

# **The concept of Japanese proposal for the traffic Scenario structure**

**Prepared by Japan**

# Framework Document

## 9. f) Validation for System Safety:

Vehicle manufacturers should demonstrate a robust design and validation process based on a systems-engineering approach with the goal of designing automated driving systems free of unreasonable safety risks and ensuring compliance with road traffic regulations and the principles listed in this document. Design and validation methods should include a hazard analysis and safety risk assessment for Automated Driving System (ADS), for the OEDR, but also for the overall vehicle design into which it is being integrated and when applicable, for the broader transportation ecosystem. **Design and validation methods should demonstrate the behavioural competencies an Automated/autonomous vehicle would be expected to perform during a normal operation, the performance during crash avoidance situations** and the performance of fall back strategies. Test approaches may include a combination of simulation, test track and on road testing.

# NATM Master Document

## 4. Applying a Multi-pillar Approach to the NATM

4.1.1 A scenarios catalogue consisting of a series of relevant, critical, and complex scenarios that represent real-world traffic situations. The goal of these scenarios is to **exercise and challenge an ADS' capabilities to safely operate**. This catalogue will provide a minimum baseline (non-exhaustive inventory) of scenarios that should be considered (and built upon as required) to validate the safety of an ADS. The NATM then proposes the next three pillars as the principal testing methodologies to validate the safety of an ADS against these traffic scenarios:

# SG1a Concept Paper

## --Why should scenario-based testing be included in the NATM?—

In order to maximize the potential safety benefits of AVs, a robust safety validation framework shall be established. Such a framework shall provide clear direction for assessing functional requirement of AVs in a **repeatable, objective, evidence-based and technology neutral manner**.

— 中略 — **Simple metrics such as kilometers** — 中略 —

Safety validation through **such testing would not** be cost and time effective, nor would it be feasible to replicate the testing later on. As validation of AV in various traffic situations is needed, therefore **different traffic scenarios shall be considered**.

A scenario-based approach helps to systematically organize safety validation activities in an efficient, objective, repeatable, and scalable manner and is critical addition to the existing testing methodologies for ensuring holistic and dense coverage of traffic situations.

## -- What is traffic scenario?--

**Traffic scenario** (or scenario for short) is a sequence or combination of situation for assessing the functional requirement for AVs. Scenarios Catalogue is a library of traffic scenarios.

**Scenarios involve** a wide range of elements, such as some or all portions of **the dynamic driving tasks (DDT), different roadway layouts; interactions with** a variety of different types of **road users and objects** exhibiting static or dynamic behaviours; and, **environmental conditions** (among many others factors).

# SG1a Concept Paper

## Scenario Properties:

Traffic scenarios are derived by combining a number of relevant properties, taken from disjunct layers describing the scenario space systematically. For instance, Pegasus (2018) grouped these elements according to the two entities of traffic: **the vehicle with the ADS and the traffic environment**. The traffic environment or the traffic scenario contains several characterizing factors that can be split into **six layers of a scenario** :

- 1) Street layout and condition of the surface;
- 2) Traffic guidance infrastructure (e.g. signs, barriers and markings);
- 3) Overlay of topology and geometry for temporal construction sites;
- 4) Road users and objects, including interactions based on maneuvers;
- 5) Environment conditions (e.g. weather and daytime), including their influence on levels 1 to 4; and
- 6) Digital information (e.g. vehicle to everything information, digital map).

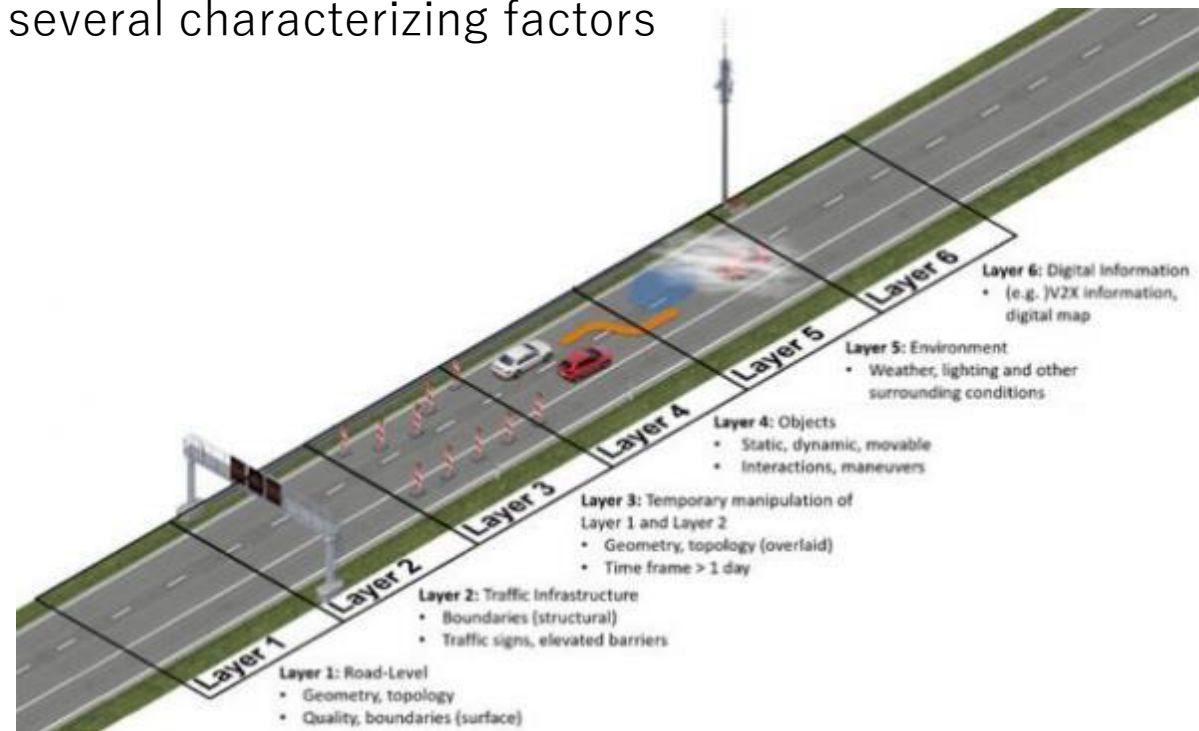


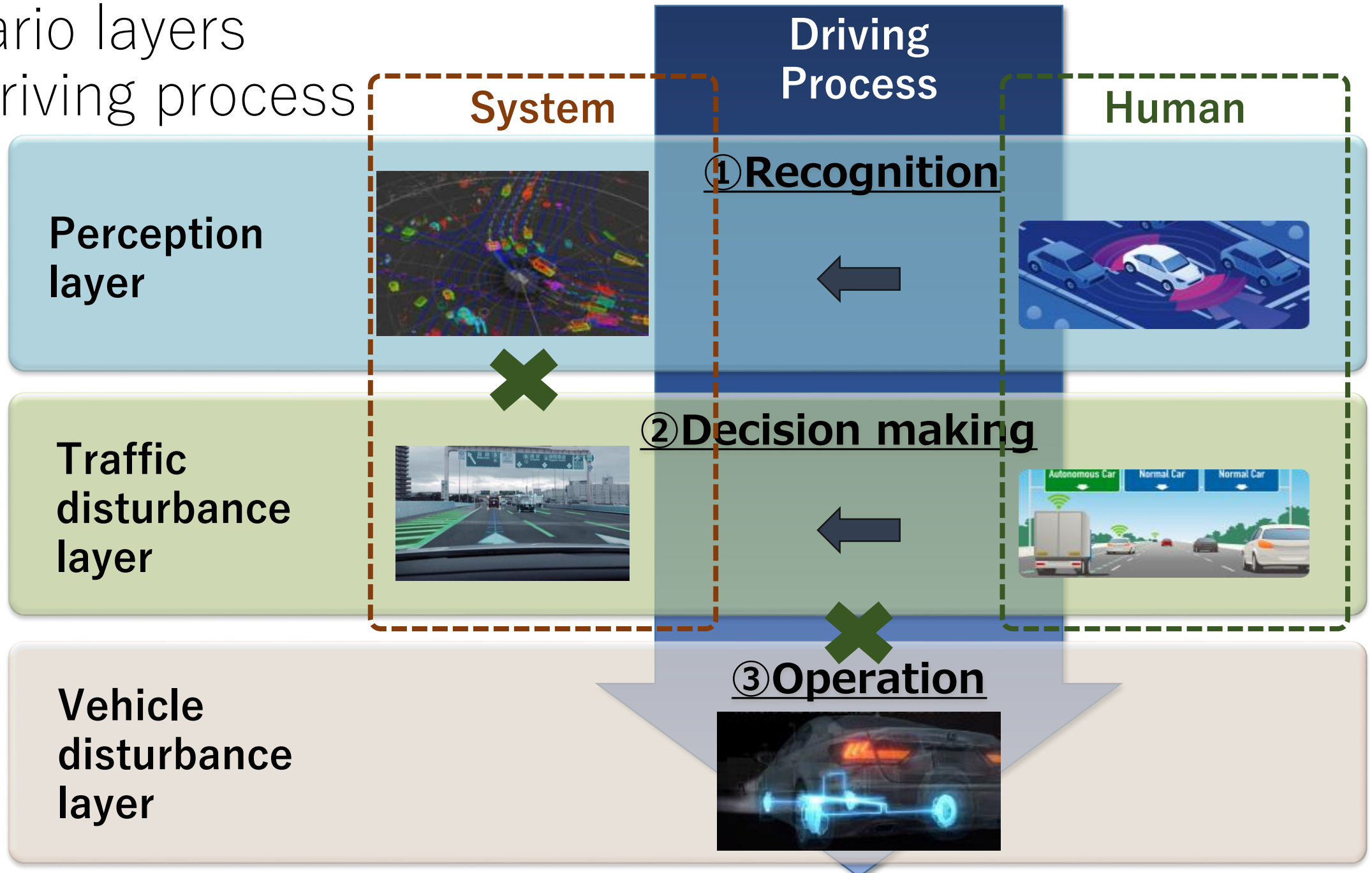
Figure 2. Six-layer-model for structuring scenarios (Pegasus, 2018).

# Japanese proposal of scenario structure

- **NATM MD:** Traffic scenarios are to exercise and challenge an ADS' capabilities to safely operate.
- **SG1 concept paper –Why-:** The scenario should be structured in a repeatable, objective, evidence-based and technology neutral manner.
- Japanese proposal: Best practice at this stage
  - ✓ In order to cover all safety related factors of the traffic environment, traffic scenario should be structuralized logically in accordance with physical principle for ADS to execute dynamic driving tasks.
  - ✓ **According to physical principle of dynamic driving tasks, the scenario can be split into three layers; Perception, Traffic and Vehicle scenarios, which also align with metrics necessary to compare with human driving.**
  - ✓ Proposed scenario structure can describe any real traffic situations and is ready for updating with never-before-thought-of scenarios.
  - ✓ All scenario properties split in 6 layers in Pegasus are covered by above three scenarios. See appendix

# Scenario layers and driving process

Traffic Scenario



# Description of each layer

## Perception layer



## Traffic disturbance layer



## Vehicle disturbance layer



Mapping real world conditions to objects and their attributes through sensors and perception system with performance limitation and misperception based on sensor physics (e.g. Camera: Passive light, Radar: Radio wave, LiDAR: Infra red, etc.)

Functional scenarios consist of geometry/location of road structures and static objects, and behavior of other road users

Ego vehicle operation to ego vehicle behavior attributed by kinetic characteristics of the vehicle, road and environmental conditions



# Proposal of amendment




[The ADS technology would be structured considering human driving process which consists of perception, **decision making and operation** ~~judgement, manoeuvre and vehicle response.~~

“Scenario **layers structure**” consists of 3 elements that cover the human driving process:

- Perception **layer disturbance scenario** represents the perception process (e.g. degradation of sensor function because of weather/disappearance of lane marking),
- Traffic disturbance **layer scenario** represents the **decision making judgement** process (e.g. cut in/cut out), and
- Vehicle disturbance **layer scenario** represents the **operation manoeuvre and the vehicle response** process (e.g. strong wind/road condition) ~~of the human driving.~~

Using the scenario-based approach is critical for ensuring holistic and dense coverage of foreseeable variation of traffic situations.]

# Appendix1 : Coverage of the layers properties listed and layered by PEGASUS

PEGASUS 6 Layers Parameters		1 Road level	2 Traffic Infrastructure	3 Temporary manipulation	4 Objects	5 Environment	6 Digital information
Scenario Layers		Geometry Topology Quality Boundaries(s urface)	Boundaries(str uctural) Traffic signs Elevated barriers	of layer 1 & 2 Time frame < 1 day	Static, dynamic, movable Interactions Maneuvers	Weather, lighting and other surrounding conditions	Digital information (V2X, digital map)
Perception layer		Variables	Variables	Variables	Variables	Variables	(Fixed)
Traffic disturbance layer		Variables	Variables	Variables	Variables	Fixed	Fixed
Vehicle disturbance layer		Variables	Fixed	Fixed	Fixed	Variables	Fixed