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Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles

Taxonomie et définitions des termes relatifs aux systèmes de conduite automatisée des véhicules routiers à moteur

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This document was jointly prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*, and SAE *On-Road Automated Driving Committee, Definitions Task Force*.

This document and its counterpart document published by SAE (SAE J3016 APR2021) are technically equivalent. The only difference between the documents is the standard number and name and minor editorial elements.

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Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles

1. SCOPE

This document describes [motor] *vehicle driving automation system*s that perform part or all of the *dynamic driving task* (*DDT*) on a *sustained* basis. It provides a taxonomy with detailed definitions for six levels of *driving automation*, ranging from no *driving automation* (Level 0) to full *driving automation* (Level 5), in the context of [motor] *vehicles* (hereafter also referred to as "*vehicle*" or "*vehicles*") and their *operation* on roadways:

Level 0: No Driving Automation

Level 1: Driver Assistance

Level 2: Partial Driving Automation

Level 3: Conditional Driving Automation

Level 4: High Driving Automation

Level 5: Full Driving Automation

These level definitions, along with additional supporting terms and definitions provided herein, can be used to describe the full range of *driving automation features* equipped on [motor] *vehicles* in a functionally consistent and coherent manner. "On-road" refers to publicly accessible roadways (including parking areas and private campuses that permit public access) that collectively serve all road *users*, including cyclists, pedestrians, and *users* of *vehicles* with and without *driving automation features*.

The levels apply to the *driving automation feature*(s) that are engaged in any given instance of on-road *operation* of an equipped *vehicle*. As such, although a given *vehicle* may be equipped with a *driving automation system* that is capable of delivering multiple *driving automation features* that perform at different levels, the level of *driving automation* exhibited in any given instance is determined by the *feature*(s) that are engaged.

This document also refers to three primary actors in driving: the (human) *user*, the *driving automation system*, and other *vehicle* systems and components. These other *vehicle* systems and components (or the *vehicle* in general terms) do not include the *driving automation system* in this model, even though as a practical matter a *driving automation system* may actually share hardware and software components with other *vehicle* systems, such as a processing module(s) or *operating* code.

The levels of *driving automation* are defined by reference to the specific role played by each of the three primary actors in performance of the *DDT* and/or *DDT fallback*. "Role" in this context refers to the expected role of a given primary actor, based on the design of the *driving automation system* in question and not necessarily to the actual performance of a given primary actor. For example, a *driver* who fails to monitor the roadway during engagement of a Level 1 adaptive cruise control (ACC) system still has the role of *driver*, even while s/he is neglecting it.

Active safety systems, such as electronic stability control (ESC) and automatic emergency braking (AEB), and certain types of *driver* assistance systems, such as lane keeping assistance (LKA), are excluded from the scope of this *driving automation* taxonomy because they do not perform part or all of the *DDT* on a *sustained* basis, but rather provide momentary intervention during potentially hazardous situations. Due to the momentary nature of the actions of *active safety systems*, their intervention does not change or eliminate the role of the *driver* in performing part or all of the *DDT*, and thus are not considered to be *driving automation*, even though they perform automated functions. In addition, systems that inform, alert, or warn the *driver* about hazards in the driving environment are also outside the scope of this *driving automation* taxonomy, as they neither automate part or all of the *DDT*, nor change the *driver*'s role in performance of the *DDT* (see 8.13).

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It should be noted, however, that crash avoidance *features*, including intervention-type *active safety systems*, may be included in *vehicles* equipped with *driving automation system*s at any level. For *automated driving system* (*ADS*) *features* (i.e., Levels 3 to 5) that perform the complete *DDT*, crash mitigation and avoidance capability is part of *ADS* functionality (see also 8.13).

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J670 *Vehicle* Dynamics Terminology

SAE J3063 Active Safety Systems Terms and Definitions

Shi, E., Gasser, T., Seeck, A., and Auerswald, R., "The Principles of Operation Framework: A Comprehensive Classification Concept for Automated Driving Functions," SAE Intl. J CAV 3(1):27-37, 2020, https://doi.org/10.4271/12-03-01-0003.

2.1.2 ANSI Accredited Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ANSI D16.1-2007 Manual on Classification of Motor *Vehicle* Traffic Accidents

2.1.3 Other Publications

49 U.S.C. § 30102(a)(6) (definition of [motor] *vehicle*)

Crash Avoidance Metrics Partnership - Automated Vehicle Research Consortium, "Automated Vehicle Research for Enhanced Safety - Final Report," available at https://www.regulations.gov/document?D=NHTSA-2014-0070-0003.

Gasser, T. et al., "Legal Consequences of an Increase in Vehicle Automation," July 23, 2013, available at http://bast.opus.hbz-nrw.de/volltexte/2013/723/pdf/Legal_consequences_of_an_increase_in_*vehicle*_automation.pdf.

Michon, J.A., 1985, "A Critical View of Driver Behavior Models: What Do We Know, What Should We Do?" In Evans, L. and Schwing, R.C. (Eds.). Human behavior and traffic safety (pp. 485-520). New York: Plenum Press, 1985.

Smith, B.W., "Engineers and Lawyers Should Speak the Same Robot Language," in ROBOT LAW (2015), available at https://newlypossible.org.

2.2 List of Abbreviations

ACC Adaptive cruise control

ADAS Advanced driver assistance system

ADS Automated driving system

ADS-DV Automated driving system-dedicated vehicle

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AEB	Automatic emergency braking
DDT	Dynamic driving task
DSRC	Dedicated short range communications
ESC	Electronic stability control
LKA	Lane keeping assistance
ODD	Operational design domain
OEDR	Object and event detection and response

3. DEFINITIONS

3.1 ACTIVE SAFETY SYSTEM (SAE J3063)

Active safety systems are *vehicle* systems that sense and monitor conditions inside and outside the *vehicle* for the purpose of identifying perceived present and potential dangers to the *vehicle*, occupants, and/or other road *users*, and automatically intervene to help avoid or mitigate potential collisions via various methods, including alerts to the *driver*, *vehicle* system adjustments, and/or active control of the *vehicle* subsystems (brakes, throttle, suspension, etc.).

NOTE: For purposes of this report, systems that meet the definition of *active safety systems* are considered to have a design purpose that is primarily focused on improving safety rather than comfort, convenience, or general *driver* assistance. *Active safety systems* warn or intervene during a high-risk event or maneuver.

3.2 AUTOMATED DRIVING SYSTEM (ADS)

The hardware and software that are collectively capable of performing the entire *DDT* on a *sustained* basis, regardless of whether it is limited to a specific *operational design domain* (*ODD*); this term is used specifically to describe a Level 3, 4, or 5 *driving automation system*.

NOTE: In contrast to *ADS*, the generic term "*driving automation system*" (see 3.6) 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.

3.3 [DRIVERLESS OPERATION] DISPATCHING ENTITY

An entity that *dispatch*es an *ADS*-equipped *vehicle*(s) in *driverless operation*.

NOTE: The functions carried out by a *dispatching entity* may be divided among one or several agents, depending on the *usage specification* for the *ADS*-equipped *vehicle*(s) in question.

EXAMPLE: A fleet of Level 4 closed campus *ADS-dedicated vehicles* is placed into service by a *driverless operation dispatching entity*, which engages the *ADS* for each *vehicle* after verifying its *operational* readiness and disengages the *ADS* when each *vehicle* is taken out of service.

3.4 DISPATCH [IN DRIVERLESS OPERATION]

To place an *ADS*-equipped *vehicle* into service in *driverless operation* by engaging the *ADS*.

NOTE 1: The term "*dispatch*," as used outside of the context of *ADS*-equipped *vehicles*, is generally understood to mean sending a particular *vehicle* to a particular pick-up or drop-off location for purposes of providing a transportation service. In the context of *ADS*-equipped *vehicles*, and as used herein, this

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