public highway (slot along the track)</li> <li>o On-track parking maneuver (in-line parking)</li> <li>o On-street parking maneuver (herringbone parking)</li> <li>o Exit from on-street parking (notch along lane)</li> <li>o Exit from on-street parking (in-line parking)</li> <li>o Exit from on-street parking (herringbone parking)</li> </ul>

### iii. Collision Precursor Event Descriptors

#### **Collision precursor event descriptors**

- Nature

- o 4 RM, 2 RM, VRU, animal, object
- o Number / density (if multiple objects)

- Size

- o NB: three dimensions for vehicles and objects

- Location in relation to the ego vehicle

- o Lane or location of the third party vehicle in relation to that of the ego vehicle
- o Distances
  - In relation to the vehicle
  - Relative to the roadway / lane (e.g. pedestrians, off-center target)
  - In relation to the lane (e.g. vehicle or object encroachment)

- Maneuver

- o Speed of travel (or stop)
- o Angle
- o Type of maneuver in progress if identified (e.g. overtaking, parking exit, etc.)

- Contextual elements that are presumed to be the attitudes of the third party user

- o E.g.: erratic movements; attached objects (e.g. balloon); foot on the road with a view to crossing; person inside the vehicle; open door (rear or side); person around the vehicle...

- NB: Descriptors of adjacent collision precursor event generation poles:

- o Characteristics of the intersecting roadway (see above)
- o Characteristics of the adjacent generating zones (public buildings, car parks,...)

### **B. Enriched descriptors**

This part presents the updating of the lists of descriptors by a first comparison with two existing databases presented in Appendix 1:

- the MOSAR scenario database of the IRT SystemX which essentially contains logical scenarios;
- ONISR's BAACs from TRAxY.

In addition, some descriptors are the result of a confrontation with other works which appear in Appendices 2 and 3:

- the table of variability factors proposed by SOTIF;
- the list of hazards resulting from GAME work.

Moreover, and in order to make additions and enrichments from this confrontation work from databases, the new descriptors appear in red.

#### *i. Layer 1: traffic environments – nominal static elements*

The driving environment describes the nominal static elements of the traffic infrastructure. In the DGITM scenario-based approach, the environment designates 3 axes, which can be found in the ONISR terminology:

- Physical infrastructure geometry

The enrichment of descriptors below is based on databases analysis and in particular on ONISR BAACs, which made it possible to complete the first list of descriptors of February 2022.

Certain attributes declined in the ONISR databases are not included below but were necessary for the enrichment process (for example, the administrative category of the road or the road typology made it possible to display the descriptor "adjacent road" which describes the type of infrastructure element adjacent to the ego lane).

<b>Geometric characteristics of the physical infrastructure</b>									
<b>• Regulatory use of lanes</b>	<table border="1"> <tr><td>Road open to public traffic for all vehicles and users</td></tr> <tr><td>Road open to public traffic with reserved access (pedestrian zone, cycle lane or zone, shared zone, meeting zone)</td></tr> <tr><td>Road closed to public traffic</td></tr> </table>	Road open to public traffic for all vehicles and users	Road open to public traffic with reserved access (pedestrian zone, cycle lane or zone, shared zone, meeting zone)	Road closed to public traffic					
Road open to public traffic for all vehicles and users									
Road open to public traffic with reserved access (pedestrian zone, cycle lane or zone, shared zone, meeting zone)									
Road closed to public traffic									
<b>• Traffic regime</b>	<table border="1"> <tr><td>One-way</td></tr> <tr><td>Bidirectional</td></tr> <tr><td>With separate carriageways</td></tr> <tr><td>With lanes with variable allocation (direction of traffic)</td></tr> <tr><td>Other</td></tr> </table>	One-way	Bidirectional	With separate carriageways	With lanes with variable allocation (direction of traffic)	Other			
One-way									
Bidirectional									
With separate carriageways									
With lanes with variable allocation (direction of traffic)									
Other									
<b>• Number of lane</b>									
<b>• Area adjacent to ego lane</b>	<table border="1"> <tr><td>Hard shoulder or hardened strip (right or left)</td></tr> <tr><td>No shoulder (vegetation, cliff, ditch, embankment, ...)</td></tr> <tr><td>Barriers – guardrails</td></tr> <tr><td>Pavements</td></tr> <tr><td>Urban furniture (including noise barrier, embankment wall, privacy screen, ...)</td></tr> <tr><td>Adjacent parking (herringbone, perpendicular, longitudinal)</td></tr> <tr><td>Railways</td></tr> <tr><td>Central island</td></tr> </table>	Hard shoulder or hardened strip (right or left)	No shoulder (vegetation, cliff, ditch, embankment, ...)	Barriers – guardrails	Pavements	Urban furniture (including noise barrier, embankment wall, privacy screen, ...)	Adjacent parking (herringbone, perpendicular, longitudinal)	Railways	Central island
Hard shoulder or hardened strip (right or left)									
No shoulder (vegetation, cliff, ditch, embankment, ...)									
Barriers – guardrails									
Pavements									
Urban furniture (including noise barrier, embankment wall, privacy screen, ...)									
Adjacent parking (herringbone, perpendicular, longitudinal)									
Railways									
Central island									
<b>• Longitudinal variation of the cross section</b>	<table border="1"> <tr><td>Chicane</td></tr> <tr><td>Lane widening</td></tr> <tr><td>Road narrowing – bottleneck</td></tr> <tr><td>Reduction of the number of lanes</td></tr> <tr><td>End of lane</td></tr> </table>	Chicane	Lane widening	Road narrowing – bottleneck	Reduction of the number of lanes	End of lane			
Chicane									
Lane widening									
Road narrowing – bottleneck									
Reduction of the number of lanes									
End of lane									
<b>• Type of intersection</b>	<table border="1"> <tr><td>Out of intersection</td></tr> <tr><td>In X</td></tr> <tr><td>T-shaped</td></tr> <tr><td>Y-shaped</td></tr> <tr><td>Has more than 4 branches</td></tr> <tr><td>Roundabout<sup>12</sup></td></tr> <tr><td>Railroad Crossing</td></tr> <tr><td>Other</td></tr> </table>	Out of intersection	In X	T-shaped	Y-shaped	Has more than 4 branches	Roundabout <sup>12</sup>	Railroad Crossing	Other
Out of intersection									
In X									
T-shaped									
Y-shaped									
Has more than 4 branches									
Roundabout <sup>12</sup>									
Railroad Crossing									
Other									
<b>• Specific infrastructure<sup>13</sup></b>	<table border="1"> <tr><td>Underground - Tunnel – cut-and-cover</td></tr> <tr><td>Bridge - autobridge - viaduct</td></tr> <tr><td>Interchange ramp</td></tr> <tr><td>Toll area</td></tr> <tr><td>Work area</td></tr> <tr><td>Other</td></tr> </table>	Underground - Tunnel – cut-and-cover	Bridge - autobridge - viaduct	Interchange ramp	Toll area	Work area	Other		
Underground - Tunnel – cut-and-cover									
Bridge - autobridge - viaduct									
Interchange ramp									
Toll area									
Work area									
Other									

<sup>12</sup> In France we distinguish roundabouts according to the priority regime in front of the entry.

<sup>13</sup> The “Specific infrastructure” category is a macro category of infrastructure that will require a more detailed description. These specific infrastructures will be described via other descriptors, as they require special attention.

<ul style="list-style-type: none"> <li>• <b>Priority regime</b></li> </ul>	Lights
	Priority on the right <sup>14</sup>
	Stop
	Yield to traffic
	Roundabout
	Railway crossing
	Other
<ul style="list-style-type: none"> <li>• <b>Vertical variation</b></li> </ul>	Speed bumps – slowing down bump
	Cassis
	Pothole
	Deformed railway crossing
	Other
<ul style="list-style-type: none"> <li>• <b>Pavement surface</b></li> </ul>	Asphalt (tar)
	Concrete
	Gravel
	Paving stones
	Dirt/sand
	Other
<ul style="list-style-type: none"> <li>• <b>Longitudinal profile (gradient)</b></li> </ul>	Flat
	Slope
	Top of coast
	Bottom of the coast
<ul style="list-style-type: none"> <li>• <b>Plan view</b></li> </ul>	Straight line
	Radius of curvature to the right or left
	Variation of the radius of curvature
	Other
<ul style="list-style-type: none"> <li>• <b>Lane width</b></li> </ul>	

- Signage

Static signage (vertical, horizontal)	
Floor markings	
	Solid lines
	Dotted lines
	Prohibited area or surface (zebra)
	Pedestrian crossing
	Cycle lane
	Cycle lock (early stopping marks for cyclists)
	Other
Traffic signs	
	Danger signs
	Intersection signs
	Prescription signs
	Directional signs (services, road identification, cultural interest, information, ...)
	Other

<sup>14</sup> The priority regime of the roundabout follows the right-of-way rule of the French Highway Code.

Traffic lights
<b>Landmarks and fixed positioning and approach markers</b>
Boundary markers
Beaconing
Closing device
Other

*Nota Bene: the signaling descriptors come from the IISR [29] and have been refined in relation to the DGITM methodological document [1].*

*Nota Bene: road signs must include information on the permanent, temporary and dynamic nature of the information available.*

### *ii. Layer 3: traffic hazards*

The hazards consist of:

- collision precursor events directly attributable to objects and other road users;
- system malfunctions: failures, functional insufficiencies and misuse (are not the subject of this deliverable).

In this part are taken into account behaviors of third parties potentially encountered by the ego as well as their behaviors.

To go back to the precise causes of an accident, a detailed accident study (EDA) must be carried out, comparable to the field investigation which is required for Judicial Treatment. In the absence of a field investigation, police reports can help to reconstruct a probable scenario which may be derived from the risky behavior of third parties, as carried out within the framework of VOIESUR, for MOSAR. Similarly, since elements of description below have been devised for the safety demonstration of systems, a large number of descriptors do not appear in the BAAC database to date because of the responsibility attributed to each driver to be attentive to his environment: we enter the subjective part of the analysis of the scene.

On the other hand, the comparisons carried out have made it possible to update an initial complement based on the observed behavior of third parties and, in particular, on accident situations.

<p><b>Collision Precursor Event Descriptors</b></p> <ul style="list-style-type: none"> <li>- <i>Nature</i> <ul style="list-style-type: none"> <li>o Road vehicles (4WD, 2WD), <b>guided transport, specific vehicles, exceptional convoys</b>, VRU (pedestrians, cyclists, personal transport device (motorized)), animal, object</li> <li>o <b>Vehicle category (M/N/O...)</b></li> <li>o Number / density (if several objects) / <b>mass (for objects and vehicles)</b></li> </ul> </li> <li>- <i>Cut</i> <ul style="list-style-type: none"> <li>o NB: three dimensions for vehicles and objects</li> </ul> </li> <li>- <i>Location relative to the ego vehicle</i> <ul style="list-style-type: none"> <li>o Lane or location of third party vehicle relative to that of ego vehicle</li> <li>o Distances <ul style="list-style-type: none"> <li>▪ Relative to the vehicle</li> <li>▪ In relation to the roadway / to the lane (cf. pedestrians, off-centering of the target)</li> <li>▪ In relation to the lane (e.g. vehicle or object encroachment)</li> </ul> </li> </ul> </li> <li>- <i>Maneuver</i></li> </ul>
--

The third party maneuver is not necessarily included in the list of maneuvers described for ego in Layer 2, as these maneuvers are derived from the "compliance with traffic regulations" requirement for the ego system. No third party control is possible, all maneuvers have to be taken into account and considered.

- o Type of maneuver intention in progress if identified (e.g. overtaking, braking, exiting the parking lot, etc.)
  - Offending maneuvers by other road users (exo) should be considered to the extent reasonably foreseeable. The notion of reasonably foreseeable will be dealt with in another context.*
- o Travel speed (or stop) / acceleration / longitudinal / lateral
- o Respect for safety distances
- o Angle

- Elements of context worth presumption of attitudes of the third party user

Erratic movements
Additional objects (ex: ball)
Foot on the roadway in order to cross
Person inside the vehicle
Open door (rear or side)
Person around the vehicle
Personal transport device (motorized) on sidewalk
Personal transport device (motorized) at an intersection
Others

- NB: Descriptors of adjacent collision precursor event generation poles:

- o Characteristics of the intersected road (see above)
- o Characteristics of adjacent generator pole areas (public establishments, car parks, schools, hospitals, square, etc.)

iii. Layer 5: hazards affecting system response

Several types of hazards are described in this section.

- **Environmental conditions**, which temporarily impact and complicate the nominal environment and infrastructure.

<b>Environmental conditions</b>							
<b>Weather conditions</b>	<table border="1"> <tr><td>Rain</td></tr> <tr><td>Snow</td></tr> <tr><td>Hail</td></tr> <tr><td>Strong wind – storm</td></tr> <tr><td>Fog</td></tr> </table>	Rain	Snow	Hail	Strong wind – storm	Fog	
Rain							
Snow							
Hail							
Strong wind – storm							
Fog							
<b>Suspended particles (smoke, dust, ashes, hail, salt, ...)</b>							
<b>Visibility related to lighting</b>	<table border="1"> <tr><td>Glare (low-angled sun, headlights, public lighting)</td></tr> <tr><td>Dusk or dawn</td></tr> <tr><td>Night without public lighting</td></tr> <tr><td>Night with public lighting off</td></tr> <tr><td>Night with public lights on</td></tr> <tr><td>Fog</td></tr> </table>	Glare (low-angled sun, headlights, public lighting)	Dusk or dawn	Night without public lighting	Night with public lighting off	Night with public lights on	Fog
Glare (low-angled sun, headlights, public lighting)							
Dusk or dawn							
Night without public lighting							
Night with public lighting off							
Night with public lights on							
Fog							

<b>Traffic information</b>	Day of the week
	Time of day
	Incident/accident on the road
<b>Adhesion</b>	Wet pavement
	Puddles
	Flooded
	Snowy
	Mud
	Icy
	Greasy

### 3. Notion and concept of masks

The notion of mask is closely linked to the two notions of legibility and visibility. First comparisons with scenario databases (see appendices) confirm the importance of the notion of masks and its multi-dimensional nature. This leads to enrich description axes of masks in this document, compared to descriptors used ab initio in the DGITM methodological document [1].

The first enrichment of descriptors consists in isolating the legibility of the infrastructure, which designates the intrinsic aptitude of the infrastructure to be perceived (e.g. damaged panel, erased marking) by the ego, whereas visibility is the aptitude of the system to perceive the said infrastructure. Legibility is independent of the existence of masks. Visibility, on the other hand, may depend on climatic conditions or masking phenomena.

This leads to a distinction between five categories of masks in addition to legibility.

<i>Types of masks</i>
1. Intrinsic legibility of the infrastructure, independent of the perceiver (e.g. erased marking)
2. Static masking (ex: wall, billboard)
3. Temporary mask (e.g. scaffolding, work zone, vegetation in front of a sign)
4. Fugitive mask (e.g. parked vehicle)
5. Dynamic masking (e.g. moving vehicle masking other users)
6. Environmental masking due to climatic conditions (ex: fog, smoke)

Therefore, it appears that the notion of mask, introduced by the notion of legibility, can intervene in different layers of description of a scenario: both in the description of the static traffic environment and in the description of hazards affecting response (cf. dynamic masks - example: heavy goods vehicle masking a vulnerable road user)

It is proposed to allocate different levels of mask description to the scenario description layers according to the following principles.

Infrastructure legibility is to be integrated into layer 1 (static description of the infrastructure). The same applies to static and temporary visibility masks. Temporary masks, in the sense given above, have the particular characteristic of pre-existing the nominal maneuver considered in the scenario (and therefore a fortiori hazards that this scenario may incorporate).

<b>Legibility of static infrastructure</b>
<b>Signage deficiencies:</b> <ul style="list-style-type: none"> <li>• <b>Road markings (e.g. erased, damaged, double marking, damaged pedestrian crossing)</b></li> <li>• <b>Traffic signs (e.g. erased, damaged, tagged, hidden by vegetation, fallen to the ground, twisted)</b></li> <li>• <b>Lauding marker faults (e.g. missing, deteriorated, broken barriers)</b></li> <li>• <b>Traffic lights (ex: broken, out of order)</b></li> </ul>
<b>Presence of vegetation, trees obscuring signs, scaffolding</b>
<b>Presence of objects or infrastructure elements that obscure visibility (e.g. wall, advertising billboard)</b>

The fleeting and dynamic masks relate more to the dynamic situation of the scenario. The particularity of these two classes of masks is that they can be part of the reading of the static configuration of the environment as well as the pure dynamic situation. It was chosen to consider some of these masks in layer 3 (hazard descriptors) insofar as they come to disturb a nominal functioning of the ego with an evolutionary character which can be assimilated to the dynamics of the scenario. Thus, the third users or objects presenting themselves as masks such as a parked vehicle for a delivery or a heavy goods vehicle circulating and masking other users will be to consider in layer 3 (descriptors of hazards).

Fugitive and dynamic masks can also affect the system's response to a hazard (and this is their main danger). For example, a truck driving by and masking a vulnerable user to the system implies an expected response affected by the a posteriori detection of the vulnerable user masked by the truck. Therefore, fleeting and dynamic masks should be considered either in layer 3 (hazards) or in layer 5 (hazards affecting the response). The existence of a fleeting or dynamic mask can thus lead to combinations of scenarios by playing on the consideration of this mask as a hazard during the nominal maneuver and as a hazard affecting the system response to a third hazard. For example, a heavy vehicle placed obstructing the lane at an intersection constitutes a traffic hazard + a hazard affecting the legibility of the intersection signal + a hazard affecting the detection of a third party user approaching the intersection.

Another example is provided in the diagram below.

The diagram below shows the complexity and the interlocking of the elements of layers 3 and 5 with respect to masks.

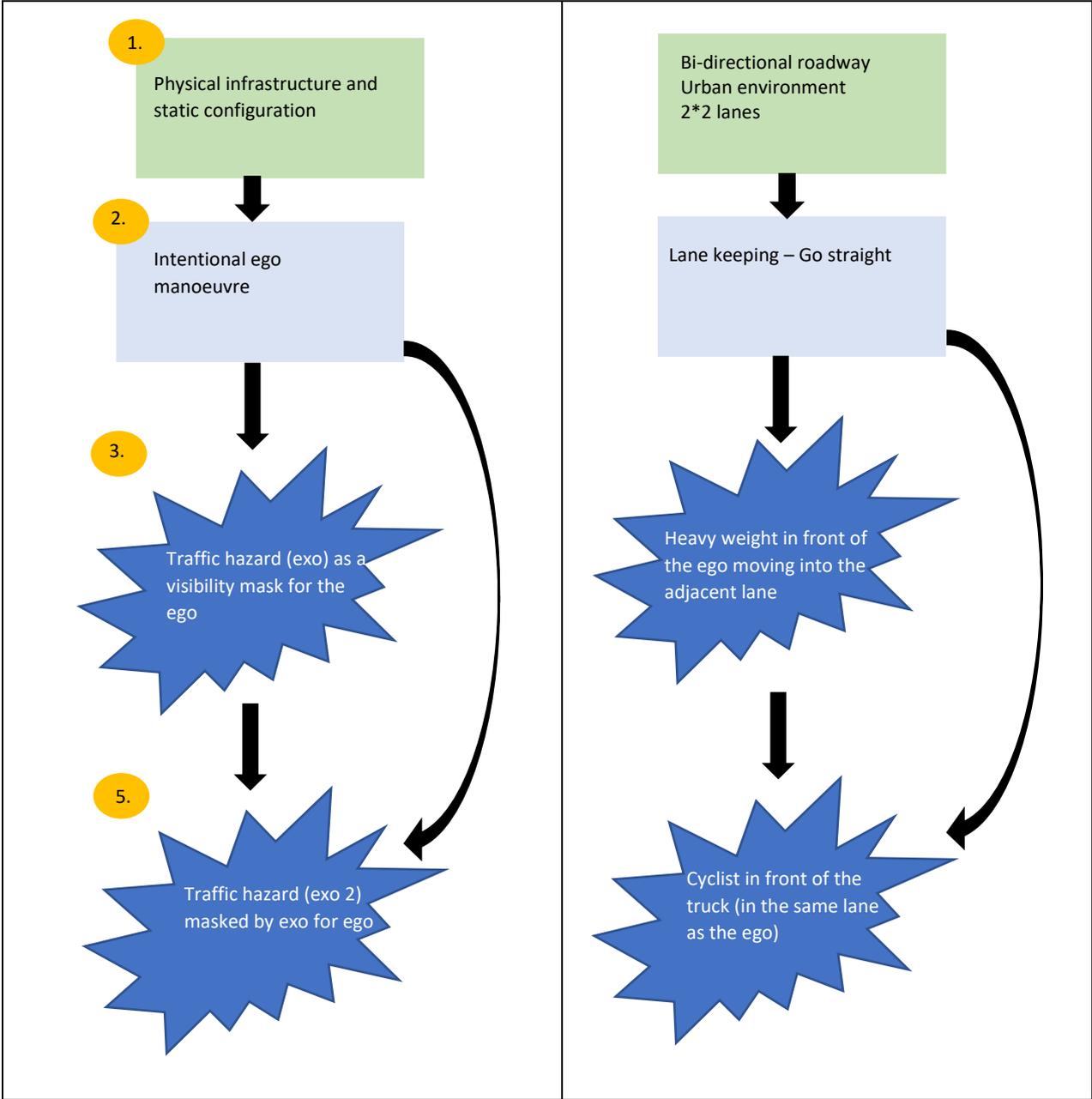


Figure 8: On the left is a general approach integrating the notion of masks and on the right is an example of a scenario based on a logical scenario for the particular case of fleeting and dynamic masks.

Masks related to environmental conditions limiting perception capabilities will be considered primarily in Layer 5 of hazards affecting response to a hazard (in this case third party interaction). However, as above for fugitive masks, it may be necessary to combine axes in which environmental visibility affects the perception of the traffic environment (including signaling at the first level) and also affects the response to a hazard generated by the interaction with a third party (e.g. the sudden appearance of dense smoke should be considered as a hazard in itself, which affects the visibility of the whole traffic environment of the vehicle, including the infrastructure and its signaling; and this hazard also affects the response to interaction with a third party vulnerable vehicle or user, which is considered a hazard).

<b>Response Affecting Masks</b>
<b>Fugitive masks (e.g. heavy goods vehicle parked at an intersection, vehicle parked at a pedestrian crossing)</b>
<b>Dynamic masks (ex: heavy truck in front of the ego that masks a pedestrian)</b>
<b>Environmental masks (e.g. rain, low sun, fog)</b>

Again, the notion of mask is complex because in the case where the mask affects the response of the system, whether static or dynamic, it is not a single element of the scene or environment but an interdependent element of the situation encountered. For example, the heavy truck in front of the ego that obscures the ego's direct visibility of a vulnerable user crossing (pedestrian) or riding on the right (cyclist), impacts the whole understanding of the situation and its third parties. The expected response is not only linked to one element of the scenario but is linked to the consideration of several users.

In general, most of the masks encountered, even if they are temporary such as vegetation or a work zone, will impact the response of the ego system.

This is why the approach proposed above proposes, schematically, to consider the mask, when it is fleeting or dynamic (and, by extension, when it is environmental - fleeting) both as a hazard in itself (decrease of the perception functionalities of the whole traffic environment) and as a hazard affecting the response to the traffic hazards identified in the scenario approach of the considered case.

#### 4. First enrichment of scenario list

This part proposes an illustrative list of scenarios resulting from the combination of layer descriptors described in the DGITM methodological document [1], taken up again in this deliverable and enriched by the first confrontations with new scenarios (see parts 1 and 2 above).

The scenarios are built from lists of ordered descriptors. On the other hand, the construction of a scenario obliges one to reflect on and question the relevance of taking into account each of the descriptors and the associated attributes (notably according to the status of the descriptor in the ODD "mandatory, prohibited, without effect"). It is recommended that choices in the consideration of descriptors be traceable. For example, some attributes of the same descriptor have an equivalent impact (e.g. cycle track, cycle lane or any other dedicated lane adjacent to the ego lane).

Added scenarios are **highlighted** below.

##### - Nominal maneuvers in the static ODD (without critical traffic hazard)

	Vehicle (or system*)	Nb min	
NB: below, the scenarios are indicated provided that the corresponding nominal maneuver appears in the ODD of the vehicle or the system			
NB: the scenarios are indicated provided that the static environment is in the ODD of the vehicle			
NB bis: the axes of definition of the scenarios below are to be combined (ex: [ I or II ] * [ i or j ])			
<b>Rollings</b>			
Driving on track	Lane keeping at vehicle speed limits:		
	I) One-way (including divided lanes) – (1; 2; 3 lanes)	}	3+3+1
	II) Bidirectional		
	II. a) Single assignment (2*1; 2*2 lanes; 2+1 lanes)	}	4
	II. b) Variable allocation (1 central lane)		
	a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)	}	2
	b) Pavement surface (standard (tar); specific (concrete, sand))	}	2
	c) Straight line; in curve (right/left curve, S)	}	2
	d) Flat road profile; sloping (including top/bottom of coast)	}	2
	i) Without vehicle on the adjacent lane in the same direction	}	2
j) With vehicle of the same speed on the adjacent lane in the same direction			
1. In nominal visibility conditions			
2. In degraded visibility conditions with degraded signage (masks , broken down, damaged)			

			2
		<i>Total</i>	896
Crossing (two-way traffic)	Lane keeping at the speed limits of the ego vehicle and the vehicle in the opposite direction (same speed as the ego vehicle), on a two-way lane:		
	II. a) Single assignment (2*1; 2*2 lanes; 2+1 lanes)	}	3+1
	II. b) Variable allocation (1 central lane)		
	a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)	}	4
	b) Pavement surface (standard (tar); specific (asphalt, sand))		
	c) Straight line; in curve (right/left curve, S)	}	2
	d) Flat road profile; sloping (including top/bottom of coast)		
	i) Without a vehicle on the adjacent lane in the same direction	}	2
	j) With vehicle of the same speed on the adjacent lane in the same direction		
	1. In nominal visibility conditions	}	2
2. In degraded visibility conditions with degraded signage (masks , broken down, damaged)			
		<i>Total</i>	512
Lane change	<i>Renunciation to change lane in presence of signage forbidding it, at the speed limits of the ego vehicle, Anticipation of drawdown on a convergent (from the right or from the left), Anticipation of lane change in view of diverging (turning right or left)</i>	}	3
	I) One-way (including divided lanes) – (2; 3 lanes)		
	II) Bidirectional:	}	5
	II. a) Single assignment (2*2 lanes; 2+1 lanes)		
	II. b) Variable allocation (1 central lane)	}	4
a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)			
b) Pavement surface (standard (tar); specific (asphalt, sand))	}	2	

	<p>c) Straight line; in curve (right/left curve, S)</p> <p>d) Flat road profile; sloping (including top/bottom of coast)</p> <p>i. Without vehicle on the adjacent lane in the same direction</p> <p>ii. With vehicle of the same speed on the adjacent lane in the same direction</p> <p>1. In nominal visibility conditions</p> <p>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</p> <p><i>Lane change in current section</i></p> <p>I) One-way (including divided lanes) – (2; 3 lanes)</p> <p>II) Bidirectional:</p> <p>    II. a) Single assignment (2*2 lanes; 2+1 lanes)</p> <p>    II. b) Variable allocation (1 central lane)</p> <p>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</p> <p>b) Pavement surface (standard (tar); specific (asphalt, sand))</p> <p>c) Straight line; in curve (right/left curve, S)</p> <p>d) Flat road profile; sloping (including top/bottom of coast)</p> <p>i. Without a vehicle in the adjacent lane in the same direction</p> <p>ii. With a vehicle of the same speed running alongside the vehicle in the adjacent lane, preventing the lane change</p> <p>iii. With a vehicle of the same speed travelling behind the vehicle in the adjacent lane, preventing the lane change</p> <p>1. In nominal visibility conditions</p> <p>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</p>	               	<p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>+</p> <p>5</p> <p>4</p> <p>2</p> <p>2</p> <p>2</p> <p>3</p> <p>2</p> <p><i>Total</i> 2880</p>
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Overtaking	Overtaking on the lane at the authorised speed limits of the ego vehicle and the approaching vehicle (overtaking can only be considered as such if the equivalent scenarios have been considered in lane change beforehand)		
	No overtaking can be undertaken if the visibility conditions for the whole overtaking slot cannot be achieved (e.g. bends)		
	<ul style="list-style-type: none"> <li>i. Without vehicle on the adjacent lane as well meaning</li> <li>ii. With vehicle of the same speed in the adjacent lane coming from behind</li> <li>iii. With vehicle of same speed in adjacent lane ahead</li> <li>iv. With vehicle ahead and behind in adjacent lane</li> </ul>	}	4
	<ul style="list-style-type: none"> <li>1. In visibility conditions nominal</li> <li>2. In degraded visibility conditions with degraded signage (masks , broken down, damaged)</li> </ul>	}	2
		<i>Total</i>	<b>8</b>
*NB : application to an automated road transport system: if the system extends the ODD of vehicle(s): duplicate testing at the new ODD limits of the system			

<b>Inserts and intersections</b>			<b>Nb min</b>
<i>NB: below, the scenarios are indicated provided that the corresponding nominal maneuver appears in the ODD of the vehicle or the system</i>			
Crossing a roundabout	Crossing a roundabout (in France we consider 2 types of roundabout, depending on the priority regime)		2
	<ul style="list-style-type: none"> <li>I. with 3 inputs (1 lane; 2 lanes)</li> <li>II. at 4 inputs (1 lane; 2 lanes)</li> <li>III. representing the number limit inputs of the vehicle's ODD (if more than 4 inputs) (1 lane; 2 lanes)</li> </ul>	}	6
	<ul style="list-style-type: none"> <li>IV. 1 way on the ring</li> <li>V. 2-way on the ring</li> </ul>	}	2
	<ul style="list-style-type: none"> <li>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</li> </ul>	}	4
			}

	<p>b) Pavement surface (standard (tar); specific (asphalt, sand))</p> <p>c) Flat road profile; sloping (including top/bottom of coast)</p> <p>i) with a vehicle travelling at a speed representative of an insertion, from a halt, at each entrance upstream of that of the vehicle concerned</p> <p>j) with a vehicle travelling at a speed representative of an insertion made at 30 km/h from each entrance upstream of that of the ego vehicle</p> <p>k) with a stream of vehicles travelling at a low speed allowing an insertion of the ego vehicle <i>(parameters to be defined by the provider)</i></p> <p>1. In nominal visibility conditions</p> <p>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</p>	   	<p>2</p> <p>3</p> <p>2</p>
		<i>Total</i>	<b>1152</b>
Crossing at an intersection	<p>Crossing at an intersection</p> <p>I. In X</p> <p>II. T-shaped</p> <p>III. Y-shaped</p> <p>IV. With more than 4 branches</p> <p>V. with traffic lights</p> <p>VI. with specific priority regime (yield, stop, right of way)</p> <p>VII. without specific priority scheme (right priority)</p> <p>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</p> <p>b) Pavement surface (standard (tar); specific (asphalt, sand))</p> <p>c) Flat road profile; sloping (including top/bottom of coast)</p>	        	<p>4</p> <p>3</p> <p>4</p> <p>2</p> <p>2</p>

	<ul style="list-style-type: none"> <li>i) with a vehicle approaching from a standstill</li> <li>j) with a vehicle approaching at a speed equal to a fixed percentage of the maximum authorised speed on the approach lane</li> <li>k) with a stream of vehicles travelling at a low speed allowing the vehicle to be inserted (parameters to be defined by the provider)</li> </ul>	}	3
	<ul style="list-style-type: none"> <li>1. In nominal visibility conditions</li> <li>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</li> </ul>	}	2
		<i>Total</i>	768
Crossing a railway crossing	Stop in accordance with the signaling of a railway crossing <ul style="list-style-type: none"> <li>I. with traffic lights</li> <li>II. with non-illuminated priority (cross of Saint Andrew, beacons)</li> <li>III. presence of safety barriers</li> <li>IV. absence of barrier</li> </ul>	}	2
	<ul style="list-style-type: none"> <li>1. In nominal visibility conditions</li> <li>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</li> </ul>	}	2
		<i>Total</i>	8
Turning right at an intersection	Turning right at an intersection <ul style="list-style-type: none"> <li>I. In X</li> <li>II. T-shaped</li> <li>III. Y-shaped</li> <li>IV. With more than 4 branches</li> <li>V. with traffic lights</li> <li>VI. with specific priority regime (yield, stop, right of way)</li> <li>VII. without specific priority regime (right priority)</li> </ul>	}	4
Turning right at an intersection	<ul style="list-style-type: none"> <li>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</li> <li>b) Pavement surface (standard (tar); specific (asphalt, sand))</li> </ul>	}	3
		}	4
		}	2

	<p><b>c) Flat road profile; sloping (including top/bottom of coast)</b></p> <p>i) without vehicle in the adjacent lane</p> <p>j) with a vehicle coming from the left, traveling at a speed equal to a fixed percentage of the maximum authorised speed on the approach lane continuing on the insertion lane of the vehicle concerned</p> <p>k) with a vehicle coming from the left, travelling at the speed representative of a standing start from the approach lane continuing onto the insertion lane of the vehicle concerned</p> <p>l) with an oncoming vehicle travelling at a speed equal to a fixed percentage of the maximum authorised speed in the approach lane continuing (by turning left) into the inside lane of the vehicle</p> <p>m) with an oncoming vehicle travelling at a speed representative of a standing start from the approach lane continuing (by turning left) into the insertion lane of the vehicle concerned</p> <p>n) with a stream of vehicles travelling at low speed on the insertion lane allowing for an insertion of the ego vehicle (<i>parameters to be defined by the provider</i>)</p> <p>o) with a stream of vehicles travelling at low speed from the front lane, with a view to entering (by turning left) the insertion lane of the ego vehicle (<i>parameters to be defined by the provider</i>)</p> <p>1. In nominal visibility conditions</p> <p>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</p>	<p>2</p> <p>7</p> <p>2</p>
	<i>Total</i>	2688
	<p>Respecting the prohibition on turning left where it applies Turning left at an intersection</p> <p><b>I. In X</b></p> <p><b>II. T-shaped</b></p> <p><b>III. Y-shaped</b></p> <p><b>IV. With more than 4 branches</b></p> <p>V. with traffic lights</p> <p>VI. specific priority regime (yield, stop, right priority)</p> <p>VII. without specific priority regime (right priority)</p> <p><b>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</b></p> <p><b>b) Pavement surface (standard (tar); specific (asphalt, sand))</b></p> <p><b>c) Flat road profile; sloping (including top/bottom of coast)</b></p>	<p>4</p> <p>3</p> <p>4</p> <p>2</p> <p>2</p>

Turning left at an intersection	<ul style="list-style-type: none"> <li>i) without vehicle on adjacent lanes</li> <li>j) with a vehicle coming from the right, travelling at a speed equal to a fixed percentage of the maximum authorised speed on the approach lane continuing on the insertion lane of the vehicle concerned</li> <li>k) with a vehicle coming from the right, travelling at the speed representative of a standing start from the approach lane continuing on to the insertion lane of the vehicle concerned</li> <li>l) with a vehicle coming from the right, travelling at a speed equal to a fixed percentage of the maximum authorised speed on the approach lane continuing by turning left</li> <li>m) with a vehicle coming from the right, travelling at the speed representative of a standing start from the approaching left turn lane</li> <li>n) with an oncoming vehicle travelling at a speed equal to a fixed percentage of the maximum authorised speed in the approach lane proceeding straight ahead</li> <li>o) with an oncoming vehicle travelling at a speed representative of a standing start from the approach lane continuing straight ahead</li> <li>p) with an oncoming vehicle travelling at a speed equal to a fixed percentage of the maximum authorised speed in the approach lane continuing by turning right into the insertion lane of the vehicle in front</li> <li>q) with an oncoming vehicle travelling at a speed representative of a standing start from the approach lane and then turning right into the inside lane of the vehicle</li> <li>r) with an oncoming vehicle travelling at a speed equal to a fixed percentage of the maximum authorised speed in the approaching lane and continuing by turning left</li> <li>s) with an oncoming vehicle travelling at the speed representative of a standing start from the left-hand approach lane</li> <li>u) with a stream of vehicles travelling at low speed on the insertion lane allowing insertion of the ego vehicle <i>(parameters to be defined by the provider)</i></li> <li>v) with a low-speed vehicle stream from the front lane, with a view to proceeding straight ahead <i>(parameters to be defined by the provider)</i></li> <li>w) with a vehicle stream travelling at low speed from the front lane, in order to insert itself (by turning right) into the insertion lane of the ego vehicle <i>(parameters to be defined by the provider)</i></li> <li>t) with a blocking of the insertion lane preventing the completion of the left turn manoeuvre <i>(parameters to be defined by the provider)</i></li> </ul> <ul style="list-style-type: none"> <li>1. In nominal visibility conditions</li> <li>2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)</li> </ul>	<p style="text-align: center;">15</p> <p style="text-align: center;">2</p>
	<i>Total</i>	5760

U-turn	Same as turning left		
Input from insertion/ acceleration lane	Insertion on the lane		
	I) One-way (including divided lanes) – (1; 2; 3 lanes)	}	6
	II) Bidirectional (2*1; 2*2 lanes; 2+1 lanes)		
	I. with traffic lights	}	3
	II. with specific priority regime (yield, stop, right priority)		
	III. without specific priority regime (right priority)		
	a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)	}	4
	b) Pavement surface (standard (tar); specific (asphalt, sand))		2
	c) Straight line; in curve (right/left curve, S)		2
	d) Flat road profile ; sloping (including top/bottom of coast)		2
i) without a vehicle on the lane targeted by the insertion	}	5	
j) with a vehicle travelling at the maximum permissible speed on the lane to be inserted			
k) with a vehicle travelling at the maximum authorised speed on the lane to be inserted and a vehicle on the adjacent lane to the right or opposite			
l) with a stream of vehicles travelling at the maximum permitted speed on the lane intended for insertion, allowing an ego vehicle insertion (parameters to be defined by the provider)			
m) with a stream of vehicles travelling at low speed on the target lane of the insertion, allowing an insertion of the ego vehicle (parameters to be defined by the provider)			
1. In nominal visibility conditions	}	2	
2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)			
		<i>Total</i>	<i>5760</i>

Exit to exit lane / deceleration	Behaviour of deceleration approaching and on the exit lane from the maximum speed authorised in the vehicle/system ODD <i>Assumed to be covered by the "entry and insertion" scenarios</i>		
Insertion from lane / private site	<i>Assumed to be covered by "turning right" scenarios</i>		
Public transport stop	Deceleration and stopping behaviour on : I) A stop in line (free of third-party parking along vehicle length + 10 m) II) An overhanging stop of vehicle length + 10 m, free of parking along the entire length of the overhang III) A stop in a notch of vehicle length + 20 m, free of parking along the entire length of the notch from an initial speed equal to the maximum authorized speed	}	3
	1. In nominal visibility conditions 2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)		}
		Total	6
Public transport stop exit	Insertion into traffic from the stop on: I) A stop in line II) A stop in the overhang of the vehicle length + 10 m, free of parking for the whole length of the overhang III) A notched stop of vehicle length + 20 m, free of parking for the full length of the notch	}	3
	i) without a vehicle on the lane targeted by the insertion j) with a vehicle travelling at the maximum authorised speed on the lane to be inserted k) with a vehicle travelling at the maximum permitted speed on the lane to be inserted and a vehicle on the adjacent lane to the right or opposite l) with a stream of vehicles travelling at the maximum authorised speed on the lane to which the insertion applies m) the insertion, allowing for an ego vehicle insertion (parameters to be defined by the provider) n) with a stream of vehicles travelling at low speed in the lane intended for insertion, allowing for an insertion of the ego vehicle (parameters to be defined by the provider)		}
	1. In nominal visibility conditions 2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)	}	2

		<i>Total</i>	<i>36</i>
Post-stop departure <i>(separate scenarios from stopping at a line stop)</i>	Insertion into traffic from the stop		
	i) without vehicle on the way targeted by insertion	} } } } }	5
	j) with a vehicle travelling at the maximum permitted speed on the lane to be inserted		
	k) with a vehicle travelling at the maximum authorised speed on the lane to be inserted and a vehicle (either on the right or opposite) on the adjacent lane		
	l) with a stream of vehicles travelling at the maximum permitted speed on the lane intended for insertion, allowing for an ego vehicle insertion <i>(parameters to be defined by the provider)</i>		
m) with a stream of vehicles travelling at low speed on the target lane of the insertion, allowing an insertion of the ego vehicle <i>(parameters to be defined by the provider)</i>			
	1. In nominal visibility conditions	}	2
	2. In degraded visibility conditions with degraded signage (masks, broken down, damaged)		
		<i>Total</i>	<i>10</i>
<i>(NB: lane stops corresponding to minimal risk or emergency manoeuvres are dealt with in the responses to critical hazards below).</i>			

**- Responses to critical traffic hazards and/or singular points of the route**

Scenarios listed below are intended to deal with "critical" (or edge) scenarios, in the sense that they include "targets" whose behavior is particularly dangerous (e.g. excessive speed of third party users) or singular route elements (visibility masks, centres of interaction generation with third party users).

	<b>Vehicle (or system*)</b>	<b>Nb min</b>
<i>NB: below, the scenarios are indicated provided that the corresponding nominal maneuver appears in the ODD of the vehicle or the system</i>		
<b>Rolling</b>	<b>Critical hazards</b>	
Driving on track	Third party user interaction scenarios below, at vehicle speed limits: III) One-way (including divided lanes) – (1; 2; 3 lanes) IV) Bidirectional II. a) Single assignment (2*1; 2*2 lanes; 2+1 lanes) II. b) Variable allocation (1 central lane)	3+3+1
	a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space, special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane) b) Pavement surface (standard (tar); specific (concrete, sand)) c) Straight line; in curve (right/left curve, S) d) Flat road profile; sloping (including top/bottom of coast)	4 2 2 2
	<ul style="list-style-type: none"> <li>• Vehicle (LV, HDV, PTW) stopped in the ego vehicle's lane</li> <li>• Vehicle (LV, HDV, PTW) in the lane of the ego vehicle decelerating up to 6 m/s<sup>2</sup></li> <li>• Vehicle with a speed of less than 25 km/h in the lane of the ego vehicle</li> <li>• Vehicle in front, travelling at the speed of the ego vehicle, swerving into the lane</li> <li>• Pedestrian: static; crossing at a constant speed of 5 km/h; stopping while crossing the lane from a speed of 5 km/h; crossing while accelerating from the edge of the lane at 1.5 m/s<sup>2</sup>; travelling in the lane at 10 km/h in the direction of travel of the vehicle or in the opposite direction to the vehicle; decelerating in the lane up to 6 m/s<sup>2</sup></li> <li>• Cyclist or personal moving device: static; crossing at a constant speed of 20 km/h; stopping while crossing the track from a speed of 20 km/h; crossing while accelerating from the track edge at 1.5 m/s<sup>2</sup>; travelling on the track at 30 km/h in the direction of travel of the vehicle or in the opposite direction to the vehicle; decelerating on the track up to 6 m/s<sup>2</sup></li> <li>• Inert object encroaching on the track with a height less than the wheelbase of the vehicle</li> <li>• Inert object encroaching on the lane, higher than the vehicle wheelbase: different encroachment scenarios (from 30 cm to the entire lane width)</li> </ul>	~30

	<ul style="list-style-type: none"> <li>Cut-in: different scenarios to be proposed by the system designer, including at least one scenario illustrating a time-to-collision towards the vehicle after its cut-in, without response from the ego-vehicle, of less than 1 s</li> <li>Cut-out: different scenarios to be proposed by the system designer, including at least one scenario illustrating a time-to-collision towards the target vehicle, after cut-out of the third vehicle, without response from the ego vehicle, of less than 1 s</li> </ul> <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>		2
Crossing (two-way traffic)	<p>Interaction scenarios between the ego vehicle and the vehicle in the opposite direction:</p> <p>I) On separate lanes (1; 2; 3 lanes) :</p> <ul style="list-style-type: none"> <li>Wrong-way vehicle with a speed equal to the maximum permitted speed</li> </ul> <p>II) On bidirectional lane (2*1; 2*2 lanes; 2+1 lanes) :</p> <ul style="list-style-type: none"> <li>Infringing overtaking of the vehicle in the opposite direction</li> <li>Opposite direction vehicle encroaching on the lane (30 cm)</li> <li>Opposite direction vehicle swerving (&lt; 30 cm in lane)</li> </ul> <p>e) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</p> <p>f) Pavement surface (standard (tar); specific (asphalt, sand))</p> <p>g) Straight line; in curve (right/left curve, S)</p> <p>h) Flat road profile; sloping (including top/bottom of coast)</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>		3 + 9 4 2 2 2 2
Lane change	<p>Lane change in current section</p> <p>I) On separate carriageways (2; 3 lanes)</p> <p>II) Bidirectional</p> <p>II. a) Single assignment (2*2 lanes; 2+1 lanes)</p> <p>II. b) Variable allocation (1 central lane)</p> <p>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</p> <p>b) Pavement surface (standard (tar); specific (asphalt, sand))</p>		5 4 2

	<p>c) Straight line; in curve (right/left curve, S)</p> <p>d) Flat road profile; sloping (including top/bottom of coast)</p> <ul style="list-style-type: none"> <li>• With a vehicle (LV, HDV, PTW) arriving from the rear, on the adjacent lane, at an excessive speed (+ 20 km/h and + 50 km/h compared to the maximum authorised speed)</li> <li>• With a vehicle arriving from the rear on the adjacent lane, with an acceleration &gt; 3 m/s<sup>2</sup></li> <li>• With a vehicle in front on the adjacent lane with a deceleration &gt; 6 m/s<sup>2</sup></li> <li>• With a PTW vehicle reversing with a speed differential &gt; 50 km/h</li> </ul> <p>a) In a straight line and nominal visibility</p> <p>b) In curve and visibility at the limits of the vehicle or system ODD</p>	<p>2</p> <p>2</p> <p>~10</p> <p>2</p>
Overtaking	Assumed to be covered by the above lane change scenarios	

<b>Inserts and intersections</b>		<b>Nb min</b>
<i>NB: below, scenarios are shown subject to the corresponding nominal manoeuvre being included in the vehicle or system's ODD</i>		
Crossing a roundabout	Crossing a roundabout (in France we consider 2 types of roundabout, depending on the priority regime)	2
	I) with 3 inputs (1 lane; 2 lanes)	6
	II) at 4 inputs (1 lane; 2 lanes)	
	III) representing the number of limit inputs of the vehicle's ODD (if more than 4 entries) (1 lane; 2 lanes)	
	VI. 1 way on the ring	2
VII. 2-way on the ring		
	<ul style="list-style-type: none"> <li>• with a vehicle approaching the roundabout (entrances n-1 and n-2 in relation to the ego vehicle) at excessive speed (&gt; 80 km/h)</li> </ul> <p>a) In nominal visibility conditions</p> <p>b) At the boundary visibility conditions of the vehicle or system</p>	~5
		2

<p>Crossing at an intersection</p>	<p>Crossing at an intersection</p> <ul style="list-style-type: none"> <li>I) In X</li> <li>II) T-shaped</li> <li>III) Y-shaped</li> <li>IV) With more than 4 branches</li> </ul> <p>V) with traffic lights VI) with specific priority regime VII) without specific priority regime</p> <ul style="list-style-type: none"> <li>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</li> <li>b) Pavement surface (standard (tar); specific (asphalt, sand))</li> <li>c) Flat road profile; sloping (including top/bottom of coast)</li> </ul> <ul style="list-style-type: none"> <li>• with a vehicle approaching at excessive speed (+ 20 km/h and + 50 km/h in relation to the maximum authorized speed on the approach lane)</li> </ul> <ul style="list-style-type: none"> <li>a) In nominal visibility conditions</li> <li>b) At the boundary visibility conditions of the vehicle or system</li> </ul>	<p style="text-align: right;">4</p> <p style="text-align: right;">3</p> <p style="text-align: right;">4</p> <p style="text-align: right;">2</p> <p style="text-align: right;">2</p> <p style="text-align: right;">~ 5</p> <p style="text-align: right;">2</p>
<p>Crossing a railway crossing</p>		
<p>Turning right at an intersection</p>	<p>Turning right at an intersection</p> <ul style="list-style-type: none"> <li>I) In X</li> <li>II) T-shaped</li> <li>III) Y-shaped</li> <li>IV) With more than 4 branches</li> </ul> <p>V) with traffic lights VI) with specific priority regime VII) without specific priority regime</p>	<p style="text-align: right;">4</p> <p style="text-align: right;">3</p>

	<p>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</p> <p>b) Pavement surface (standard (tar); specific (asphalt, sand))</p> <p>c) Flat road profile; sloping (including top/bottom of coast)</p> <ul style="list-style-type: none"> <li>with a vehicle coming from the left, travelling at excessive speed (maximum authorised speed, + 20 km/h and + 50 km/h in relation to the maximum authorised speed) and not respecting the priorities</li> <li>with an oncoming vehicle turning right into the lane of insertion of the ego vehicle, travelling at excessive speed (maximum authorised speed, + 20 km/h and + 50 km/h in relation to the maximum authorised speed) and not respecting the priorities</li> </ul> <p>a) In nominal visibility conditions</p> <p>b) At the boundary visibility conditions of the vehicle or system</p>	<p>4</p> <p>2</p> <p>2</p> <p>~10</p> <p>2</p>
Turning left at an intersection	<p>Turning left at an intersection</p> <p>I) In X</p> <p>II) T-shaped</p> <p>III) Y-shaped</p> <p>IV) With more than 4 branches</p> <p>V) with traffic lights</p> <p>VI) with specific priority regime</p> <p>VII) without specific priority regime</p> <p>a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)</p> <p>b) Pavement surface (standard (tar); specific (asphalt, sand))</p> <p>c) Flat road profile; sloping (including top/bottom of coast)</p> <ul style="list-style-type: none"> <li>with a vehicle coming from the right, travelling at excessive speed (maximum authorised speed, + 20 km/h and + 50 km/h in relation to the maximum authorised speed) and not respecting the priorities</li> <li>with an oncoming vehicle turning right into the lane of insertion of the ego vehicle, travelling at excessive speed (maximum authorised speed, + 20 km/h and + 50 km/h in relation to the maximum authorised speed) and not respecting the priorities</li> </ul> <p>a) In nominal visibility conditions</p> <p>b) At the boundary visibility conditions of the vehicle or system</p>	<p>4</p> <p>3</p> <p>4</p> <p>2</p> <p>2</p> <p>~10</p> <p>2</p>

U-turn	Same as above for the turn left		
Entry from insertion lane / acceleration	Insertion on lane		
	I) One-way (including divided lanes) – (1; 2; 3 lanes)	}	6
	II) Bidirectional (2*1; 2*2 lanes; 2+1 lanes)		
	I. with traffic lights	}	3
	II. with specific priority regime		
	III. without specific priority regime		
	a) Roadside (absence of shoulders including vegetation, ditch, embankment, cliff; guardrail; pavement, street furniture, parking space; special lane including lane/cycle path, hard shoulder, slow-moving vehicle lane)	}	4
	b) Pavement surface (standard (tar); specific (asphalt, sand))		
	c) Straight line; in curve (right/left curve, S)	}	2
	d) Flat road profile ; sloping (including top/bottom of hill)		
• with a vehicle circulating at a speed excessive on the way aiming by insertion (+ 20 kph and + 50 km/h in relation to the maximum authorized speed) and not respecting the priorities		~5	
a) In a straight line and in nominal visibility conditions	}	2	
b) In curve and at visibility limit of the vehicle or system ODD			
Exit to exit lane / deceleration	Deceleration behaviour on approach and in the exit lane from the maximum speed allowed in the vehicle's / system's ODD in an exit lane blocking situation beyond the end of the deceleration lane		
	a) In nominal visibility conditions	}	2
	b) In curve and at visibility limit of the vehicle or system ODD		
Insertion from lane / private site	Assumed to be covered by “turn right” scenarios		
Public transport stop	Deceleration and stopping behaviour at a stop (in-line, overhanging, notched) obstructed by obstructive parking		3
	• partially: reduction of nominal parking length by less than 5 m	}	2
	• strongly: parking length less than the length of the vehicle + 5 m from an initial driving speed equal to the maximum permitted speed		
	a) In nominal visibility conditions	}	2
b) At visibility limit of the vehicle or system ODD			

Public transport stop exit	Insertion into traffic from the stop (in line, overhanging, notched), free of parking over the whole nominal length		3
	<ul style="list-style-type: none"> <li>with a vehicle travelling at excessive speed in the targeted lane (+20 km/h and +50 km/h over the maximum authorized speed) and not respecting priorities</li> <li>with a stream of vehicles travelling at low speed on the targeted lane, allowing an insertion of the ego vehicle (<i>parameters to be defined by the provider</i>)</li> </ul>	}	~5
	<ul style="list-style-type: none"> <li>a) In nominal visibility conditions</li> <li>b) At visibility limit of the vehicle or system ODD</li> </ul>	}	2
Post-stop departure ( <i>separate scenarios from stopping at a line stop</i> )	Insertion into traffic from a standstill		
	<ul style="list-style-type: none"> <li>with a vehicle travelling at excessive speed in the lane to be inserted (+ 20 km/h and + 50 km/h in relation to the maximum authorised speed) and not respecting priorities</li> <li>with a vehicle travelling at the maximum authorised speed on the lane targeted by the insertion and a vehicle (to the right or in front) travelling at excessive speed on the lane targeted by the insertion (+ 20 km/h and + 50 km/h in relation to the maximum authorised speed) and not respecting priorities</li> </ul>	}	~6
	<ul style="list-style-type: none"> <li>a) In nominal visibility conditions</li> <li>b) At visibility limit of the vehicle or system ODD</li> </ul>	}	2

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## Appendices

The various annexes of this document are sources of comparison of the scenario-based approach presented in the DGITM methodological document [1], which are intended to enrich layers of description of the method presented in this document.

The use of each of the appendices 1 to 4 presented below has enabled the identification of new scenario descriptors. However, some descriptors that were previously unnecessary in the scenario description have been added as new descriptors or new parameters in part III.2.

## Appendix 1: Illustrative application to two existing databases

### 1. Illustrative application of the descriptors to scenarios

This part also aims to illustrate the use of scenario axes of description defined above, on concrete scenarios already integrated in existing databases. The chosen databases are those managed by the IRT SystemX and the scenarios below aim to illustrate a diversity of situations, in particular nominal driving situations and hazards. The aim here is to evaluate the coverage of scenarios by the 5 layers of descriptors proposed, and to assess how certain scenarios could reveal gaps in descriptors. Visibility masks can be taken as an example here, which are important but complex characteristics of scenarios because of their heterogeneity.

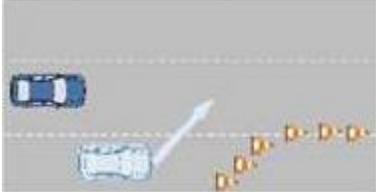
Through this illustrative application on a few scenarios, this part prefigures what could be an approach of progressive enrichment of scenario description approach, by confrontation with new types or particular scenarios. In the remainder of this appendix, the contents of two databases have been used to consolidate the taxonomy presented. The VOIESUR pictograms have been associated to describe the considered accident situation when relevant in order to make the link between the French scenario-based approach and an accident analysis approach.

#### a. Flooded road

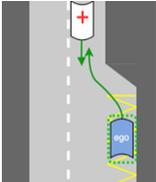
<b>DGITM approach layer</b>	<b>Description of the scenario from the Law Enforcement WG</b> The ego arrives at a puddle on its lane -> water retention on the road 			
<b>Static environment</b>	<b>Environment:</b> any type of environment	<b>Physical infrastructure geometry</b> Any type of road, any type of profile, any type of road curvature	<b>Signaling</b> Permanent VMA: NA VMA <sup>15</sup> : not specified	<b>Readability</b> NA
<b>Maneuver</b>	<b>Vehicle</b> Any type of road vehicle		<b>Maneuver</b> Driven in its lane	
<b>Hazard</b>	Puddle on the way			
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	<i>Precipitation to be informed</i>			

<sup>15</sup>Maximum authorized speed (in km/h)

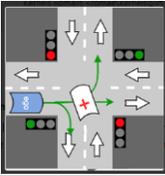
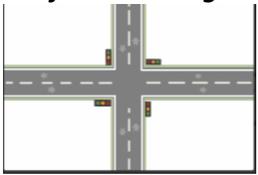
b. Work zone

<b>DGITM approach layer</b>	<b>Description of the scenario from the Law Enforcement WG</b> The ego is traveling in its lane, a vehicle in an adjacent lane falls back into the ego's lane due to a temporary closure of its lane for work. 			
<b>Static environment</b>	<b>Environment :</b> highway	<b>Physical infrastructure geometry</b> Type of road: motorway – divided carriageways Number of lanes: 3 lanes Reduction in the number of lanes (2)	<b>Signaling</b> Permanent VMA: NA VMA: 130 km/h Traffic cones	<b>Readability</b> NA
<b>Maneuver</b>	<b>Vehicle</b> Any type of road vehicle		<b>Maneuver</b> Keeping in lane	
<b>Hazard</b>	Any type of road vehicle		Dropping on the adjacent lane	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b> normal	<b>Response Affecting Masks</b>	<b>Adhesion</b> NA	<b>Third party behaviors</b> Dangerous folding, no turn signal

c. Interactions with priority vehicles

<b>DGITM approach layer</b>	<b>Description of the scenario from the Law Enforcement WG</b> Priority vehicle arrives near to the ego by not respecting the essential traffic rules near a notched passenger station 			
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<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b> 	<b>Signaling</b> Permanent VMA: NA VMA: 50	<b>Readability</b> NA
	<b>Environment:</b> urban			
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Autonomous shuttle		Notch Stop Exit Lane change and start	
<b>Hazard</b>	Priority Vehicle		Driving in the opposite direction on the roadway	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	NA		Road surface condition: normal	

<b>DGITM approach layer</b>	<b>Description of the scenario from the Law Enforcement WG</b> Priority vehicle stopped in the middle of the intersection 			
<b>Static environment</b>	Environment : NA	<b>Physical infrastructure geometry</b> 	<b>Signaling</b> Floor markings Traffic lights	<b>Readability</b> NA

<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Autonomous shuttle		Cross the intersection Turn right Turn left	
<b>Hazard</b>	Priority Vehicle		Stop in the middle of the intersection	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	NA		Road surface condition: normal	

Scenarios entered in MOSAR are for the most of them part functional and logical scenarios. The confrontation of the IRT SystemX tool (MOSAR) with the method proposed by DGITM makes it possible to check the consistency between the method and a possible implementation.

If the illustration of the MOSAR scenario-designed method does not lead to a multiplication of descriptors, a confrontation of the lists of descriptors seems relevant within the framework of the enrichment of scenario descriptors.

d. Lists of descriptors present in MOSAR

More generally, the MOSAR tree structure offers lists of descriptors, which can be compared with lists defined in the DGITM methodological document [1].

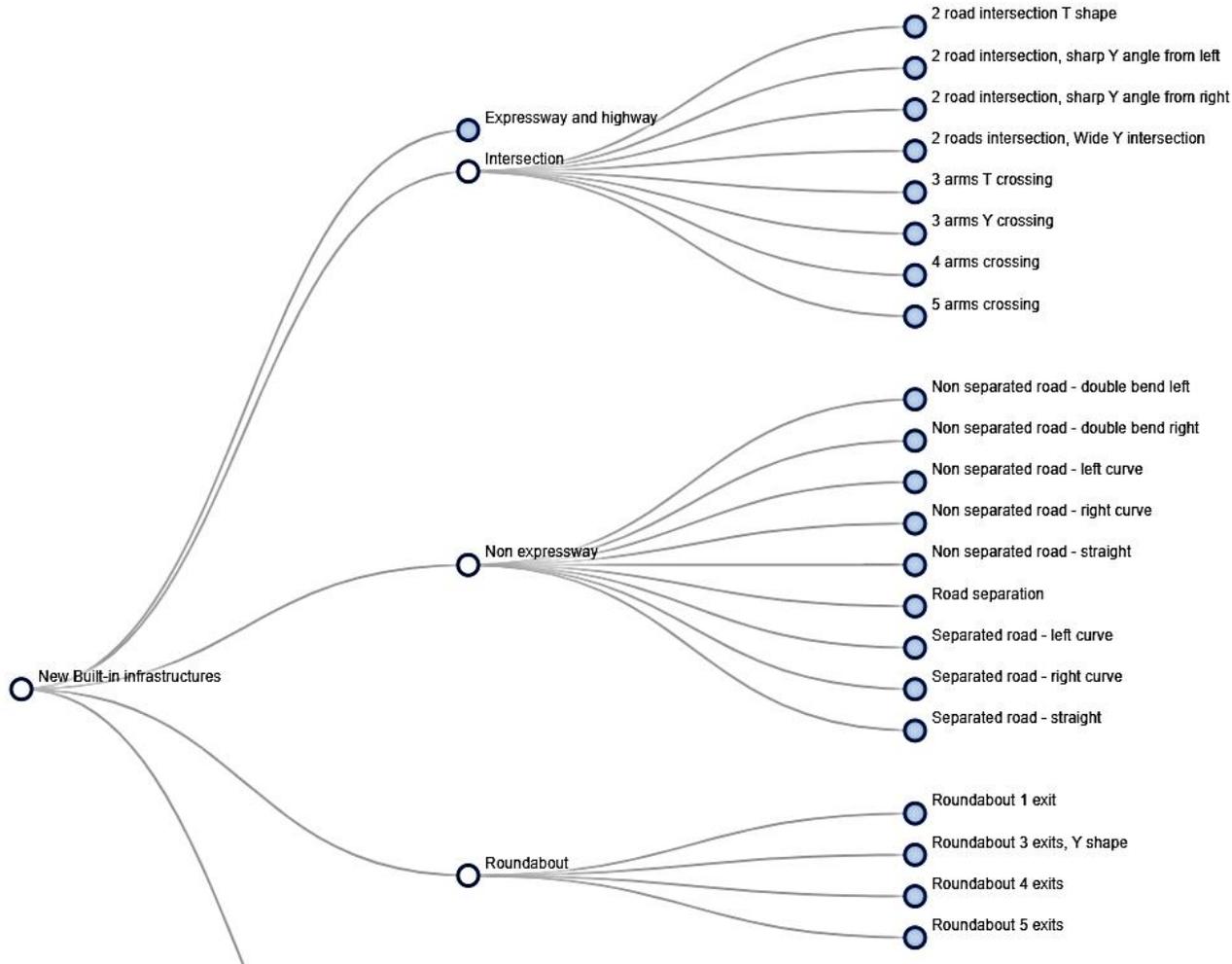


Figure 9: List of descriptors of the static environment of the IRT SystemX tool

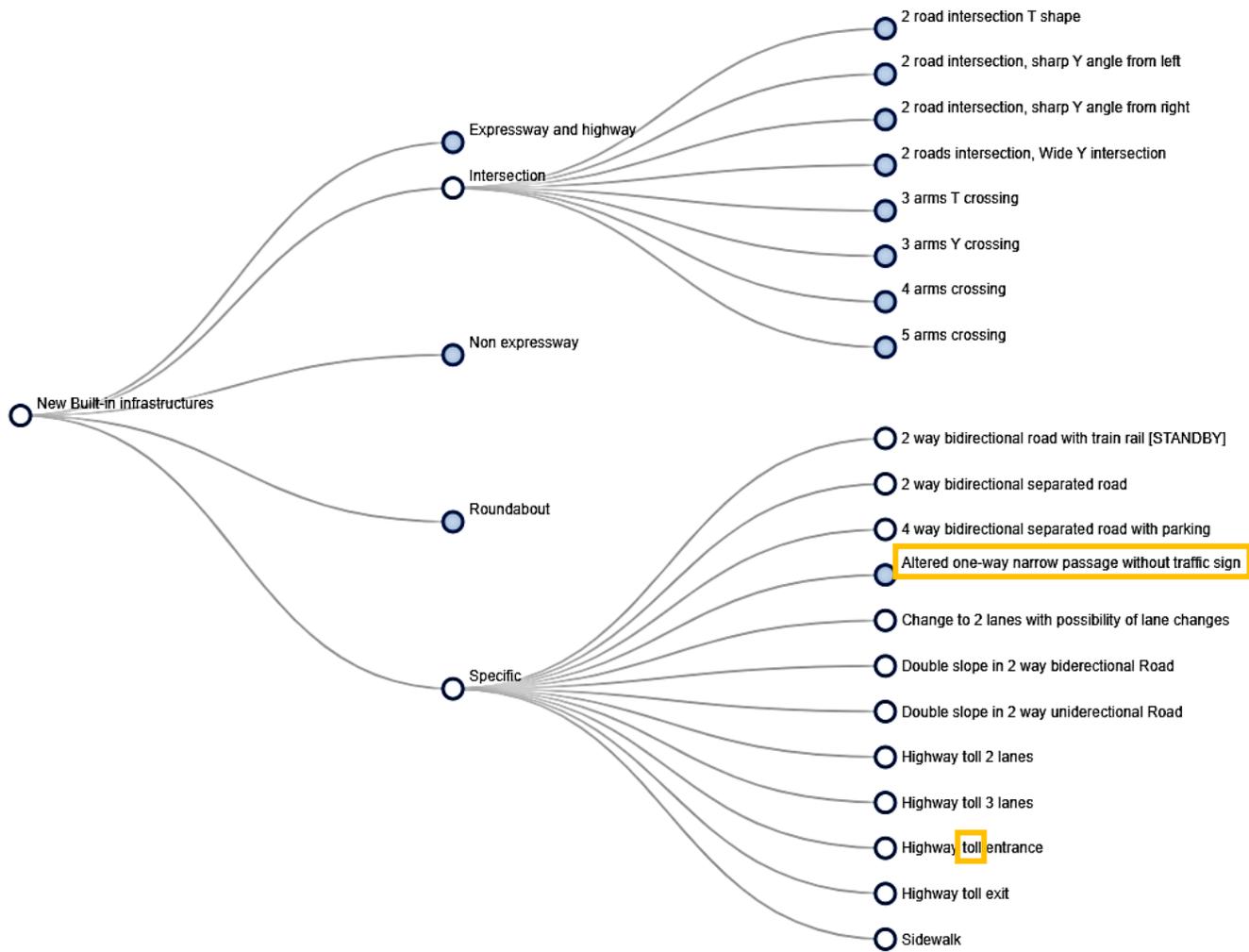


Figure 10: List of descriptors of the static environment of the IRT SystemX tool (continuation)

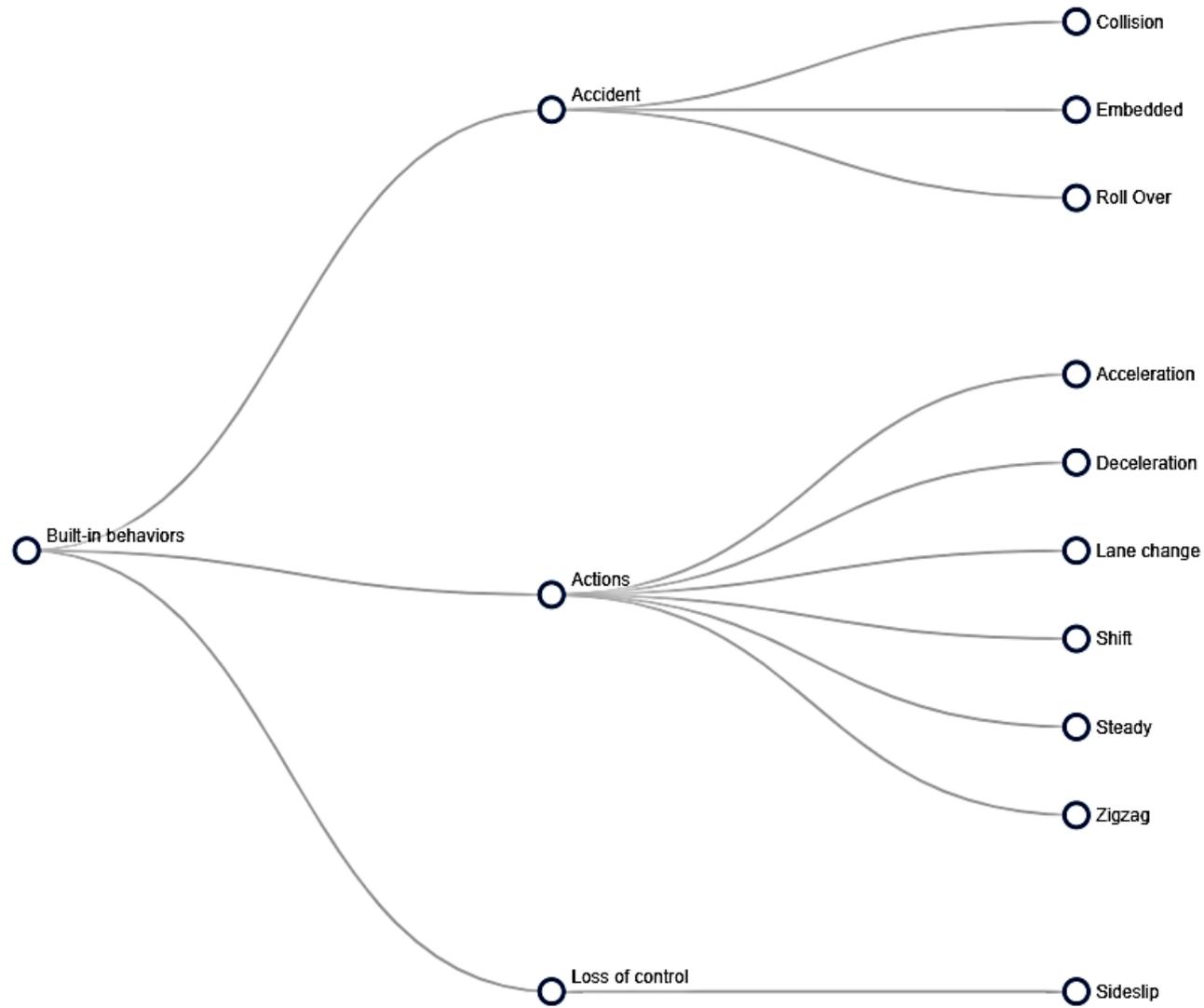


Figure 11: List of descriptors of possible operational maneuvers in MOSAR

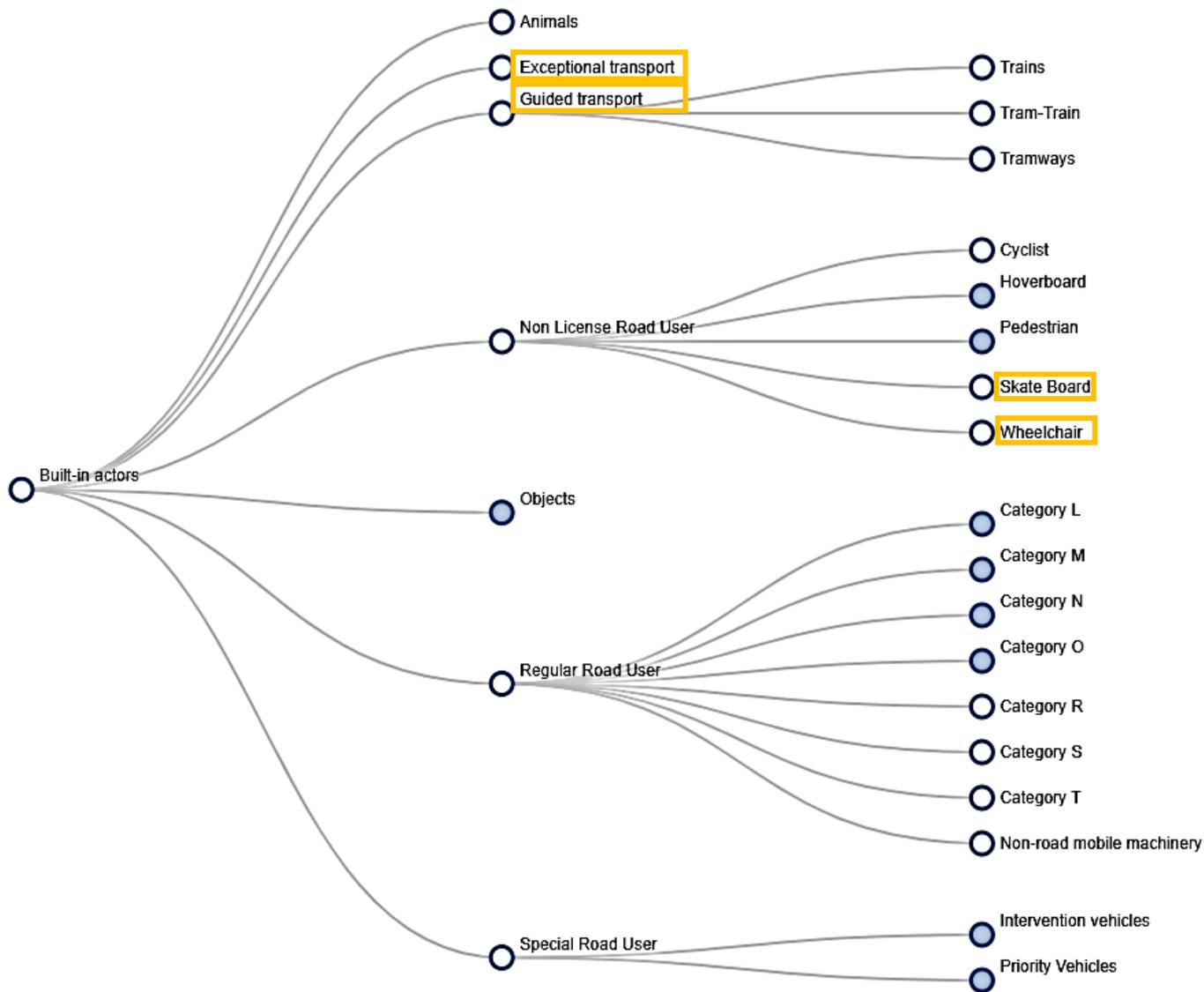


Figure 12: List of descriptors of scenario actors (cf. hazards in the DGITM approach)

## 2. Illustrative application from the BAACs

The ONISR's bulletins (BAAC) are a source of comparison of our scenario construction method. The confrontation of accident situations described with our list of descriptors makes it possible to bring out certain missing descriptors.

Confrontations were all carried out on the basis of accidents recorded in 2019 in metropolitan France.

In the tables below, rows correspond to DGITM layers while columns show information entered in ONISR reports. Information are directly stored in categories of the DGITM method.

The objective of this confrontation is to be able to reproduce configurations as diverse as possible in order to fill in the gaps in the lists of descriptors from the DGITM methodological document [1]. To do this, it is a question of generating accident scenarios involving different static and dynamic configurations in order to involve complex situations at the level of driving environments and behaviors of third parties.

In this part, the work is done in relation to accident situations involving one or more conventional vehicles. Insofar as an analogy is desired between a "responsible" user, hazards in our approach, and an "ego" vehicle, considered "perfect" from a Highway Code point of view, the maneuver of the ego will always be taken in relation to the non-responsible vehicle<sup>16</sup>. More generally, insofar as even when the vehicle is not at fault, an accident is likely to happen, it should be noted that the comparability of the "ego" and "hazard" layers from an accidentology is large.

NB: at this stage in scenarios, the system response is not described.

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<sup>16</sup> This implies that it is not always the LV which is taken as the "ego" reference. When none of the vehicles in the accident scenario is a LV (or "tourism vehicle" in ONISR terminology), the liability rule applies.

a. Crossing an intersection with a third party going too fast

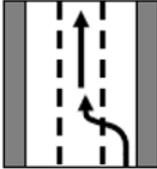
DGITM approach layer	Accident description (ONISR)			
Static environment	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: urban School proximity: NA Near pedestrian crossing: NA	Intersection: in X Priority: NA	Permanent VMA: NA VMA at the time of the accident: 50 Special VMA: NA Average speed practiced: NA	NA
		Type of road: municipal road (1) Priority regime: bidirectional Number of lanes: 2 Special route: NA Pavement width (excluding TCP <sup>17</sup> ): NA TCP Width: NA Priority mode: right priority Longitudinal profile: Flat Plan view: rectilinear part Layout: Construction site		
Type of road: municipal road Traffic pattern: one-way Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Longitudinal profile: Flat Plan view: rectilinear part Accommodation: Construction site				
Maneuver	<b>Vehicle</b>		<b>Maneuver</b>	
	Scooter with a cylinder capacity of less than 50cc (moped)		Turning left	
Hazard	Scooter with a cylinder capacity between 50 and 125 cm3 (light motorcycle) <i>1 passenger in the back of the light motorcycle</i>		Driving without changing direction	
	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>

<sup>17</sup> Road median

<b>Hazard affecting the response</b>	Day: Sunday Holidays: NA Holiday eve: NA Light: full day Atmospheric conditions: normal		Road surface condition: normal	Light motorcycle: <ul style="list-style-type: none"> <li>• Excessive speed</li> <li>• Dangerous overtaking</li> </ul>
VOIESUR database	Rear collision	Pictogram 305 		

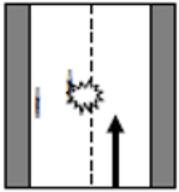
*b. Changing lanes with a vehicle coming too fast*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: outside agglomeration School proximity: NA Near pedestrian crossing: NA	Intersection: out of intersection Priority: NA Type of road: divided Traffic pattern: one-way Number of lanes: 4 Special lane: reserved lane Pavement width (excluding TCP): NA TCP Width: NA Priority regime: NA Longitudinal profile: flat Plan view: rectilinear part Accommodation: NA	Permanent VMA: NA VMA at the time of the accident: 130 Special VMA: NA Average speed practiced: NA	NA
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Heavy weight (PTAC > 3.5T + trailer)		Circulating without changing direction	
<b>Hazard</b>	Passenger vehicle (LV) <i>1 front passenger in the LV</i>		Changing lanes to the left	
	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>

<b>Hazard affecting the response</b>	Day: Thursday Holidays: NA Holiday eve: NA Light: night without public lighting Atmospheric conditions: normal		Road surface condition: normal	LV: <ul style="list-style-type: none"> <li>Excessive or inappropriate speed</li> <li>Dangerous overtaking</li> </ul>
VOIESUR database	Rear collision	Pictogram 113 		

*c. Public transport output*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: chipboard School proximity: NA Near pedestrian crossing: NA	Intersection: out of intersection Priority: NA Type of road: secondary road Priority regime: bidirectional Traffic regime: NA Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Priority regime: NA Longitudinal profile: flat Plan view: rectilinear part Accommodation: NA	Permanent VMA: NA VMA at the time of the accident: 50 Special VMA: NA Average speed practiced: NA	NA
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Passenger vehicle (LV)		Circulating without changing direction	

<b>Hazard (here other than a motor vehicle)</b>	Bus		Parking maneuver	
	3PTW engine > 125 cm3		Offset left	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Wednesday Holidays: NA Holiday eve: NA Light: full day Atmospheric conditions: normal		Condition of the road surface: wet	Public transport: <ul style="list-style-type: none"> <li>• Obstacle-free road exit</li> <li>• Vehicle movement</li> </ul>
VOIESUR database	Chain Collision	Pictogram 701 		

*d. Turn right with a hazard*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: urban School proximity: NA Near pedestrian crossing: less than 50 m from a pedestrian crossing	Intersection: out of intersection Priority: NA Manager: departmental council Type of road: secondary road Priority regime: bidirectional Traffic regime: NA Number of lanes: 2 Special route: cycle path Pavement width (excluding TCP): NA TCP Width: NA Right of way: yield Longitudinal profile: flat	Permanent VMA: NA VMA at the time of the accident: 50 Special VMA: NA Average speed practiced: NA	NA

		Plan view: in curve on the right Accommodation: other (?)		
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Passenger vehicle (LV)		Turning right	
<b>Hazard (here other than a motor vehicle)</b>	1 pedestrian crossing and located less than 50 m from a pedestrian crossing			
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Friday Holidays: NA Holiday eve: NA Light: night with public lighting on Atmospheric conditions: normal	<ul style="list-style-type: none"> <li>Restricted visibility from the passenger compartment (due to the vehicle)</li> </ul>	Road surface condition: normal	<ul style="list-style-type: none"> <li>Drowsiness, fatigue, inattention (here ego)</li> </ul>
VOIESUR database	Other Collision	Pictogram 311 		

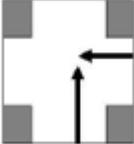
*e. Turning left with hazards*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: rural School proximity: NA Near pedestrian crossing: NA	Intersection: Y Priority: NA RD31 Type of road: secondary road Traffic regime: two-way Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA	Permanent VMA: NA VMA at the time of the accident: 70 Special VMA: NA Average speed practiced: NA	N / A

		Right of way: give way Long profile: bottom of the coast Plan view: rectilinear part Accommodation: bridge - flyover		
		Type of road: secondary road Traffic pattern: one-way Number of lanes: NA Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Priority regime: NA Long profile: slope Plan view: in curve on the right Acommodation: interchange ramp		
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Passenger vehicle (LV)		Driving without changing direction	
<b>Hazard (here other than a motor vehicle)</b>	Passenger vehicle (LV) 1 passenger in one of the LVs		Turning left	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Saturday Holidays: NA Holiday eve: NA Light: night without public lighting on Atmospheric conditions: normal	<ul style="list-style-type: none"> <li>Restricted visibility from the passenger compartment (due to the vehicle)</li> </ul>	Road surface condition: normal	LV turning left: <ul style="list-style-type: none"> <li>Lane change</li> </ul>
VOIESUR database	Collision from the left	Pictogram 305 		

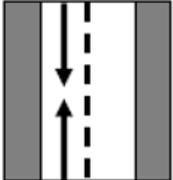
f. Visibility mask: glare

DGITM approach layer	Accident description (ONISR)			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: rural School proximity: NA Near pedestrian crossing: NA	Intersection: in X Priority: NA Manager: county council Type of road: secondary road Traffic regime: two-way Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Priority regime: priority road and occasional priority Longitudinal profile: flat Plan view: rectilinear part Accommodation: NA	Permanent VMA: NA VMA at the time of the accident: 80 Special VMA: NA Average speed practiced: NA	NA
		Type of road: municipal road Traffic pattern: bidirectional Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Right of way: give way Longitudinal profile: flat Plan view: rectilinear part Accommodation: NA		
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
<b>Hazard (here other than a motor vehicle)</b>	Passenger vehicle (LV) 2 passengers in the LV going straight on the D51 1 passenger in the LV crossing on the RC		Driving without changing direction Crossing the road	
	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>

<b>Hazard affecting the response</b>	Day: Friday Holidays: NA Holiday eve: NA Light: dusk or dawn Atmospheric conditions: normal	<ul style="list-style-type: none"> <li>• Impediment to visibility</li> </ul>	Road surface condition: normal	
VOIESUR database	Frontal collision	Pictogram 302 		

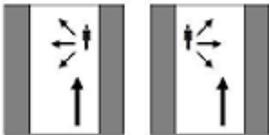
*g. Damaged pavement and presence of oil on the pavement*

DGITM approach layer	Accident description (ONISR)			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: rural School proximity: NA Near pedestrian crossing: NA	Intersection: out of intersection Priority: NA Manager: departmental council Type of road: secondary road Traffic regime: two-way Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Priority regime: NA Long profile: slope Plan view: in curve on the right Accommodation: NA	Permanent VMA: NA VMA at the time of the accident: 50 Special VMA: NA Average speed practiced: NA	NA
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Passenger vehicle (LV)		Driving without changing direction	

<b>Hazard (here other than a motor vehicle)</b>	Motorcycle with engine capacity > 125 cm3		Other maneuvers	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Monday Holidays: NA Holiday eve: NA Light: full day Weather conditions: light rain	<ul style="list-style-type: none"> <li>Obstruction of visibility</li> </ul>	State of the road surface: <ul style="list-style-type: none"> <li>fat, oil</li> <li>degraded road</li> </ul>	
VOIESUR database	Frontal collision	Pictogram 101 		

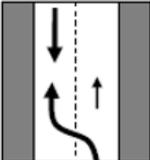
#### *h. Degraded weather and pedestrian*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: urban School proximity: NA Near pedestrian crossing: more than 50 m from the pedestrian crossing	Intersection: out of intersection Priority: NA Manager: county council Type of road: secondary road Traffic regime: two-way Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Priority regime: others Longitudinal profile: flat Plan view: rectilinear part	Permanent VMA: NA VMA at the time of the accident: 50 Special VMA: NA Average speed practiced: NA	NA

	Accommodation: NA			
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Pedestrian		Crossing	
<b>Hazard (here other than a motor vehicle)</b>	Scooter with engine capacity < 50 cm3		Overtaking on the right	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Friday Holidays: NA Holiday eve: NA Light: full day Weather conditions: light rain	<ul style="list-style-type: none"> <li>Route Setup</li> <li>Obstruction of visibility</li> </ul>	State of the road surface: wet road	<ul style="list-style-type: none"> <li>Inattention</li> <li>Dangerous overtaking</li> </ul>
VOIESUR database	Other Collision	Pictogram 803 or 804 		

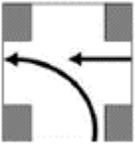
*i. Erased lane marking, visibility mask, degraded weather*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: rural School proximity: NA Near pedestrian crossing: NA	Intersection: out of intersection Priority: NA Manager: county council Type of road: secondary road Traffic regime: two-way Number of lanes: 2 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA	Permanent VMA: NA VMA at the time of the accident: 80 Special VMA: NA Average speed practiced: NA	<ul style="list-style-type: none"> <li><i>Erased lane marking</i></li> </ul>

		Priority regime: priority road and occasional priority Longitudinal profile: flat Plan view: in curve on the right Accommodation: NA		
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Moped with engine capacity < 50 cm3		Driving against the direction	
<b>Hazard (here other than a motor vehicle)</b>	Passenger vehicle (LV) 1 passenger on board the LV		Driving without changing direction	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Friday Holidays: NA Holiday eve: NA Light: full day Atmospheric conditions: dazzling weather	<ul style="list-style-type: none"> <li>Road configuration</li> </ul>	Road surface condition: normal	<ul style="list-style-type: none"> <li>Inattention</li> <li>Dangerous overtaking</li> </ul>
VOIESUR database	Frontal collision	Pictogram 203 		

*j. Crossroads fitted out with traffic lights*

<b>DGITM approach layer</b>	<b>Accident description (ONISR)</b>			
<b>Static environment</b>	<i>Excluding scenario approach (accident specificity)</i>	<b>Physical infrastructure geometry</b>	<b>Signaling</b>	<b>Readability</b>
	Environment: urban School proximity: NA Near pedestrian crossing: NA	Intersection: in X Priority: NA Traffic pattern: bidirectional Number of lanes: 3 Special route: NA	Permanent VMA: NA VMA at the time of the accident: 50 Special VMA: NA Average speed practiced: NA	<ul style="list-style-type: none"> <li>Broken lights</li> </ul>

		Pavement width (excluding TCP): NA TCP Width: NA Priority regime: traffic lights Longitudinal profile: flat Plan view: rectilinear part Accommodation: converted crossroads		
		Traffic pattern: two-way Number of lanes: 6 Special route: NA Pavement width (excluding TCP): NA TCP Width: NA Priority regime: traffic lights Longitudinal profile: flat Plan view: rectilinear part Layout: NA		
<b>Maneuver</b>	<b>Vehicle</b>		<b>Maneuver</b>	
	Passenger vehicle (LV)		Circulating without changing direction	
<b>Hazard (here other than a motor vehicle)</b>	Cyclist 1 passenger on board the LV		Turning left	
<b>Hazard affecting the response</b>	<b>Environmental conditions</b>	<b>Response Affecting Masks</b>	<b>Adhesion</b>	<b>Third party behaviors</b>
	Day: Saturday Holidays: NA Holiday eve: NA Light: night with public lighting on Weather conditions: heavy rain	<ul style="list-style-type: none"> <li>Obstruction of visibility</li> </ul>	Condition of the road surface: wet	<ul style="list-style-type: none"> <li>Non-compliance with priority</li> </ul>
VOIESUR database	Side collision	Pictogram 312 		

## Appendix 2 – Table of factors proposed by SOTIF

This appendix reproduces a table proposed in PAS SOTIF 21448 [8], as a list against forgetting variability factors to be considered.

Table F.1 Example Scenario of Factors

Factor	
climate	fine
	cloudy
	rainy
	sleet
	snow (accumulation of snow)
	hail
time of day	fog
	early morning
	daytime
	evening
shape of road/lane	night time
	straight
	curve
	downhill
	uphill
	banked road
	step difference
	uneven spot (uneven road)
	Belgian brick road
	narrow road
	wide road
	existence of median
	manhole cover
	tollgate
merging	
road condition	branching
	pothole
	dry
	wet
	low $\mu$ path
	crossover road
ego vehicle operation	water trough
	gravel road
	vehicle is accelerating
	vehicle is decelerating
	vehicle is driving at constant speed
	vehicle is stopping
	drive at high speed
	drive at low speed
	vehicle is making a turn
	vehicle is making a sudden traversing
vehicle around <ul style="list-style-type: none"> <li>▪ preceding vehicle</li> <li>▪ to side vehicle</li> <li>▪ oncoming vehicle</li> </ul> including <ul style="list-style-type: none"> <li>▪ motorcycle</li> <li>▪ bicycle</li> </ul>	passing
	right or left turn
	preceding vehicle makes sudden deceleration
	preceding vehicle makes deceleration
	preceding vehicle makes acceleration
	preceding vehicle makes sudden acceleration
	interrupting vehicle
	trailing vehicle in stop and go traffic
	there is vehicle to right of ego vehicle going in same direction
	there is vehicle to left of ego vehicle going in same direction
	there is an oncoming vehicle
	high beam of oncoming vehicle
	passing by a motorcycle
	bicycle

Other road participants	pedestrian is walking across
	truck
	three-wheeled motorcycle
	peculiar vehicle
objects off-roadway (surroundings)	sidewall
	sign (upside)
	sign (side)
	pole
	tunnel
	multi-story parking space
	beneath a viaduct
	kerb
	guardrail
	pylon
	pots dots, cats eye
	vehicle stopping on the side of the road
	animal jumping out
	railway crossing
	construction site
	marked crosswalk
water alongside road	

*NOTE Table F.1 is not comprehensive. Other factors can be considered when constructing use cases such as local driving customs and infrastructure.*

## Appendix 3 – First list of accidents resulting from GAME work (WG)

- Collision with vulnerable road user (cyclist, pedestrian, etc.)
- Collision (lateral/frontal) with a massive obstacle (containers, animals, falling trees, etc.)
- Collision with another road vehicle
- Collision with the vehicle of a guided transport system (trams, etc.) or rail (heavy rail)
- Collision with another type of vehicle
- Person falling inside the vehicle
- Person falling from the system vehicle outside the station
- Person falling from the system vehicle to the outside in line
- Vehicle rollover
- Electrification / Electrocutation in the vehicle
- Electrification / Electrocutation in a station
- Electrification / Electrocutation on the course at system equipment
- Fire / smoke in the vehicle
- Fire / smoke at a station
- Fire / smoke on the course at a system equipment
- Explosion in the vehicle
- Explosion at a station
- Explosion on the course at system equipment
- Passengers trapped / pinched by openings (windows, doors, etc.) of a system component
- Passengers trapped / pinched by a moving part of a system component
- Entrapment of persons by the vehicle (in particular entrapment of people when leaving the station or following clothing jamming)
- Contact with an aggressive element of a system component (injury following contact with protruding, cutting, pointed parts, etc.)
- Contact with a hot or cold part of one of the system components
- Contact with a dangerous liquid (toxic, corrosive, etc.) from one of the system components
- Contact with a dangerous gas (toxic, etc.) from one of the system components
- Fall / projection / loss of elements of a vehicle from the system to the road
- Passengers struck following the fall / projection / loss of an element of a vehicle in its passenger compartment
- Passengers struck following the fall of objects transported in the passenger compartment of a vehicle (e.g. luggage, parcels, etc.)
- Falling objects from the system infrastructure (e.g. traffic lights, signs or station lighting, etc.)

## Appendix 4 – List of pictograms from the VOIESUR database

The VOIESUR database comes from the VOIESUR project (Vehicle occupying infrastructure Studies of the safety of road users). This project was funded by the National Research Agency (ANR) and involved CEESAR, LAB, formerly IFSTTAR and CEREMA.

As part of this project, accident reports of 2011 were studied. Both fatal and non-fatal accidents were taken into account in this study. This database takes into account both light vehicles and all other road users.

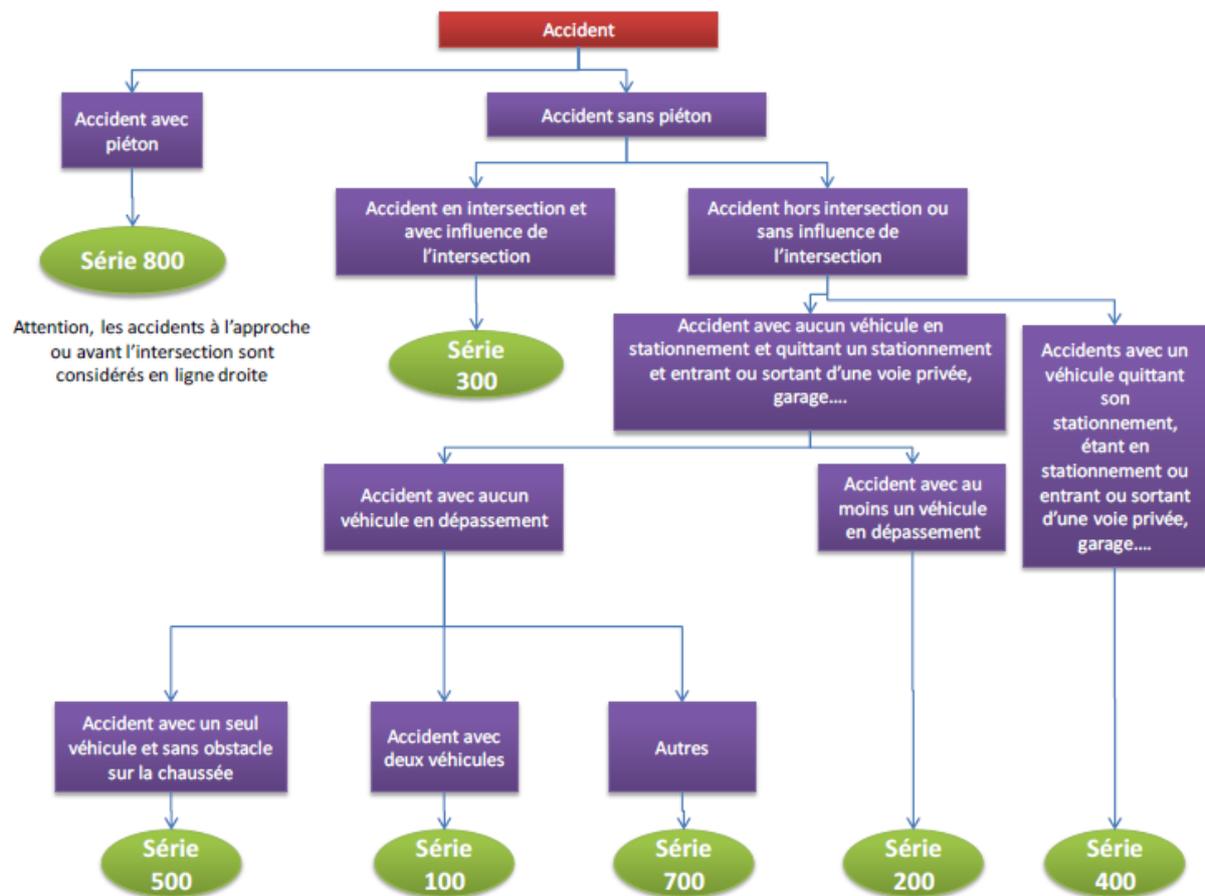


Figure 13: Nomenclature of pictograms according to major accident configurations

Pictograms presented below present scenarios considered in each of the categories defined above. It is useful to consider the following assertions:

- The arrows represent directions of the vehicles;
- No distinction is made between vehicle types;
- A parked vehicle is represented by a car;
- An arrow with a dotted line means that the vehicle is decelerating;
- An arrow starting with a perpendicular dash means that the vehicle is stopped or in the process of stopping;
- When there are several directions of arrows for the same vehicle or pedestrian, this means that the vehicle (or the pedestrian) can take any direction defined by the arrows;
- When an arrow has a circle, it means that the vehicle is rolling or rolling over;

- When an arrow has a star, this means that the vehicle has suffered a 1<sup>st</sup> impact (often not very significant, for example against a safety barrier);
- The pedestrian is characterized by a man.

a. Class 100: accidents between 2 vehicles

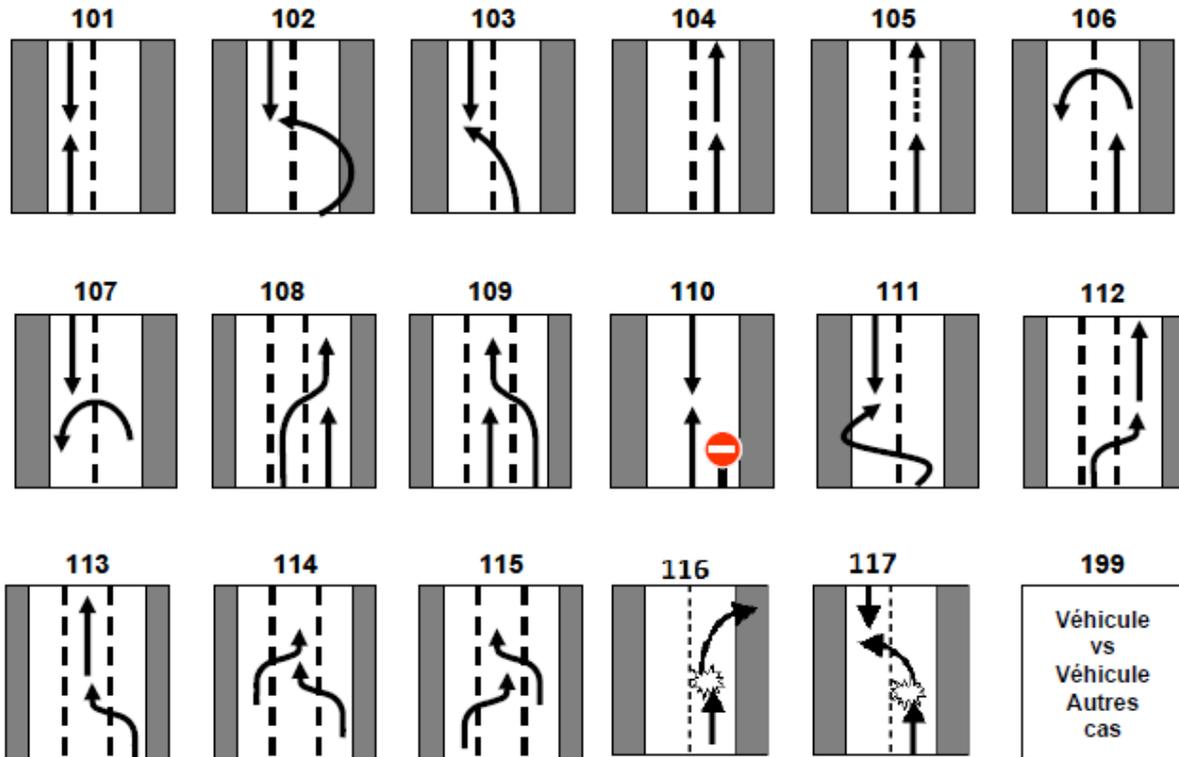


Figure 14: Accidents between two vehicles outside the intersection

101	A vehicle is driving in the opposing lane while another vehicle is coming in the opposite direction.
102	A vehicle drives on the right shoulder then returns to the roadway, crosses the lanes to the left while another vehicle arrives in the opposite direction.
103	A vehicle swerves towards the opposing lane while a vehicle is coming in the opposite direction.
104	A vehicle hits the rear of the vehicle in front, which was maintaining its speed.
105	A vehicle hits the rear of the preceding vehicle which was slowing down.
106	A vehicle arrives while the vehicle in front makes a U-turn.
107	A vehicle arrives while a vehicle traveling in the opposing lane makes a U-turn in front of it.
108	A vehicle changes lanes (or falls back) to the right and is hit from behind by a vehicle traveling in that lane.
109	A vehicle changes lanes (or falls back) to the left and is hit from behind by a vehicle traveling in that lane.
110	A vehicle is traveling in a one-way street and in the wrong direction when another vehicle is coming in front.
111	The vehicle swerves to the right, swerves left, bites the left shoulder, swerves right and collides with the oncoming vehicle
112	A vehicle changes lane to the right and hits the vehicle that was traveling in that lane from behind.
113	A vehicle changes lane to the left and hits a vehicle in that lane from behind.
114	A vehicle changes lanes to the left while the vehicle in front changes lanes to the right.
115	A vehicle changes lanes to the right while the vehicle in front changes lanes to the left.
116	Vehicle hit from behind then leaving the roadway on the right with a 2nd impact.
117	Vehicle hit from the rear then leaving the roadway on the left with a 2nd impact.
199	Véhicule vs Véhicule Autres cas

*b. Class 200: overtaking accidents*

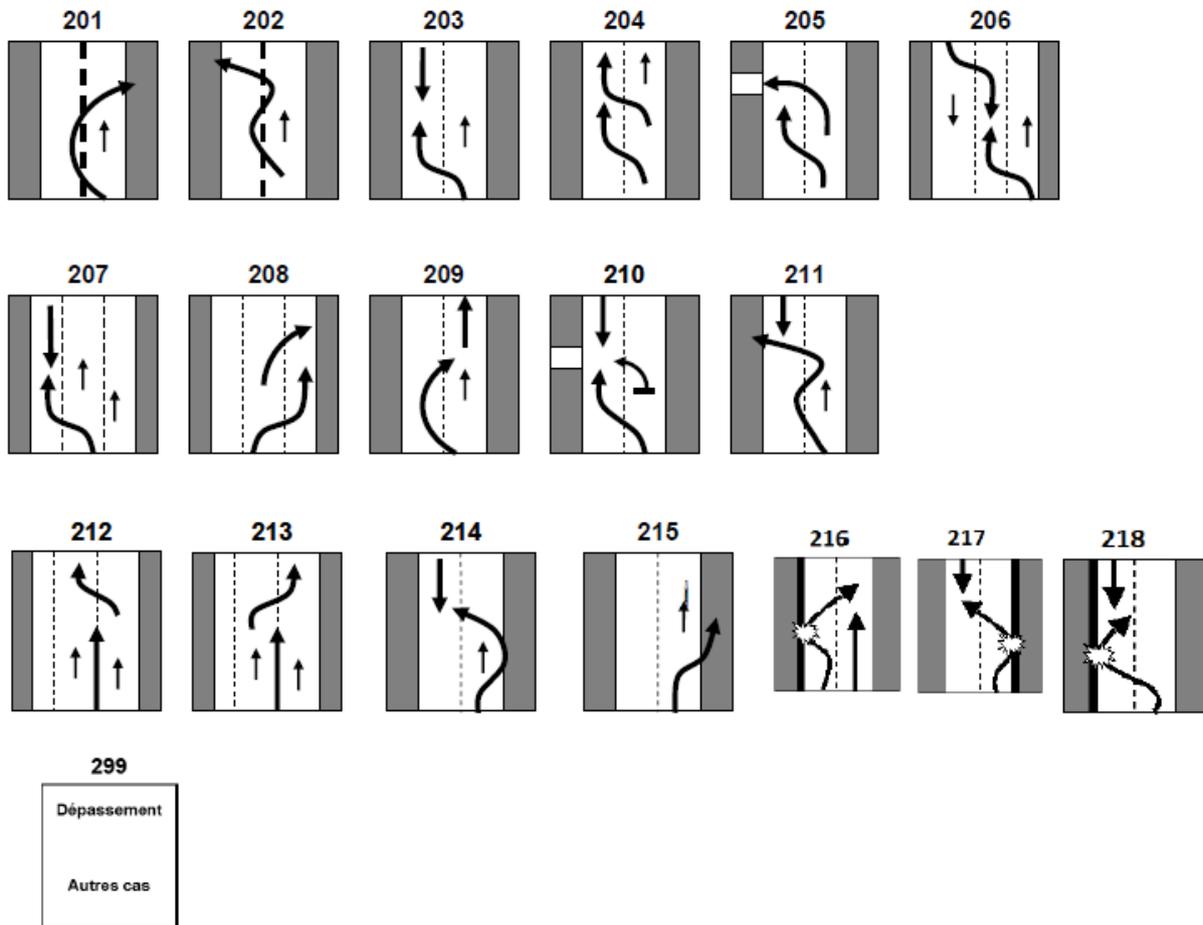


Figure 15: Overtaking accidents

201	A vehicle overtakes another vehicle and loses control during its downturn.
202	A vehicle overtakes another vehicle and loses control during the overtake.
203	A vehicle overtakes a vehicle and hits another oncoming vehicle.
204	A vehicle decides to overtake when an overtaking vehicle arrives behind itself.
205	A vehicle overtakes a vehicle that decides to turn left.
206	Collision between two vehicles passing simultaneously on a variable-direction lane
207	A vehicle decides to overtake in 3 <sup>rd</sup> position when another vehicle arrives in the opposite direction.
208	A vehicle overtakes on the right a vehicle that decides to fall back or turn right.
209	An overtaking vehicle folds over and collides with the vehicle in front.
210	A vehicle overtakes a stopped vehicle to turn left and collides with an oncoming vehicle.
211	A vehicle overtakes another vehicle and loses control during the overtake and hits the oncoming vehicle.
212	A vehicle goes up the queues and hits a vehicle that is changing lanes to the left.
213	A vehicle goes up the lanes and hits a vehicle changing lanes to the right.
214	A vehicle overtakes on the right, loses control in its drawdown phase and collides with an oncoming vehicle
215	A vehicle overtakes on the right and collides with a parked vehicle

216	Vehicle swerves to the left, followed by a first impact then crosses the road to the right with a 2nd impact with another vehicle.
217	Vehicle swerves to the right, followed by a first impact then crosses the road to the left with a 2nd impact with another vehicle.
218	Vehicle swerves to the left, followed by a first impact then crosses the roadway to the right with a 2nd impact with another vehicle coming in the opposite direction.
299	Other case of overtaking accidents

*c. Class 300: intersection accidents*

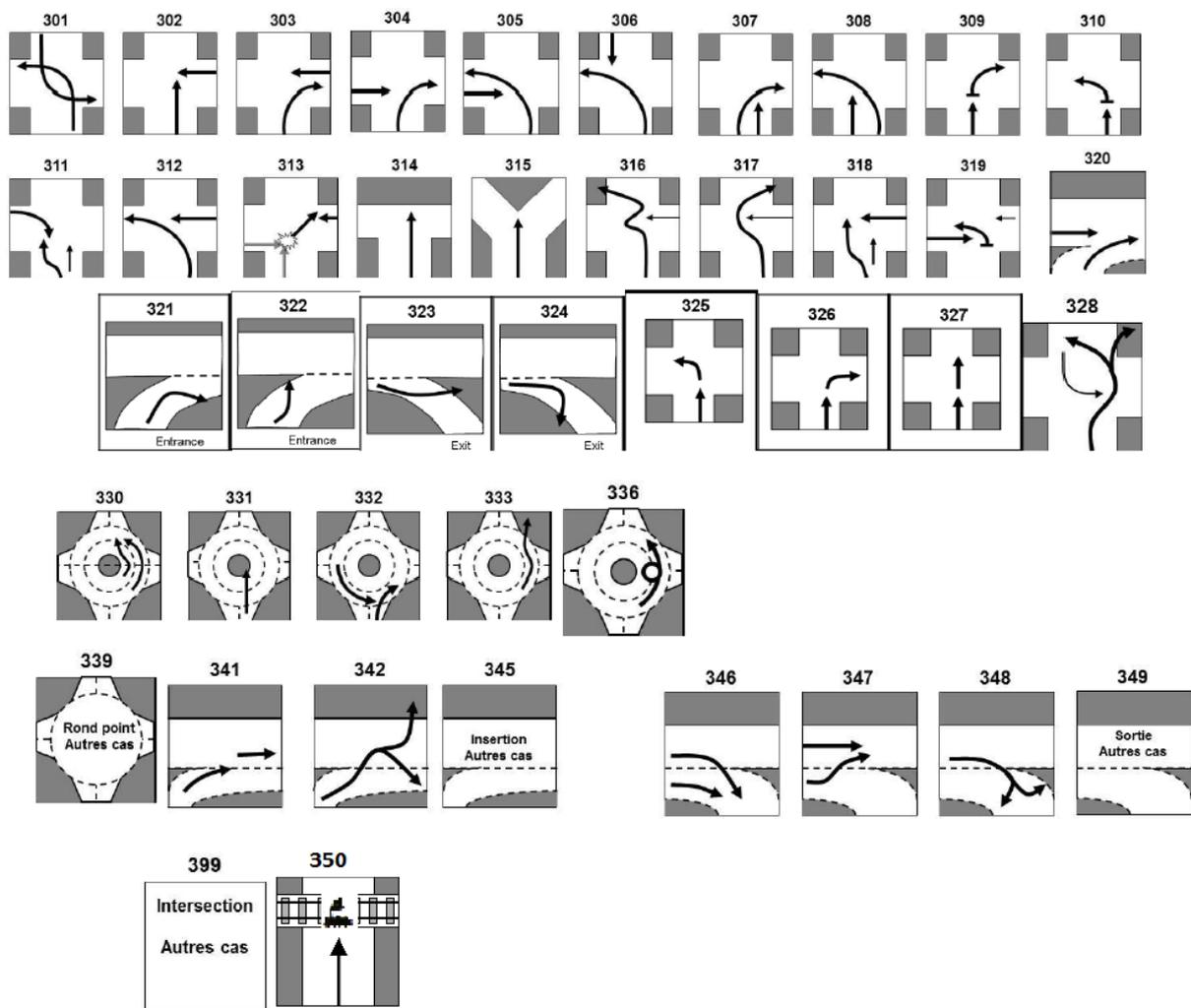


Figure 16: Intersection accidents

301	Intersection accident; 2 vehicles turning right and coming from opposite directions.
302	Intersection accident; 2 vehicles going straight (or we do not know where the vehicles are going) and coming from perpendicular directions.
303	Intersection accident; 2 vehicles coming from perpendicular directions, one coming from the right and going straight and the other turning right.
304	Intersection accident; 2 vehicles coming from perpendicular directions, one coming from the left and going straight and the other turning right.
305	Intersection accident; 2 vehicles coming from perpendicular directions, one coming from the left and going straight and the other turning left.
306	Intersection accident; 2 vehicles coming from opposite directions, one going straight and the other turning left.

307	Intersection accident; 2 vehicles coming from the same direction, of which the leftmost vehicle decides to turn right cutting off the road from the other.
308	Intersection accident; 2 vehicles coming from the same direction, of which the rightmost vehicle decides to turn left cutting the road of the other.
309	Front-to-rear accident at intersection; the first vehicle turning right stops to let another user pass while the second vehicle arrives behind it.
310	Front-to-rear accident at intersection; the first vehicle turning left stops to let another user pass while the second vehicle arrives behind it.
311	Intersection accident; 2 vehicles coming from perpendicular directions, one of which coming from the left turns right and the other in passing goes straight.
312	Intersection accident; 2 vehicles coming from perpendicular directions, one coming from the right and going straight and the other turning left.
313	Over-accident at an intersection.
314	T-intersection accident; the vehicle is going straight.
315	Y-intersection accident; the vehicle is going straight.
316	Intersection accident; 2 vehicles coming from perpendicular directions, one of which is losing control.
317	Intersection accident; 2 vehicles coming from perpendicular directions of which one of the two performs an avoidance.
318	Intersection accident; 2 vehicles coming from perpendicular directions, one coming from the right and going straight and the other overtaking going straight.
319	Intersection accident; 2 vehicles coming from perpendicular directions, one of which arriving from the right and turning right stops in the middle of the intersection to let other users pass.
320	Entrance ramp accident: A vehicle coming from the entrance ramp is hit from behind by another vehicle.
321	Accident on the entrance ramp: a vehicle coming from the entrance ramp lost control and exited on the right of the roadway.
322	Accident on the entrance ramp: a vehicle coming from the entrance ramp lost control and exited on the left of the road.
323	Accident on exit ramp: a vehicle entering the exit ramp loses control and exits on the left side of the road.
324	Accident on the exit ramp: a vehicle entering the exit ramp loses control and exits on the right of the roadway.
325	Front-to-rear accident at intersection; the first vehicle turns left as the second vehicle comes up behind it.
326	Front-to-rear accident at intersection; the first vehicle turns right as the second vehicle comes up behind it.
327	Front-to-rear accident at intersection; the first vehicle goes straight while the second vehicle comes up behind it.
328	Intersection accident: 2 vehicles coming from opposite directions, one of which is avoiding.
330	Accident on a roundabout: the vehicle traveling on the inner ring decides to exit the roundabout while another vehicle is on the outer ring.
331	Accident on a roundabout: a vehicle arrives too quickly on a roundabout and goes straight.
332	Accident on a roundabout: a vehicle enters the roundabout while a priority vehicle arrives on its left.
333	Accident on a roundabout: loss of control of a vehicle traveling in the roundabout.
336	Accident on a roundabout: overturning of a vehicle traveling in the roundabout (generally heavy goods vehicles).
339	Accident on a roundabout; other configurations.
341	Accident on entrance ramp; a vehicle coming from the entrance ramp collides with the rear of another vehicle.
342	Accident on entrance ramp; loss of control of a vehicle coming from the entrance ramp.
345	Accident on entrance ramp; other crash configurations.
346	Accident on exit ramp; a vehicle decides at the last moment to take the exit ramp while another vehicle is traveling there.

347	Accident on exit ramp; a vehicle using the exit ramp decides at the last moment to return to the traffic lane when another vehicle arrives.
348	Accident on exit ramp; loss of control of a vehicle using the exit ramp.
349	Accident on exit ramp; other crash configurations.
350	Collision with a rail vehicle.
399	Other cases of accidents at intersections.

*d. Class 400: accidents with a vehicle leaving its parking place being parked or entering or leaving a private road, garage*

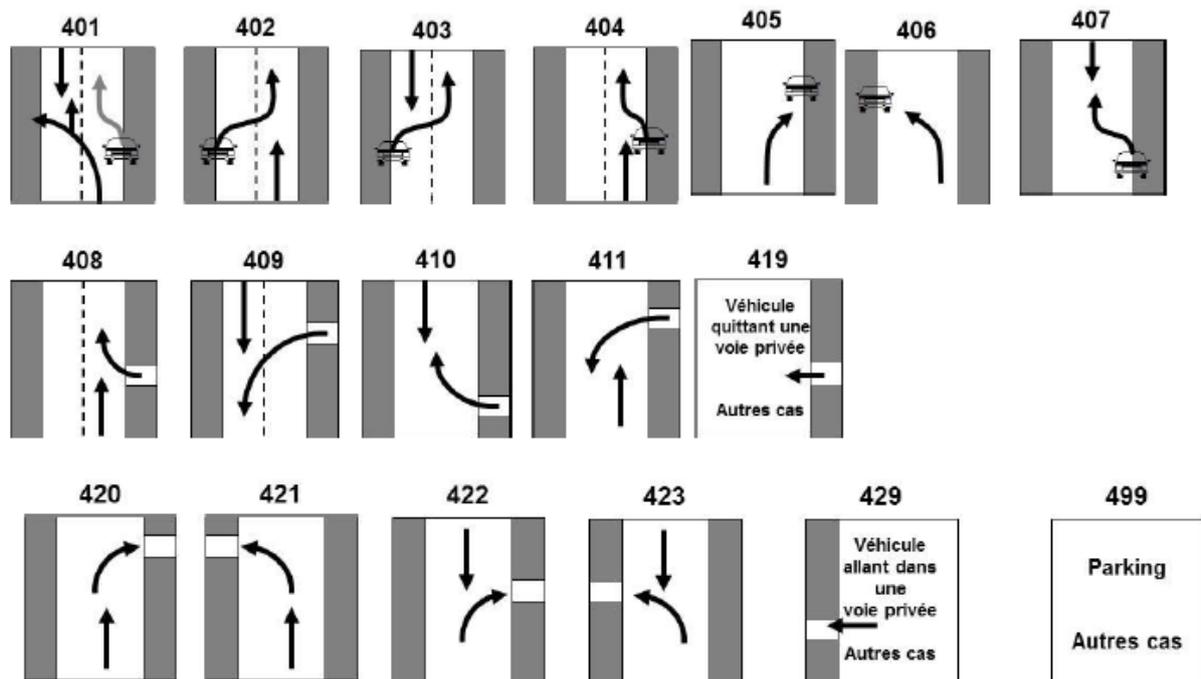


Figure 17: Accidents with a vehicle leaving its parking place being parked or entering or leaving a private road, garage

401	A vehicle surprised by the start of a parked vehicle on its side of traffic, makes an avoidance.
402	Vehicle parked on the left and leaving its parking place is hit by a vehicle arriving behind it.
403	Vehicle parked on the left and leaving its parking place is hit by a vehicle coming in front.
404	Vehicle parked on the right and leaving its parking place is hit by a vehicle arriving behind it.
405	Accident against a vehicle parked on the right.
406	Accident against a vehicle parked on the left.
407	Vehicle parked on the right and leaving its parking place is hit by a vehicle coming from opposite.
408	Vehicle leaving a private road or a garage and turning right is struck by a vehicle coming from its left.
409	A vehicle coming out of a private road or a left-turning garage is struck by a vehicle coming from its right.
410	Vehicle leaving a private road or a garage and turning right is struck by a vehicle coming from its right.
411	Vehicle leaving a private road or a left-turning garage is struck by a vehicle coming from its left.
419	Vehicle leaving a private road or a garage; other setups.
420	Vehicle entering a private road or a garage on the right is struck by a vehicle traveling behind it.
421	Vehicle entering a private road or a garage on the left is struck by a vehicle traveling behind it.
422	Vehicle entering a driveway or garage on the right is struck by a vehicle traveling in the opposite direction.

423	Vehicle entering a private road or a garage on the left is struck by a vehicle traveling in the opposite direction.
429	Vehicle entering a private road or garage; other setups.
499	Other cases of accidents with vehicle leaving or being parked.

e. Class 500: single vehicle accidents involved in current section

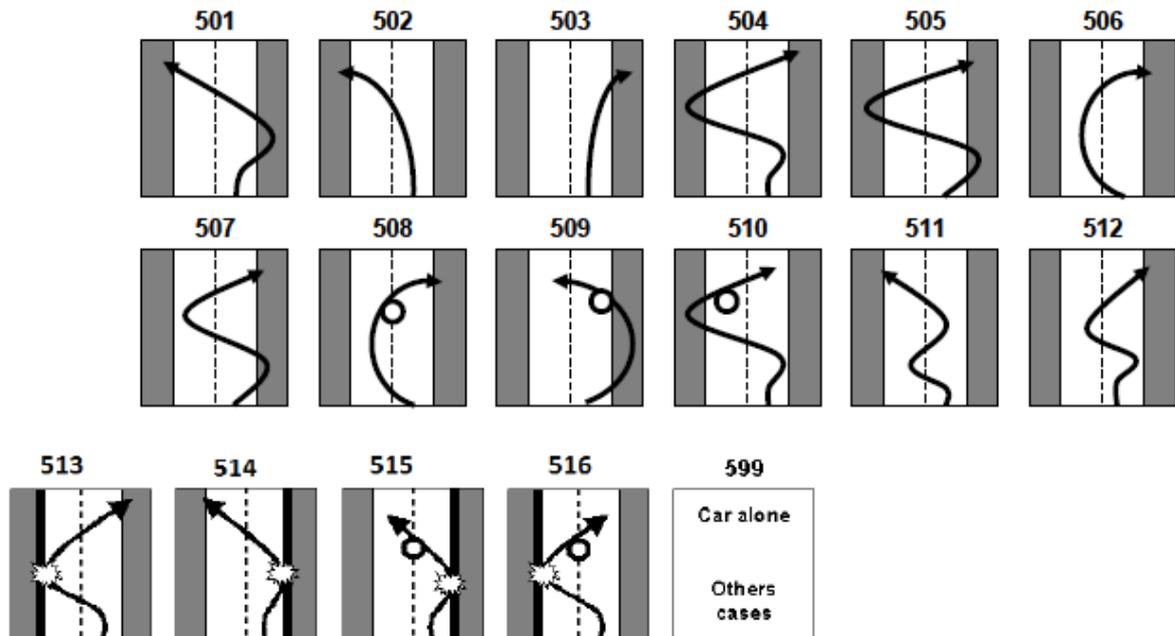


Figure 18: Single vehicle accidents in current section

501	The only vehicle leaves the roadway on the left after biting the right shoulder.
502	Single vehicle involved with lane departure on the left.
503	Single vehicle involved with lane departure on the right.
504	Single vehicle in question with exit from the lane on the right after biting the shoulder on the left.
505	The only vehicle involved left the lane on the right after biting the 2 shoulders (regardless of the order).
506	The only vehicle involved bites into the opposite lane and exits to the right.
507	Single vehicle in question with exit from the lane on the right after biting the right-hand shoulder.
508	Single vehicle involved with lane departure on the right after a primer or a rollover on the road.
509	Single vehicle with lane departure on the left after biting the right shoulder followed by a primer or a barrel roll on the road.
510	Single vehicle involved with leaving the lane on the right after biting the left shoulder followed by a bait or a barrel roll on the road.
511	Single vehicle involved with lane departure to the left after a succession of zigzags on the road.
512	Single vehicle involved with lane departure to the right after a succession of zigzags on the road.
513	The only vehicle swerves to the left, followed by a first impact then crosses the roadway to the right with a 2nd impact.
514	The only vehicle swerves to the right, followed by a first impact then crosses the roadway to the left with a 2nd impact.
515	The only vehicle swerves to the right, followed by a first impact then crosses the road to the left with a rollover.
516	The only vehicle swerves to the left, followed by a first impact then crosses the road to the right with a rollover.

599	Other cases of accidents with a single vehicle involved.
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*f. Class 600: accidents with a vehicle losing control following a 1<sup>st</sup> impact (excluding rollovers)*

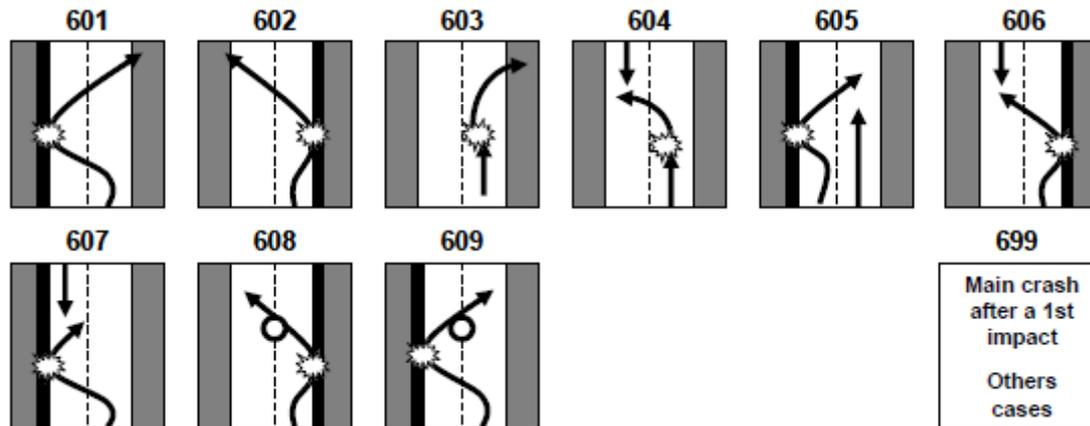


Figure 19: Accidents with a vehicle losing control following a 1<sup>st</sup> impact (excluding rollovers)

601	The only vehicle swerves to the left, followed by a first impact then crosses the roadway to the right with a 2 <sup>nd</sup> impact.
602	The only vehicle swerves to the right, followed by a first impact then crosses the roadway to the left with a 2 <sup>nd</sup> impact.
603	Vehicle hit from behind then exiting the roadway on the right with a 2 <sup>nd</sup> impact.
604	Vehicle hit from behind then leaving the roadway on the left with a 2 <sup>nd</sup> impact.
605	The only vehicle swerves to the left, followed by a first impact then crosses the roadway to the right with a 2 <sup>nd</sup> impact with another vehicle.
606	The only vehicle swerves to the right, followed by a first impact then crosses the roadway to the left with a 2 <sup>nd</sup> impact with another vehicle.
607	The only vehicle swerves to the left, followed by a first impact then crosses the roadway to the right with a 2 <sup>nd</sup> impact with another vehicle coming in the opposite direction.
608	The only vehicle swerves to the right, followed by a first impact then crosses the road to the left with a rollover.
609	The only vehicle swerves to the left, followed by a first impact then crosses the road to the right with a rollover.
699	Other cases of accidents with several violent impacts.

*g. Class 700: other types of accidents*

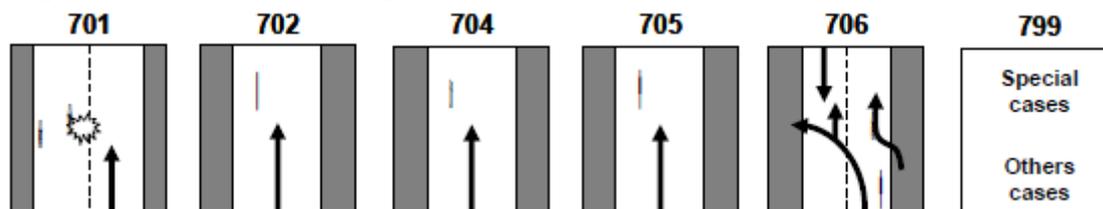


Figure 20: Other accident typologies

701	Chain crashes.
702	Fixed obstacle on the roadway.
704	Collision with an animal
705	Collision with pedestrian (before creation of category 800)

706	Collision with avoidance of a pedestrian (before classification 800)
799	Other types of accidents

*h. Class 800: accidents with a pedestrian*

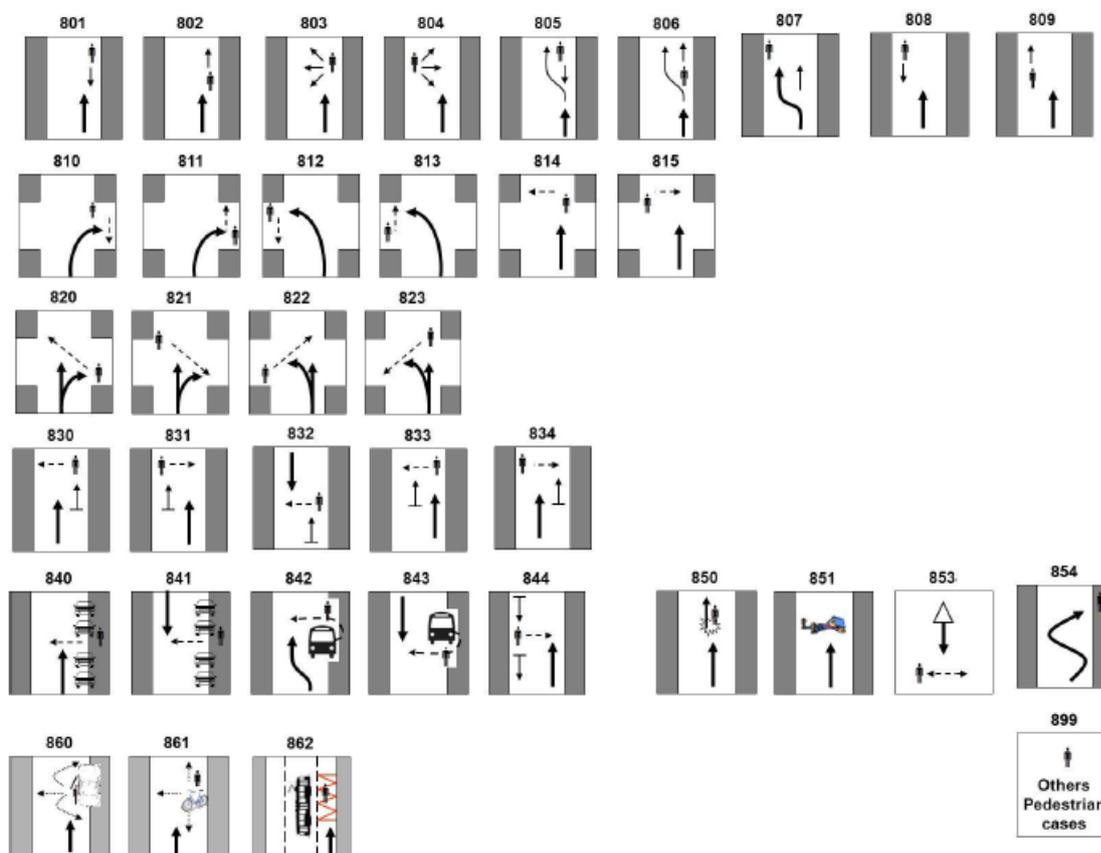


Figure 21: Accidents with a pedestrian

801	Pedestrian facing along the path of the vehicle.
802	Pedestrian from behind following the path of the vehicle.
803	Pedestrian crossing the road from right to left.
804	Pedestrian crossing the road from left to right.
805	Pedestrian in front following the trajectory of the vehicle hidden by a vehicle traveling in front.
806	Pedestrian from behind following the trajectory of the vehicle hidden by a vehicle traveling in front.
807	Pedestrian following the path of the vehicle struck by an overtaking vehicle.
808	Pedestrian in front following the trajectory of the vehicle on the opposite lane.
809	Rear pedestrian following the trajectory of the vehicle on the opposite lane.
810	Pedestrian in intersection; vehicle turns right with pedestrian crossing on a perpendicular axis from left to right.
811	Pedestrian in intersection; vehicle turns right with pedestrian crossing on a perpendicular axis from right to left.
812	Pedestrian in intersection; vehicle turns left with pedestrian crossing on a perpendicular axis from right to left.
813	Pedestrian in intersection; vehicle turns left with pedestrian crossing on a perpendicular axis from left to right.
814	Pedestrian in intersection; vehicle going straight with pedestrian crossing after the intersection from right to left.

815	Pedestrian in intersection; vehicle going straight with pedestrian crossing after the intersection from left to right.
820	Pedestrian in intersection; pedestrian crossing diagonally with a trajectory going from bottom right to top left.
821	Pedestrian in intersection; pedestrian crossing diagonally with a trajectory going from top left to bottom right.
822	Pedestrian in intersection; pedestrian crossing diagonally with a trajectory going from bottom left to top right.
823	Pedestrian in intersection; pedestrian crossing diagonally with a trajectory going from top right to bottom left.
830	Pedestrian crossing from right to left and hit by the vehicle traveling in the left lane with the presence of a vehicle in the right lane stopped or decelerating to let the pedestrian pass.
831	Pedestrian crossing from left to right and struck by the vehicle traveling in the right lane with the presence of a vehicle in the left lane stopped or decelerating to let the pedestrian pass.
832	Pedestrian crossing from left to right with the presence of a vehicle on the opposite lane stopped or decelerating to let the pedestrian pass.
834	Pedestrian crossing from left to right and hit by the vehicle traveling in the left lane with the presence of a vehicle in the right lane stopped or decelerating to let the pedestrian pass.
835	Pedestrian crossing from right to left and hit by the vehicle traveling in the right lane with the presence of a vehicle in the left lane stopped or decelerating to let the pedestrian pass.
840	Pedestrian crossing from right to left initially masked by parked vehicles and hit by a vehicle coming from his left.
841	Pedestrian crossing from left to right initially masked by parked vehicles and hit by a vehicle coming from his right.
842	Pedestrian crossing from right to left descending or initially masked by a stationary bus.
843	Pedestrian crossing from left to right descending or initially masked by a stationary bus.
844	Pedestrian crossing from left to right initially hidden by vehicles stopped in traffic.
850	Pedestrian lying on the ground having previously been hit by another vehicle.
851	Pedestrian lying or stretched out on the roadway (generally alcoholic pedestrian).
853	Pedestrian struck by a reversing vehicle.
854	Pedestrian struck by a vehicle losing control.
860	Change of mode: Pedestrian descending or ascending in his vehicle.
861	Change of mode: Pedestrian descending, ascending or pushing his 2 wheels.
862	Pedestrian hit while getting off a tram running on the central axis.
899	Other configurations involving a pedestrian.

## Appendix 5 – Participants in the scenario working group

This methodological document was drafted within the framework of the working group on scenarios co-directed by the DGITM and the IRT SystemX, with the participation of the members listed in the following table.

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