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Road vehicles — Test scenarios for automated driving systems — Vocabulary

Véhicules routiers — Scénarios d'essai pour les systèmes de conduite automatisée — Vocabulaire

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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 and chassis components*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Automated driving systems (ADS) combine a variety of sensors to perceive their surroundings, such as cameras, radars, lidars, sonars, GNSS receivers, HD maps, odometry and inertial measurement units. ADS advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage and automatically control the vehicle. To make this work, the vehicle is developed by simulation and real-world operation to ensure the driving capacities of the ADS, with the priority being safety. Prior to releasing to the public, the system is tested for many scenarios from varieties of sources, not limited to naturalistic driving situations and known corner cases.

Scenario-based test methods for ADS mainly consist of four aspects: test scenarios, procedures, equipment and criteria with which the performance of ADS can be evaluated. Among these aspects, the development of test scenarios is most fundamental since their integrity and representativeness are crucial for evaluating the performance of ADS. Test scenarios serve as a basis for developing relevant procedures, equipment and criteria. Because of the importance of the test scenarios, the needs for standardizing the language we use to describe scenarios are derived from the demand of government and industry in terms of performing ADS design, testing, evaluation, and management, etc.

A universal norm of vocabularies supports providing basic ideas and clarifying the interrelations and concepts commonly used in scenarios. These vocabularies could be useful to facilitate the mutual-understanding, communication, and development of scenario-based engineering process.

In the context of automated driving, the vocabulary of test scenario is inevitably associated with existing standards like ISO 21448, ISO 26262-1 or other technical documents. However, people may find that some terms being defined in this document might not be identical with those in other documents. That is because, terms in this document are defined and interpreted in the context of test scenarios description with emphasis on their interrelationship to each other, while other standards may focus on safety or other aspects.

Road vehicles — Test scenarios for automated driving systems — Vocabulary

1 Scope

The document defines terms in the context of test scenarios for automated driving systems (ADS).

The document is applicable to ADS of Level 3 and above defined in ISO/SAE PAS 22736.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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/

3.1
automated driving system
ADS
hardware and software that are collectively capable of performing the entire *dynamic driving task (DDT)* (3.27) on a sustained basis, regardless of whether it is limited to a specific *operational design domain (ODD)* (3.26)

Note 1 to entry: ADS is used specifically to describe a Level 3, 4, or 5 driving automation system.

Note 2 to entry: In contrast to ADS, the generic term "driving automation system" refers to any Level 1 to 5 system or feature that performs part or all of the DDT on a sustained basis. Given the similarity between the generic term, "driving automation system" and the Level 3 to 5 specific term, "automated driving system", the latter term should be capitalized when spelled out and reduced to its abbreviation, ADS, as much as possible, while the former term should not be.

[SOURCE: ISO/SAE PAS 22736: 2021, 3.2, modified — Note 1 to entry has been added.]

3.2
system under test
SUT
automated driving system (ADS) (3.1) that is tested with *test scenarios* (3.5)

3.3
subject vehicle
ego vehicle
host vehicle
vehicle under observation in the process of testing, evaluation, or demonstration

Note 1 to entry: Subject-vehicle testing can be connected with *automated driving system (ADS)* (3.1) testing. In certain cases, the ADS can be tested via vehicle testing. Under these circumstances, the performance of the vehicle does not differ from the performance of the ADS. This is not applicable to the tests that involve the interaction between the ADS and the user.

3.4
scenario
sequence of *scenes* (3.6) usually including the *automated driving system(s) (ADS)* (3.1)/*subject vehicle(s)* (3.3), and its/their interactions in the process of performing the *dynamic driving task (DDT)* (3.27)

Note 1 to entry: The definition is an editorial rework of the definition in ISO 21448. The intended meaning of both definitions is the same.

EXAMPLE In the scenario in Figure 1, there are two *actors* (3.16), actor 1 is the subject vehicle, actor 2 is the pedestrian who is about to cross the street. The purpose of this scenario is to specify the behaviour of the subject vehicle (actor 1) in response to the given *actions* (3.15) of the pedestrian (actor 2). There are two 2 *triggers* (3.14) in this scenario. The initiation of the scenario is indicated by trigger 1, which corresponds to the moment that the pedestrian starts crossing the street. At the same time, the subject vehicle is traveling at a pre-set speed for the test purpose. In this case, the scene of a pedestrian appearing on the street becomes the *situation* (3.17) from the perspective of the subject vehicle. The expected behaviour of the subject vehicle under ADS control is to decelerate to stop until the pedestrian safely finishes crossing the road. The *event* (3.13) of a pedestrian arriving at the opposite roadside could be the trigger 2 for the next series of actions in the scenario. Figure 1 illustrates the relationship between several relevant terms of the scenario.

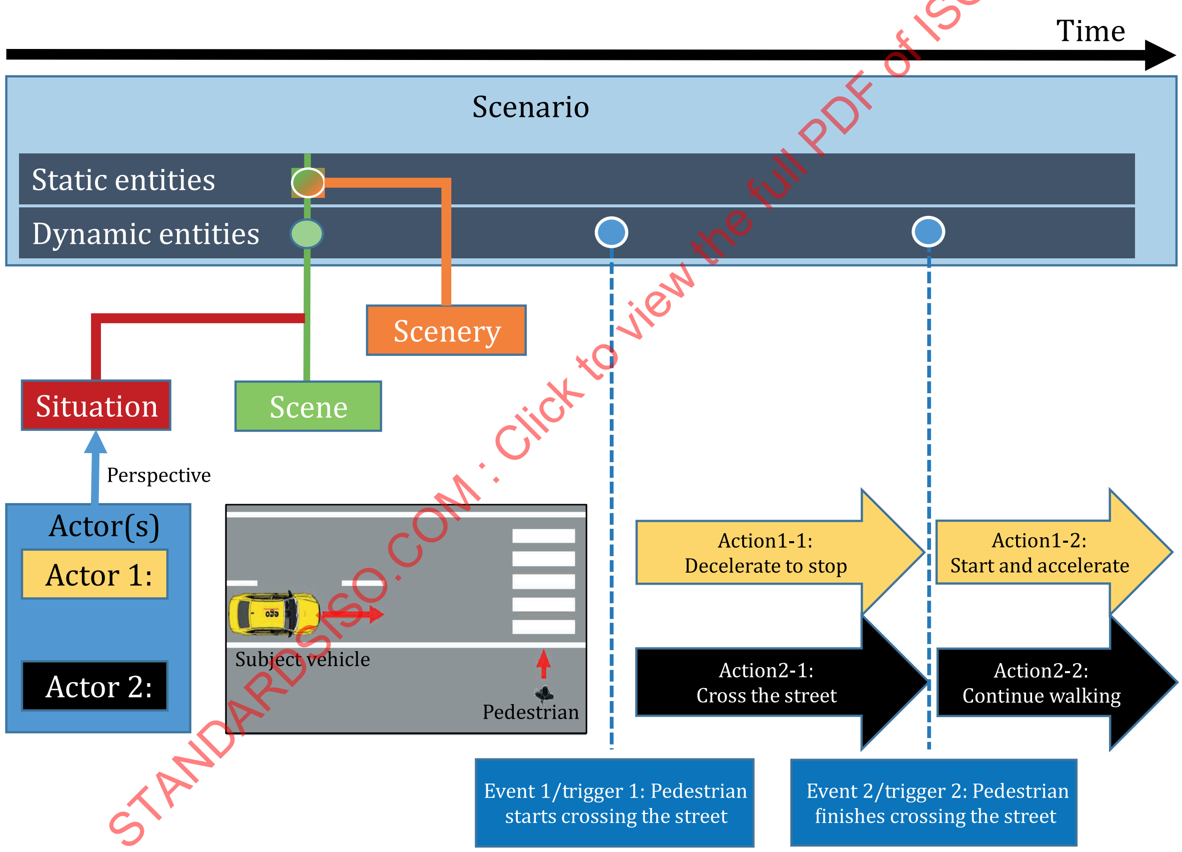

Figure 1 — Example for the relationship of relevant terms of scenario

3.5
test scenario
scenario (3.4) intended for testing and assessing *automated driving system(s) (ADS)* (3.1)/*subject vehicle(s)* (3.3)

Note 1 to entry: A test scenario may include additional items for the purpose of assessing the ADS performance or behaviour in addition to the scenario content, which include, but are not limited to, sampling *events* (3.13), flagging *system under test(s) (SUT)* (3.2) error check(s), relevant *operational design domain (ODD)* (3.26) data, success criteria, HMI event that may trigger *action(s)* (3.15).

3.6
scene
snapshot of all *entities* (3.7) including, but not limited to the *automated driving system (ADS)* (3.1)/ *subject vehicle* (3.3), *scenery* (3.12), *dynamic environment* (3.11), and all *actors* (3.16) and observer's self-representations, and the relationships between those entities

Note 1 to entry: The definition is an editorial rework of the definition in ISO 21448. The intended meaning of both definitions is the same.

Note 2 to entry: A scene is a snapshot of the *scenario* (3.4) which consists of both *static entities* (3.8) and *dynamic entities* (3.9) in a scenario, whereas the scenery only consists of static entities, excluding parts belonging to ADS/ subject vehicle.

EXAMPLE Figure 2 is a snapshot of a scenario (as the timeline indicates), at the moment that the subject vehicle is cruising on the road while the pedestrian is about to cross the street.

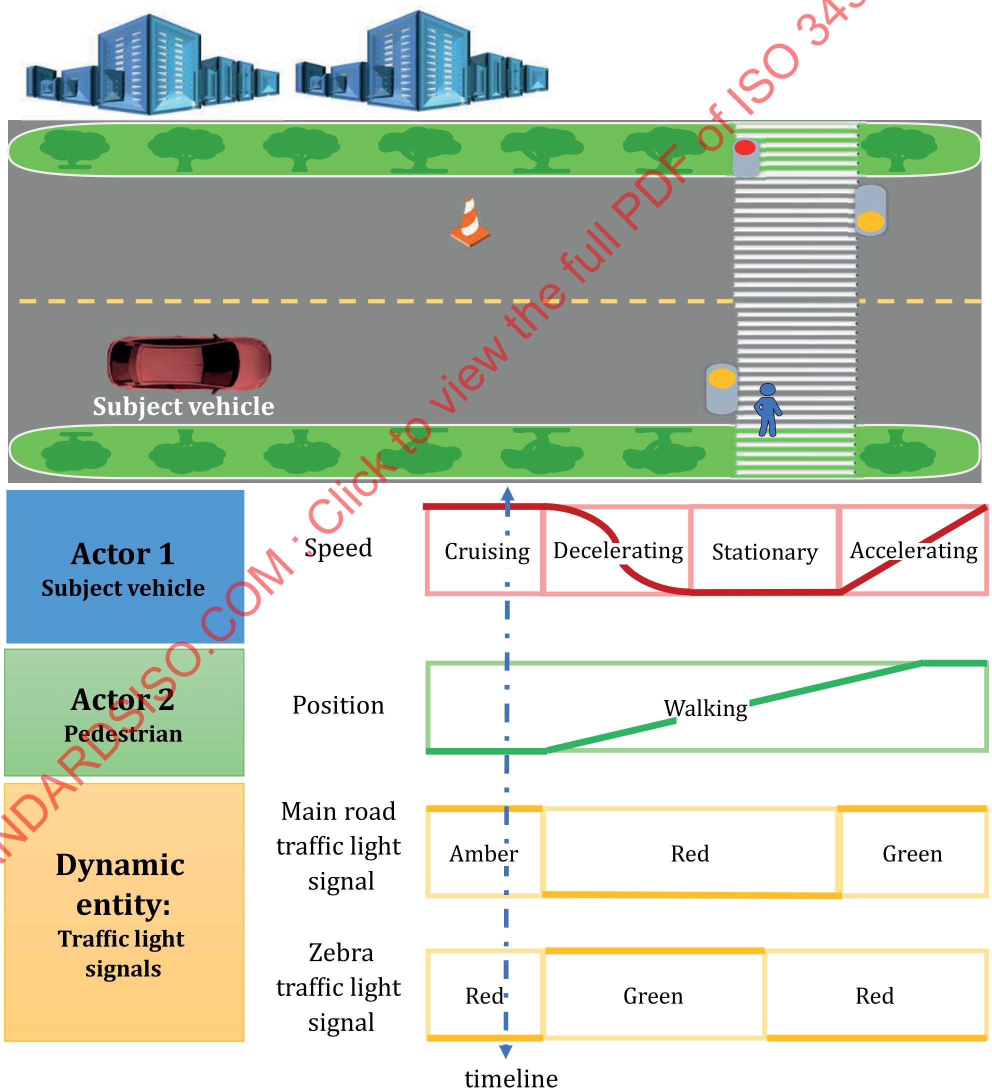

Figure 2 — Example of a snapshot of a scenario

3.7
entity
element of interest in a *scenario* (3.4)

3.8
static entity
entity (3.7) that does not experience state change(s) during a *scenario* (3.4)

Note 1 to entry: This is an entity belonging to the *scenery* (3.12).

3.9
dynamic entity
entity (3.7) that experiences state change(s) during a *scenario* (3.4)

Note 1 to entry: The nature of an entity can be different in different scenarios. The same entity can be dynamic in one scenario and maybe static in another one.

EXAMPLE 1 A tree is generally a *static entity* (3.8), but a scenario aiming to test the *automated driving system's (ADS)* (3.1) response to a sudden falling down tree makes it a dynamic entity. The traffic light is a static entity if the light does not change in the scenario, but is a dynamic entity if it changes.

EXAMPLE 2 Figure 3 illustrates dynamic/static entities in a scenario.

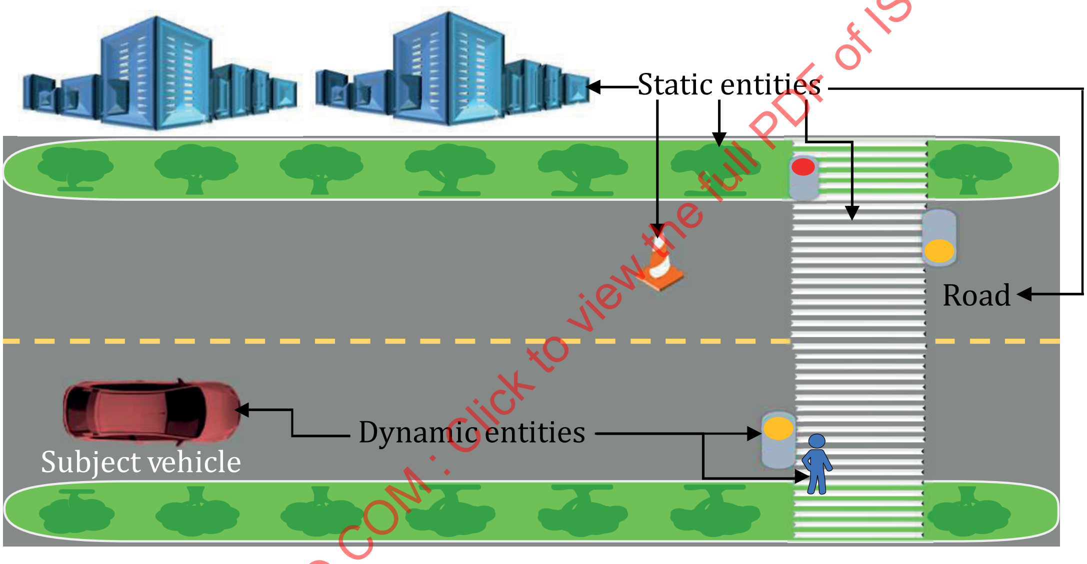

Figure 3 — Dynamic/static entities in a scenario

3.10
surrounding environment
all *entities* (3.7) in a *scenario* (3.4), excluding the *subject vehicle(s)* (3.3) or *automated driving system(s) (ADS)* (3.1)

Note 1 to entry: The surrounding environment should appropriately reflect the subject under observation. When the subject under observation is the ADS, the surrounding environment can incorporate entities in the vehicle.

3.11
dynamic environment
entities (3.7) within the *surrounding environment* (3.10) that experience a state change

3.12
scenery
static environment
part of the *surrounding environment* (3.10) that remains unchanged during a *scenario* (3.4)

Note 1 to entry: The scenery is equivalent to the set of all relevant *static entities* (3.8) that are part of the surrounding environment.

3.13
event
relevant state change of an *entity* (3.7) within a *scenario* (3.4)

Note 1 to entry: The definition is an editorial rework of the definition in ISO 21448. The intended meaning of both definitions is the same.

EXAMPLE Traffic light initiates the change and pedestrian starts crossing the sidewalk are both events.

3.14
trigger
event (3.13) that initiates or ends an *action* (3.15)

Note 1 to entry: An event is not necessarily a trigger.

3.15
action
activity
behaviour or act that is executed by any *actor* (3.16) in a *scenario* (3.4)

Note 1 to entry: The definition extends the concept in ISO 21448 through the dimension of time span. The action is defined at a given point of time characterized by scene as a snapshot of the environment in ISO 21448, whereas the definition here emphasizes the behaviour and act process which has the *attribute* (3.19) of timescale, more according with the concept of scenario.

3.16
actor
entity (3.7) with the capability to act and react in a *scenario* (3.4)

Note 1 to entry: There may be multiple actors existing in the scenario at a certain point of time.

Note 2 to entry: Not all *dynamic entities* (3.9) are necessarily actors. For example, a sudden falling tree is not an actor, because it has no capability to actively react to *events* (3.13).

3.17
situation
scene (3.6) from the perspective of an *actor* (3.16)

Note 1 to entry: A situation is equal to a scene except it is described as the condition from the perspective of the actor(s). The *scenery* (3.12), scene, or situation all represent a fixed point in time and have no time history element.

EXAMPLE Figure 4 illustrates the situation from the perspective of the *subject vehicle* (3.3), or *automated driving system (ADS)* (3.1) in the given example.

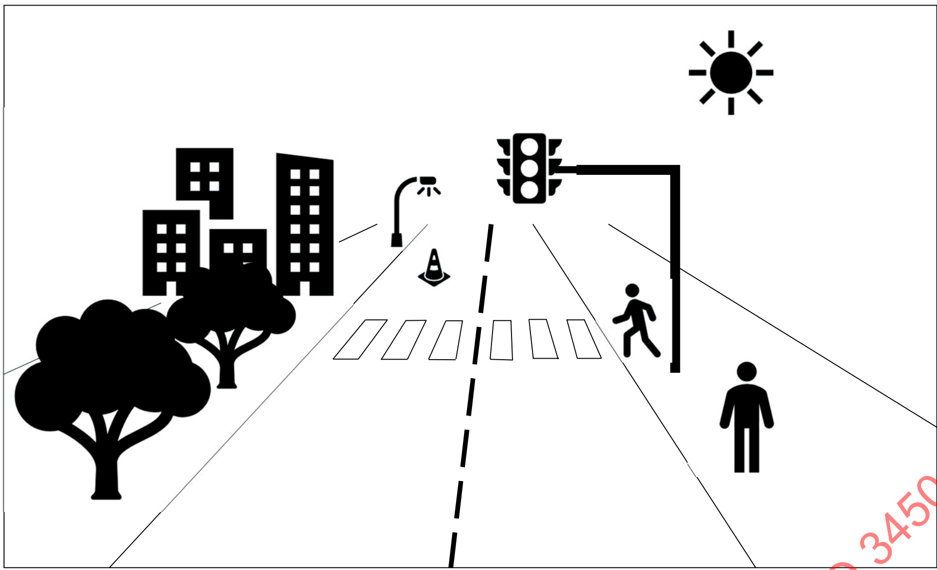

Figure 4 — The situation from the perspective of the subject vehicle or ADS

3.18
manoeuvre
series of *actions* (3.15) executed by an *actor* (3.16) in order to achieve a specific goal or outcome

3.19
attribute
property
quality or feature regarded as a characteristic or inherent part of an *entity* (3.7), *scenery* (3.12), *operational design domain (ODD)* (3.26), etc.

3.20
tag
label attached to a *scenario* (3.4) for the purpose of categorization

3.21
scenario category
set of *scenarios* (3.4) that share one or more characteristics

3.22
functional scenario
scenario (3.4) described in natural language on a conceptional level, in general without specific physical values

3.23
abstract scenario
formalized, declarative description derived from a *functional scenario* (3.22)

Note 1 to entry: The semantic of the description will be closely tied to an ontology, increasing the precision of the employed terminology. The declarative specification on the abstract level enables the focusing of the relevant aspects of the *scenario* (3.4) while omitting the details which are unimportant for the causal relation for the later refinement steps.

3.24
logical scenario
scenario (3.4) described with the inclusion of parameters, where the values of some of the parameters are defined as ranges

Note 1 to entry: One way of generating the logical scenario is to translate from the given *abstract scenario* (3.23) to the scenario parameter space.

Note 2 to entry: The range of parameter values can also be represented by a probability distribution (e.g. normal distribution).

3.25
concrete scenario

scenario (3.4) depicted with explicit parameters values, describing physical attributes

Note 1 to entry: Parameter values consist of default values, randomly chosen values or values chosen based on engineering judgement.

Note 2 to entry: One way of generating the concrete scenario is to choose a set of explicit parameters from the given *logical scenario* (3.24) parameter space.

Note 3 to entry: The abstraction level of scenarios from the top to the bottom is: *functional scenario* (3.22), *abstract scenario* (3.23), logical scenario, concrete scenario. Accordingly, the number of scenarios tends to increase from top to bottom (see Figure 5).

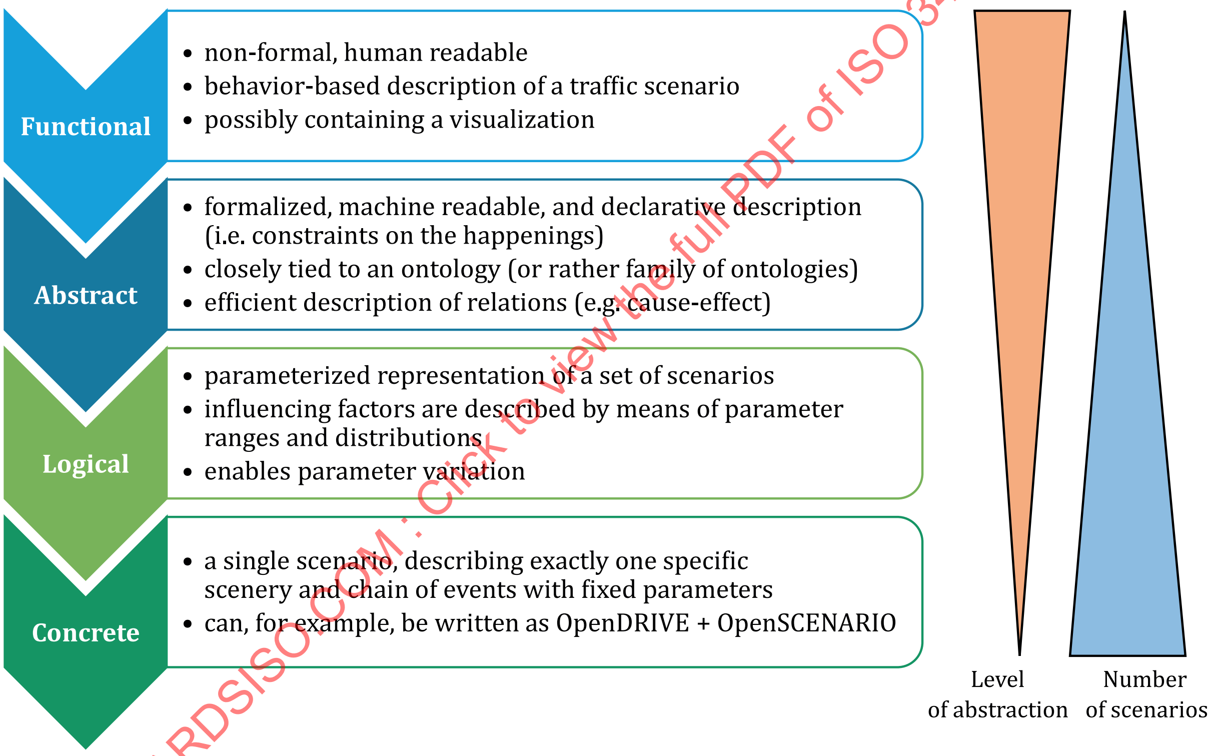

Figure 5 — Relationship of functional scenario, abstract scenario, logical scenario, and concrete scenario

EXAMPLE Figure 6 (using the Pegasus 6-layer approach for scenario modelling) illustrates the relationship between the scenario abstraction levels by using the instance “left cut in”.

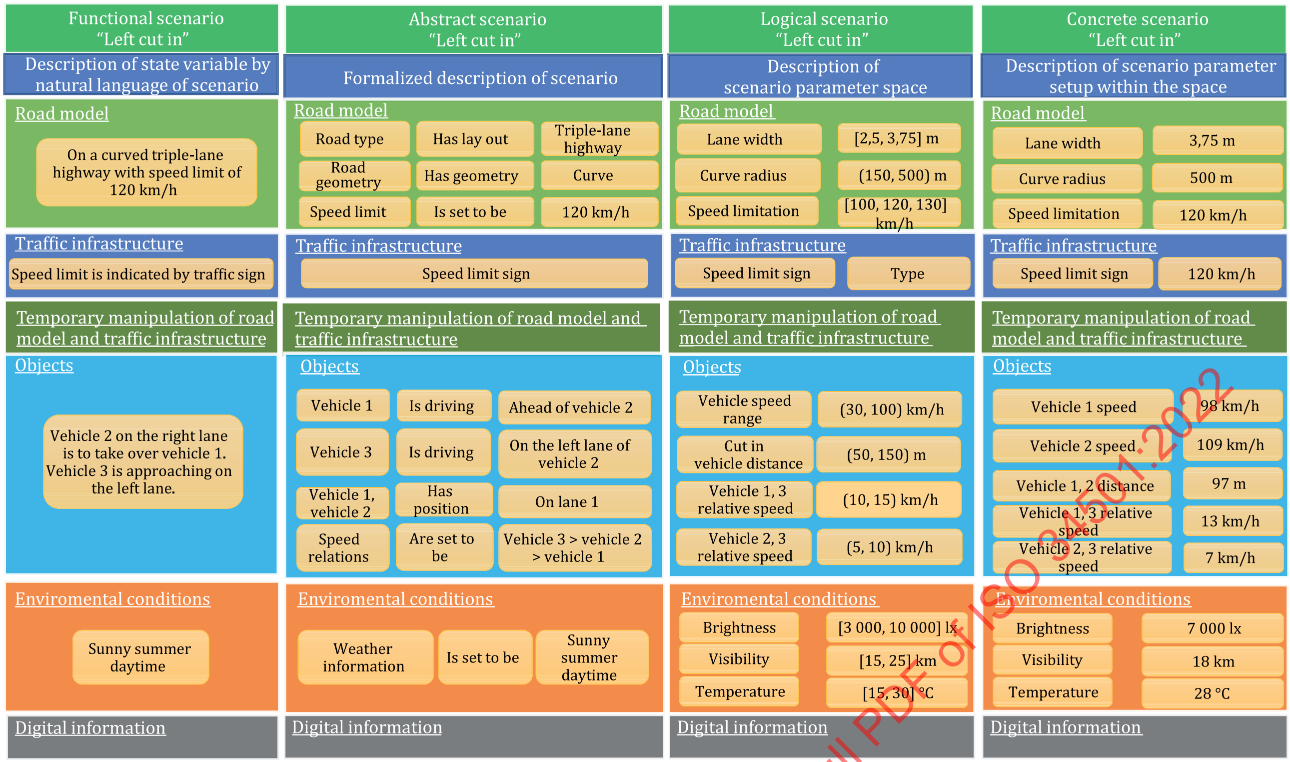

Figure 6 — Example of the relationship of functional scenario, abstract scenario, logical scenario and concrete scenario

3.26
operational design domain
ODD
operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics

Note 1 to entry: In this document, the ODD only refers to the vehicle’s external environment condition. If all conditions are referred to, a different term can be defined. For example, the operational design condition then can be used to describe the overall design constraints of ADS and can be divided into ODD (external environment condition), vehicle status, driver/passenger conditions and other necessary conditions.

[SOURCE: ISO/SAE PAS 22736:2021, 3.21, modified — Notes 1 and 2, and examples 1-5 have been deleted, Note 1 to entry has been added.]

3.27
dynamic driving task
DDT
all of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints

[SOURCE: ISO/SAE PAS 22736: 2021, 3.10, modified — All notes have been deleted.]