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# Road vehicles — Test scenarios for automated driving systems — Scenario categorization

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# National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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International Standard

# ISO 34504

# Road vehicles — Test scenarios for automated driving systems — Scenario categorization

*Véhicules routiers — Scénarios d'essai pour les systèmes de conduite automatisée — Catégorisation des scénarios*

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# Foreword

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This document was prepared by Technical Committee ISO/TC *22*, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics, chassis components and driving automation systems testing*.

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# Introduction

Test and verification of automated driving systems (ADS) is one of the main challenges for the introduction of ADS into the market. Scenario-based testing is an approach for prospective verification of ADS that is broadly supported in the automotive field. It is expected that many test scenarios will be used to conduct the validation and verification of ADS, e.g. see ISO 34502. It is common practice to use some form of categorization of the scenarios.

The goal of this document is to propose a way to categorize scenarios. Scenario databases, such as the German In-Depth Accident Study (GIDAS)[2], the Community database on Accidents on the Roads in Europe (CARE)[3], the Initiative for the GLobal harmonization of Accident Data (IGLAD)[4], road safety from the government of the United Kingdom[5], and the National Automotive Sampling System (NASS) General Estimates System (GES) from the United States[6], already contain categories, but these categories are generally not shared among different databases. This document provides a method to harmonize the way scenarios are categorized. To enable the scenario categorization, “tags” are defined as meta-attributes that provide an additional source of information for each of the scenarios. A scenario category is defined using tags, such that all scenarios that share the same tags are considered to belong to that scenario category.

NOTE This document does not provide a hierarchical structure for the scenarios. There are many ways to provide a hierarchical structure and there is no best way to do this. For example, scenarios can be structured based on the road layout or based on the driving behaviour of a vehicle. The most suitable way to structure the scenarios depends on the application.

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# Road vehicles — Test scenarios for automated driving systems — Scenario categorization

## 1 Scope

This document defines an approach for the categorization of scenarios by providing tags that carry information about the scenarios.

This document is applicable to SAE level 3 to SAE level 5 Automated Driving System (ADS)[19].

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 34501, *Road vehicles — Test scenarios for automated driving systems — Vocabulary*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 34501 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

## 4 Categorization

### 4.1 Objectives

The objective of this clause is to provide a way to categorize scenarios.

### 4.2 General

A scenario category refers to a set of scenarios that share one or more characteristics. Tags are attached to a scenario for the purpose of categorizing the scenarios. A given scenario is part of a scenario category if all tags of the scenario category are also part of the tags that are applicable to the given scenario. Scenario categories do not need to be mutually exclusive. A standardized set of tags for defining scenario categories makes sharing and transferring scenario (categories) between different entities easier.

Scenario categorization can be used to structure the test cases for ADS. Another application of scenario categorization is the scenario assignment for the assessment of ADS within a given Operational Design Domain (ODD) because it might be easier to relate an ODD to scenario categories instead of relating an ODD to all possible scenarios. Scenario categorization can also be used to select scenarios from a scenario database or scenario library by using tags or a combination of tags.

In some cases, there is a need of having generic scenario categories – and thus a wide variety among the scenarios belonging to the scenario category – and, in other cases, there is a need of having specific scenario categories without much variety among the scenarios in the scenario category. For some systems, one may be interested in a very specific set of scenarios, while for another system one might be interested in a set

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of scenarios with a high variety. To accommodate this, tags can be structured in hierarchical trees. The different layers in a tree can be regarded as different abstraction levels.

If the provided tags do not adequately represent a specific characteristic of a scenario, stakeholders may extend the provided tags. This applies to tags that provide a more specific description of a characteristic described by one of the tags of this clause. It may also apply to tags that describe a characteristic of a scenario that is not addressed in this document.

The actual implementation of the tags into a specification is out of scope of this document. Stakeholders may choose to support, for example, scenario hierarchy whereby a specific scenario (category) inherits tags from another scenario (category). It is also possible to combine tags of the same level to create a new scenario category, e.g. a definition of a scenario category that includes the wind tag “light breeze”, “gentle breeze”, “moderate breeze”, or “fresh breeze”.

## 4.3 Inputs to this clause

### 4.3.1 Informative references

a) ISO 34502[1]

b) ISO 34503 [7]

c) ASAM OpenLABEL[8]

d) Scenario Categories for the Assessment of Automated Vehicles[9]

e) Proposal for a second iteration of the New Assessment/Test Method for Automated Driving – Master Document, ECE/TRANS/WP.29/GRVA/2022/2[10]

f) HEADSTART deliverable on the integration of simulation and physical testing[11]

## 4.4 Requirements and recommendations

### 4.4.1 General

A scenario category shall be defined by a collection of tags, where this collection contains one or multiple tags. A scenario category shall comprise scenarios for which these tags are applicable. A scenario category Y shall include a scenario category X if this scenario category X contains the same (structure of) tags as this scenario category Y.

NOTE 1 This implies that if scenario category X includes scenario category Y, then scenario category X comprises all scenarios that scenario category Y comprises.

EXAMPLE Figure 1 illustrates this, where three scenario categories are shown:

a) the red circle denotes the scenario category with the tag “daytime”;

b) the green circle denotes the scenario category with the tag “heavy rain”;

c) the overlap of the red and green circles denotes the scenario category with the tags “daytime” and “heavy rain”.

In this example, let X be the scenario category with tags “daytime” and “heavy rain” and let Y be the scenario category with the tag “daytime”. Since X contains the same tag as Y, Y includes X. Figure 1 illustrates this, as Y (the circle with tag “daytime”) fully overlaps the area that represents X (the intersection area of both circles). As a result, both the X and Y comprise the scenario occurring at daytime with heavy rain, i.e. Y comprises all scenarios of X.

NOTE 2 Figure 1 is simplified in the sense that there are typically many other characteristics considered for categorizing scenarios.

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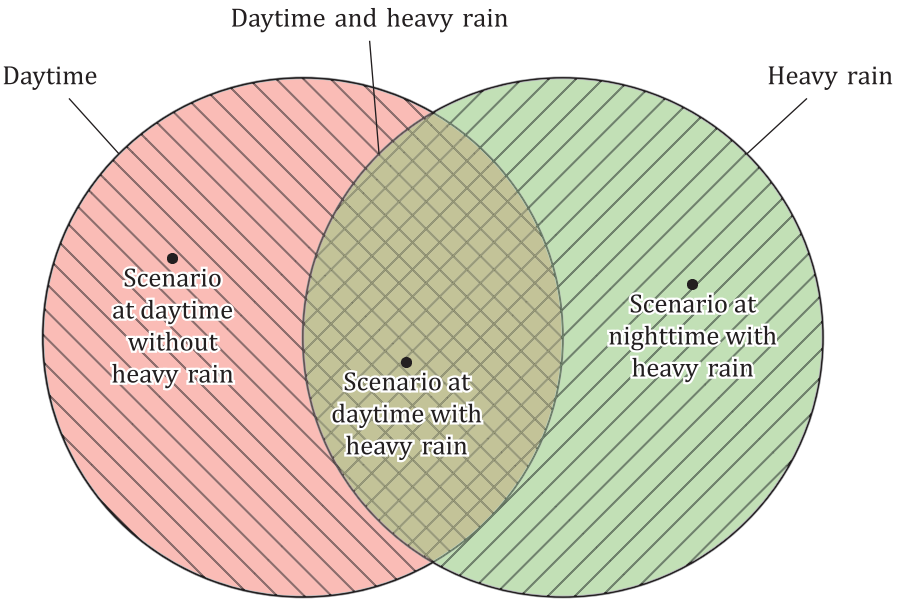


**Figure 1 — An example of a relation between scenarios and scenario categories**

In addition to tags, the scenario attributes can be used for allocating the scenarios into scenario categories. In that case, a scenario attribute shall be considered as equivalent to a tag. For example, a scenario that contains heavy rain can be categorized into the scenario category "heavy rain" even though the scenario does not contain the tag "heavy rain".

### 4.4.2 Purpose of tags

The tags of a scenario contain information about the scenario. In order to indicate the purpose of a tag, the kind of information the tag provides shall be indicated. A tag shall address a range of topics, including but not limited to:

a) dynamic entities;

b) scenery elements;

c) environmental conditions;

d) additional information of a scenario;

e) intended test usage.

NOTE 1 Figure 2 visualizes the different groups of tags.

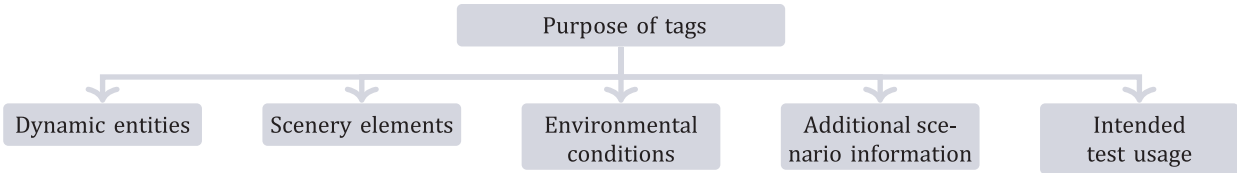


**Figure 2 — Groups of tags**

NOTE 2 In most cases, the purpose of the tags is to provide qualitative information. Stakeholders can specify more details regarding the quantification of tags. For example, the tag "faster" can be applied to a dynamic entity that is moving "faster" than the subject vehicle. The exact meaning of "faster" is not further specified in this document. A stakeholder can choose to apply the tag if the dynamic entity is moving at a higher speed than the subject vehicle, but it can also, for example, apply the tag only when a dynamic entity is moving with a speed faster than 1 m/s for a duration of at least 1 s.

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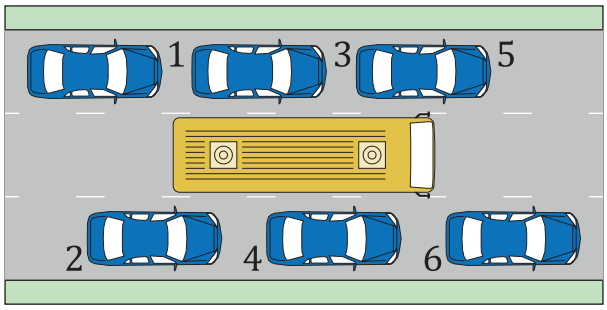
NOTE 3 To illustrate that the meaning of the tags can be ambiguous, consider the tag "in front of subject", which is used to indicate that a dynamic entity is in front of the subject vehicle. Consider the bus in Figure 3 as the subject vehicle. Clearly, the tag "in front of subject" does not apply to the left-most car, indicated with the label "car 1", of Figure 3. However, for "car 6", the tag applies, since this passenger car is fully in front of the subject vehicle. For the remaining four passenger cars, it depends on how "in front of" is defined. For example, the front of "car 2" is behind the front of the bus, but the front of "car 2" is in front of the rear of the bus. The rear of "car 3" is in front of the rear of the bus. Similarly, the centre of "car 4" is ahead of the centre of the bus and the front of "car 5" is in front of the bus.




**Key**

1 car 1
2 car 2
3 car 3
4 car 4
5 car 5
6 car 6

**Figure 3 — A bus and six passenger cars; it is unclear which cars are in front of the bus**

### 4.4.3 Extension of tags and trees of tags

The tags shall be structured into trees and each layer shall represent a different abstraction level. If a scenario category contains a tag at a certain level, all the lower-level tags may be applicable.

Stakeholders may extend the list of tags if those tags that are specified do not adequately describe a scenario characteristic. While the tags are extensible, any extension which conflicts with the specified tags shall be avoided.

NOTE Even if tags are at the same layer in the same tree of tags, they do not need to be mutually exclusive.

### 4.4.4 Tags for a dynamic entity

For a dynamic entity, the tags shall address:

a) road user type;

b) longitudinal action;

c) lateral action;

d) mixed action;

e) state or initial state;

f) role of a dynamic entity with respect to the subject vehicle;

g) enhancing conspicuity;

h) visibility;

i) collision information.

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If, for a dynamic entity, no tags are mentioned for one or more of the aforementioned items, it shall be assumed that any of the tags of that item may be or may not be applicable for the scenarios that the scenario category comprises.

EXAMPLE A dynamic entity of a scenario category only contains tags for the “road user type”. As a result, the scenarios that the scenario category comprises contain at least one dynamic entity with the tags for the “road user type” as specified and this dynamic entity can contain any tag related to “longitudinal action”, “lateral action”, etc.

#### 4.4.4.1 Road user type

At the top level, the tags for the road user type should be:

a) vehicle;

b) pedestrian;

c) cyclist;

d) animal;

e) inanimate obstacle.

To further specify a vehicle, the following tags can be used:

— passenger car;

— bus;

— school bus;

— truck;

— tram;

— goods vehicle;

— dangerous goods vehicle;

— long, large vehicle;

— vehicle transporting protruding cargo;

— vehicle towing trailers;

— vehicle towing combination trailers;

— special convoy, slow-moving vehicle;

— caravan/recreational vehicle, including towing trailers;

— agricultural vehicle;

— fire truck;

— ambulance;

— police vehicle;

— rescue vehicle;

— street sweeper;

— road sprinkler;

— training car;

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— crane, Non-Road Mobile Machinery (NRMM);

— other automated/connected (V2V) vehicle;

— disabled (broken-down) vehicle.

To further specify a pedestrian, the following tags can be used:

— child;

— adult;

— person with disabilities;

— hearing-impaired pedestrian;

— visually-impaired pedestrian;

— road-works crew;

— police officer (on foot);

— person directing traffic;

— person pushing stroller;

— person in wheelchair;

— motorists on the roadside (e.g. person next to stranded vehicle, changing tire).

To further specify a cyclist, the following tags can be used:

— bicyclist;

— e-Bike user;

— skater (roller, skateboard);

— motorcycle;

— moped/scooter;

— powered three-wheeler;

— quadricycle;

— self-balancing scooter.

To further specify an animal, the following tags can be used:

— small size animal;

— medium size animal;

— large size animal.

To further specify an inanimate obstacle, the following tags can be used:

— stationary vehicle;

— debris;

— construction equipment;

— moving obstacle.

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NOTE 1 Figure 4 visualizes the tree of tags for the road user type.

NOTE 2 The tags for the road user type are based on ongoing VMAD/FRAV UNECE discussions in the Other Road User workstream[12].

NOTE 3 A moving obstacle can refer to blowing debris like a tumbleweed or a plastic tarp.

NOTE 4 A disabled (broken-down) vehicle can have its emergency lights on, and an emergency triangle can be located behind this vehicle. A stationary vehicle can refer to a parked vehicle.

NOTE 5 For categorizing animals based on their size, the tag “small size animal” can apply to animals shorter and thinner than 0,5 m, while animals larger or wider than 1 m can be tagged with “large size animal”. All other animals are then tagged with “medium size animal”.

NOTE 6 A combination of the tags is also possible, e.g. both “passenger car” and “disabled (broken-down) vehicle" can apply.

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**Figure 4 — Tree of tags for the road user type**

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#### 4.4.4.2 Longitudinal action

At the top level, the tags for the longitudinal action should be:

a) standing still;

b) driving forward;

c) reversing.

To further specify driving forward and reversing, the following tags can be used:

— decelerating;

— keeping speed;

— accelerating.

NOTE 1 The longitudinal action refers to the behaviour of a dynamic entity in the direction in which the dynamic entity is travelling.

NOTE 2 Figure 5 visualizes the tree of tags for the longitudinal action.

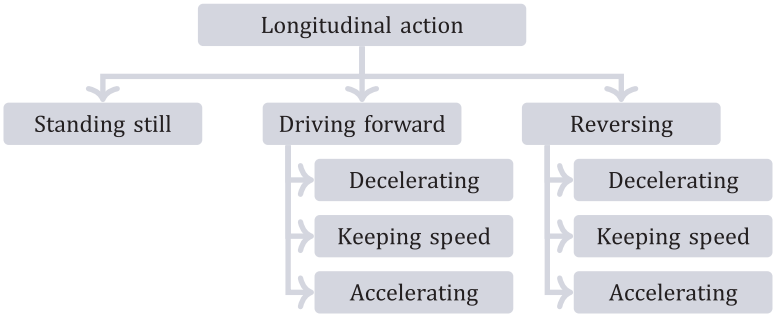


**Figure 5 — Tree of tags for the longitudinal action**

#### 4.4.4.3 Lateral action

At the top level, the tags for the lateral action should be:

a) following lane;

b) changing lane;

c) turning;

d) swerving;

e) other.

NOTE 1 The lateral action refers to the direction perpendicular to the direction of travel of the dynamic entity. The tag “following lane” is applicable if the dynamic entity stays in its lane. When a dynamic entity changes lane to an adjacent lane, the tag “changing lane” is applicable. The tag “turning” is applicable if the dynamic entity turns. The tag “swerving” is applicable if the dynamic entity moves partly into its adjacent lane without performing a lane change. The tag “other” can be applicable if the dynamic entity performs manoeuvres that are not necessarily related to a lane, such as parking.

To further specify changing lane, the following tags can be used:

a) left;

b) right;

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c) double left;

d) double right.

To further specify turning, the following tags can be used:

— left;

— right;

— left U-turn;

— right U-turn.

To further specify swerving, the following tags can be used:

— left;

— right.

NOTE 2 Figure 6 visualizes the tree of tags for the lateral action.

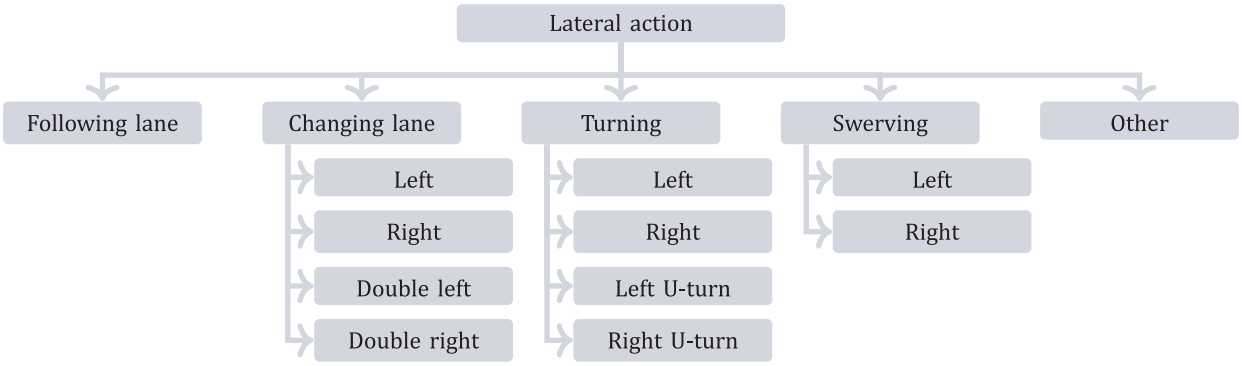


**Figure 6 — Tree of tags for the lateral action**

#### 4.4.4.4 Mixed action

At the top level, the tag for the mixed action should be:

a) Parking manoeuvre.

NOTE 1 Tags that describe a mixed action can be used to describe combinations of actions that cannot easily be categorized as a longitudinal action, a lateral action, or a combination of these.

NOTE 2 Figure 7 visualizes the tree of tags for the mixed action.

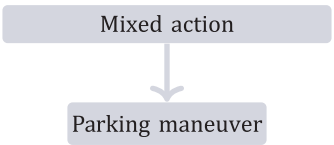


**Figure 7 — Tree of tags for the mixed action**

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#### 4.4.4.5 State or initial state

Tags describing the state or the initial state relative to the subject vehicle(s) shall only be used for dynamic entities other than the subject vehicle(s). In case the scenario does not contain a subject vehicle, the state relative to the subject vehicle(s) shall not be described for a dynamic entity.

NOTE 1 The initial state of the subject vehicle(s) can be described if its behaviour is not described.

At the top level, the tags for the (initial) state should address:

a) (initial) longitudinal position;

b) (initial) lateral position;

c) (initial) direction;

d) (initial) relative speed.

The tags for the (initial) longitudinal position can be:

— in front of the subject vehicle(s);

— beside the subject vehicle(s);

— behind the subject vehicle(s).

At the top level, the tags for the (initial) lateral position can be:

— in the same lane as the subject vehicle(s);

— to the left of the subject vehicle(s);

— to the right of the subject vehicle(s).

To further specify left or right of the subject vehicle, the following tags can be used:

— in the adjacent lane;

— next to the adjacent lane.

At the top level, the tags for the (initial) direction can be:

— similar to the subject vehicle(s);

— oncoming;

— crossing.

To further specify crossing, the following tags can be used:

— from left;

— from right;

— from far side;

— from near side.

NOTE 2 The tag “from left” is used for a dynamic entity whose direction of travel is approximately perpendicular to the direction of travel of the subject vehicle and the heading direction (direction from the rear of dynamic entity to the front) is towards the right. Similarly, the tag “from right” is used for a dynamic entity whose direction of travel is approximately perpendicular to the direction of travel of the subject vehicle and the heading direction (direction from the rear of dynamic entity to the front) is towards the left. The tag “from far side” is used for a dynamic entity for which “from left” (“from right”) applies in right-hand traffic (left-hand traffic) and the tag “from near side” is used for a dynamic entity for which the tag “from right” (“from left”) applies in right-hand traffic (left-hand traffic).

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