Operating scenarios for testing Automated Driving Systems in challenging conditions

Anastasia Bolovinou*, Christina Anagnostopoulou*, Hendrik Weber**, Innamaa Satu***, Johannes Hiller**, Angelos Amditis*, Jean Louis Sauvaget*****
*ICCS, Athens, Greece

**IKA, Aachen, Germany

***VTT, Espoo, Finland

*****Stellantis, Paris, France

Contact: anastasia.bolovinou@iccs.gr

Abstract

During planning of a prototype automated driving system's (ADS) testing, the operating scenarios of the systems to be tested are usually described in an abstract, linguistic way as a function of the system's Operational Design Domain (ODD). In this paper, a methodology for operating scenarios definition that integrates ODD conditions under focus, as developed in the European project Hi-Drive, will be presented. For this purpose, two sub-types of ODD specification will be considered for testing the integration of a Hi-Drive enabler technology in the ADS under test: a) the ODD for testing “AD-performance”, in which we test if higher AD performance and prolonged AD usage can be achieved under nominal ODD conditions and b) an extended ODD for testing “AD-availability”, where additional challenging operating conditions are tested which extend the nominal ODD of the AD system under test.

Content

1 Introduction

Connected and Automated Driving (CAD) has the potential to drastically change transportation and to create far reaching impacts that currently are under investigation by several European, US-based and Japan-based research projects. SAE level 3 'Conditional Automation' (L3) automated functions were piloted in Europe by the L3Pilot project in 2017–2021. The collected driving and user data was used to analyse the vehicles behaviour in traffic and to gain an understanding of their future users. Beyond that impact assessments were carried out, which studied which potential gains in safety, efficiency and mobility could be achieved by automated driving technology.

Hi-Drive builds on the L3Pilot results [1] and advances the European state-of-the-art by demonstrating in multi-modal trials (open road, test track, simulation in a mixed analogy, as presented in Figure 1) the robustness and reliability of CAD functions in demanding and error-prone conditions. The project investigates automated driving in multiple directions aiming at maximizing the time the function can be used later by the user. Benefits of automated driving can only be achieved, when automated operation can be sustained for a significant continuous time span. For example, L3Pilot impact assesment results [2] have shown, that the ability to do side tasks increases the willingess to use of the systems.

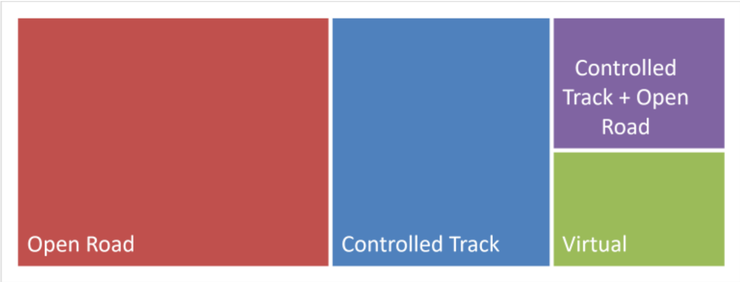

Figure 1: Hi-Drive test environments

Hi-Drive strives to extend the CAD functions' ODD and reduce the frequency of the takeover requests generated by them by selecting and implementing technology enablers integrated within existing CAD functions. Technology enablers forming thirteen technological clusters part falling under four thematic groups will be developed and tested:

- CAD connectivity;
- CAD cybersecurity;
- CAD high precision positioning;
- CAD Machine Learning.

The technology enablers will allow the operation in diverse driving scenarios within the domains of urban traffic, motorways and rural roads. The minimization of fragmentation in the CAD functions' ODD is expected to give rise to a gradual transition from a conditional operation towards higher levels of automated driving.

Within the project, a variety of different experiments will be conducted. Those experiments differ in their nature as well as in their scope. Hi-Drive develops a methodology that allows that the evaluation can derive the results needed to answer the research questions in a harmonized way for the project. For this it is necessary to combine the findings of the different experiments to a comprehensive picture for automated driving functions (ADF), technology enablers and the users (Figure 2). Therefore, the evaluation activities in Hi-Drive have two main scopes: users and effects on transport system. User evaluation focuses on acceptance, usage, user experience, and interaction with externals. Effects evaluation addresses how technology enablers enhance the AD performance and contribute to defragmentation of ODD, how traffic and travel behaviour are affected by high-level automation, and what are the societal impacts these changes have.

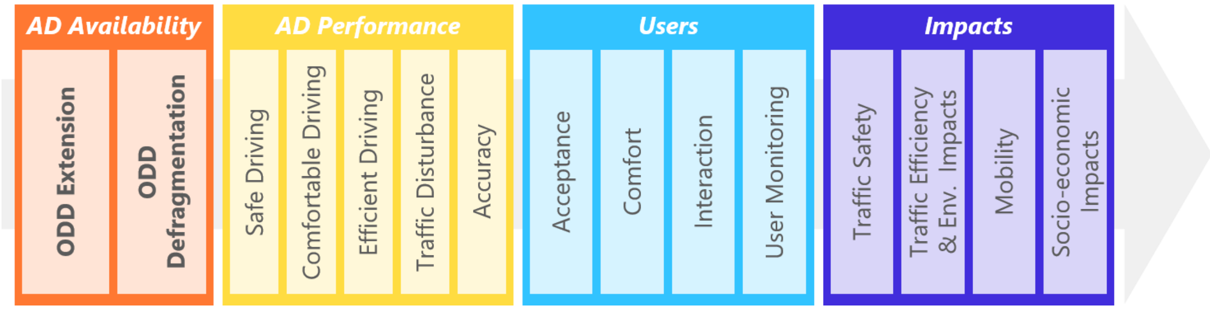

Figure 2: Effects scope within Hi-Drive

During planning of ADF testing, the operating scenarios for the AD sub-systems/system to be tested are usually described in an abstract, linguistic way. Recently, draft ISO 35403 (Test scenario generation), proposes three types of scenarios to be generated taking an AD stack persective: percpetion testing scenarios, decision making testing scenarios and control test scenarios. In this work, a methodology for describing the set of Automated Driving Systems under test and their assosiated use cases for the Hi-Drive multi-domain testing activity (including more than 35 prototype reseach vehicles owned by 20 Hi-Drive vehicle owners) with a special focus on ODD considerations' integration into several steps of the work (from ADF description to its evaluation) is in focus. For the latter, the main objective of the Hi-Drive Use Case (UC) catalogue is to provide on overview of the vehicles' functions, the enablers' impacts and the users' reactions in a holistic way. The UC catalogue will be used to guide the real-life demonstration of the project developments as well as provide information for the research questions derivation part of the project's methodology definition.

The remaining of the paper is structured as follows: Section 2 presents the proposed ODD specification template and provides an example. Furthermore it explains how we link the ADF design to the ADF evaluation by proposing a custom ODD specification where ODD attributes are tagged as either 'nominal ODD', 'performance ODD' or 'extended ODD' (see section 2). Section 3 presents a set of empirical rules for creating test scenarios out of abstract use cases as well as for grouping UCs coming from various ADF owners (see section 3). An example of generating test scenarios for a motorway collaborative driving ADF is also provided.

2 Towards an ODD specification to assist AD evaluation

2.1 Process

An ODD specification file determines the ODD attributes out from a predefined ODD taxonomy that are supported by the ADS [3]. The designer of the system (here the system’s tester, too) is invited to fill in the ODD template to report the detailed operational conditions where its AD system can be deployed. Based on light adaptations of the taxonomy defined in BSI PAS 1883 [4] and combining elements from the two ODD-related technical reports by AVSC [5] and MUSICC [6], the Hi-Drive ODD taxonomy, which is presented in Figure 3, was defined. Few modifications with repsect to BSI

PAS 1883, that were concidered as useful only for describing the Hi-Drive operational context, include for category 'Scenery':

- Category title was renamed to "Roads" (for audience not familiar with scenario representation terms)
- Add attribute "Ramps (on/off motorway)" to the sub-category Road type/motorways (Hi-Drive develops technology enablers espesially for motorway entry/exit)
- Add attribute "lane marker quality" borrowed from [5] to the 'Lane specification' sub-category of the 'Scenery' category (Hi-Drive develops enablers able to identify such deteriorate lane marking conditions)
- Add atributes "rush hours affected zones" and "local on-road hazard affected zone" under "Zones" sub-category.

For category 'Environmental conditions':

- Sub-category "Connectivity" was not used since in Hi-Drive, connectivity attributes needed by the ADS are already described in the enabler technology specification. (about positioning, GNSS signal interruption is already covered by ODD element "Interference zones" under Roads sub-category).

For category "Dynamic elements":

- Category "dynamic elements" was renamed to "Road Users" for clarity since other ODD attributes belonging to categories environmental conditions or scenery, like weather, are also dynamic.
- Sub-category "traffic" is further split into "vehicles" and "VRUs".
    - New traffic agent types added based on [5].
- Sub-category "subject vehicle" was replaced by the "ego-vehicle category" split into passenger car or truck, borrowed from [6].

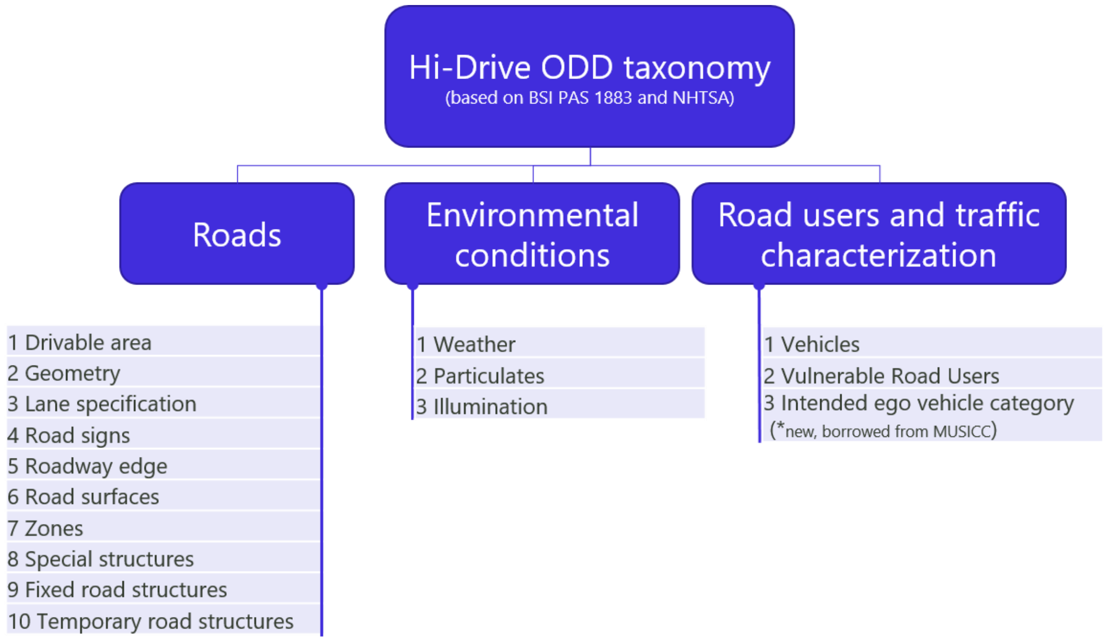

Figure 3: Hi-Drive ODD taxonomy based on BSI PAS 1883

2.2 ODD integration and tags

As also considered by the recent EU regulation for ADS type approval [7], considerations about the ODDs are not limited to the design phase of the ADS but hold a significant role in the whole ADS testing and verfication toolchain. As such, testing scenarios should explore the occurrence of conditions that would exceed the ODD. More specifically, the EU regulation splits the nominal scenarios for AD testing (the other two categories of scenarios, i.e. critical and failure scenarios are not considered by this work) into those where dynamic driving task (DDT), as defined in [8], is performed under nominal traffic scenarios or those where DDT is performed under ODD boundaries.

For integrating the ODD specification into the process of of Hi-Drive UC catalogue generation, two general considerations have been taken into account:

- The ODD shall be part of both the ADS description and the UC/scenario description since the test scenarios to be generated shall be always a function of the ODD. This the motivation behind the field "types of ODD extention" inside the UC catalogue template (see in Tab. 2, element 4.4).
- The ADS's ODD is NOT identical with the testing operational domain (OD) which can be smaller (subset of the ODD) or bigger (extended ODD) depending on the test track or open road applicable experiment’s road surface, structure, traffic and/or weather characteristics. The testing OD is roughly described by the test scenarios and will be further detailed in Hi-Drive's Operations description (i.e. the ODD coverage acheived in real-world tests and/or in simulation and/or on test track).

In Hi-Drive, a significant technical evaluation aspect is how the technology enablers, which are integrated in the ADFs to be tested, enhance the AD performance under nominal ODD conditions and if ODD extension, i.e. support for new ODD attributes (not handled by the ADF without the technology enabler), can be achieved, i.e. effect on AD availability. For this reason, for each Hi-Drive ADF instance one ODD specification file, implementing the taxonomy presented in sec. 2.1, is created by additionally labeling the ODD attributes with the three following types of tags:

1. 'nominal ODD' tag: Applies to operational conditions that the ADF instance is designed to safely handle, at the start of Hi-Drive project (e.g. motorway sections with three lanes, under fairly good weather, excluding tunnels and entries/exits)

2. 'performance ODD' tag: Applies to a subset of the Nominal ODD conditions describing the Hi-Drive operational conditions on which testing the ADF instance's performance after technology enabler integration will be performed (e.g motorway sections with three lanes, all with good quality lane markings, under good weather, excluding tunnels and entries/exits).

3. 'extended ODD' tag: Applies to an additional set of ODD attribute(s) not handled before Hi-Drive but now possible due to the Hi-Drive technology enabler integration (e.g. adverse weather conditions added, on-ramp road segment added, special or temporary road structure or a new type of traffic agent that is now handled etc.).

The full Hi-Drive ODD template is not provided here due to space limitations (to be published in the upcoming Hi-Drive deliverable D3.1). An ADF ODD file extract presenting the proposed labeling is shown in the example of Figure 4.

_Drivable area		
a) Motorway roads		
	with active traffic management (smart motorways);	
	without active traffic management.	**X**
b) Ramps (on/off motorway)	X	
c) Radial roads		
d) Distributor roads		
e) Minor roads		
_Road surfaces		
a) Dry	**X**	
b) Damp	**X**	
c) Wet	X	
d) Snow-covered		
e) Icy		
f) Leaves		
g) presence of holes in the asphalt		
h) type		
	i) uniform (e.g.asphalt)	**X**
	ii) segmented (e.g. cobblestones)	

Figure 4: Extract from a HI-Drive motorway ADF ODD specification using the proposed template (Tag 'nominal ODD' is denoted with a plain 'x', tag 'performance ODD' is denoted with a bold 'x' and tag 'extended ODD' is denoted with 'x' in red font).

2.3 ODD specification textual example

In addition to the ODD specification file, an ODD description textual summary was required to be provided by each ADS owner when describing its ADS, as shown in Tab. 1.

Tab. 1 ODD textual description

ODD textual description	The enablers extend and improve the capability of Vehicle Owner 3 (VO3)'s Motorway ADS on merging sections, as well as on areas affected by hazardous situations or where dynamic signage is provided. The targeted ODD geometry is defined by straight roads (motorways) with physical separation between traffic directions (i.e. “divided” roads). Partial road obstruction for example by crossing bridges, gantry signs or trees are possible. For on-ramp crossing (author note: 'Ramps' is an ODD attribute for motorways road in Hi-Drive ODD specification template as presented in sec. 2.1), the ADF will additionally operate on curvy roads. In terms of lanes, the supported ODD accounts for 3 lanes of standard width on the motorway (the on-ramp will have at least one lane) with good quality lane marking (both solid and dashed). The roadway edge is expected to be line-marked and the road surface uniform (e.g. asphalt, concrete).

	A certain set of static, fixed landmarks (e.g. lane markings, traffic sign posts, road dividers, bridges, buildings) is required, the minimum number and shape of such landmarks will be investigated during the implementation phase. In terms of environmental conditions, the ADF is expected to operate also in presence of calm wind/breeze and light rain, under daytime illumination conditions and irrelevantly on cloudiness or position of the sun. Finally, in terms of traffic, the ADF is expected to support ODDs of at least low flow rates.
Special ODD conditions to be tested (Y/N)	☐ Testing ODD transition (e.g., weather turns from sunlight to snow) : Yes ☐ Testing ODD new attribute that was not handled before (e.g., motorway on-ramp entry) : Yes ☐ Testing ODD violation (e.g., deteriorate lane markings) : No

3 Use cases & test scenarios catalogue generation

As stated in [7], "the combination of objects, events and their potential interaction, as function of the ODD, constitute the set of nominal scenarios pertinent to the ADS under analysis. The identification of nominal scenarios is not limited to traffic conditions but also covers environmental conditions, human factors, connectivity." Taking this general approach and based on the test scenario format proposed by ISO/DIS 34502 [9], where the test scenario flow of events starts with a triggering condition, guidelines for forming test scenarios were derived.

3.1 Process

Two types of assosiated UCs are considered: a) UCs with high-level targets as these used in the piloting experiments of L3Pilot [10], e.g. driving in motorway up to 130km/h, excluding night, tunnels and toll stations coping with all types of driving maneuvers excluding lane change; b) UCs with low-level targets that can be 'staged' and repeated taking advantage of controlled test track environments that focus on enabler technology efficient integration and testing, e.g. motorway on-ramp crossing for merging onto main motorway with presence of two vehicles and use of V2V and standard GNSS equipement. As the focus in Hi-Drive is more on this second type of experiments, the UC template also included detailed test scenarios for each UC even if this information for open road experiments would be only indicative.

The process followed for the Hi-Drive UC catalogue generation included three steps as also depicted in Figure 5.

Step 1: Each ADS owner describes the ADS hosted in its vehicle.

Step 2: For each ADS, the associated UCs and test scenarios to be considered in future Hi-Drive operations are generated. The test scenario template also includes complementary info on system under test (SuT) limitations, test scenario execution domain and test scenario evaluation area, giving a preliminary picture of the operation purpose and context.

Step 3: A core team checks and merges all information collected from step 2, based on the criteria listed hereafter, creating a Hi-Drive UC catalogue.

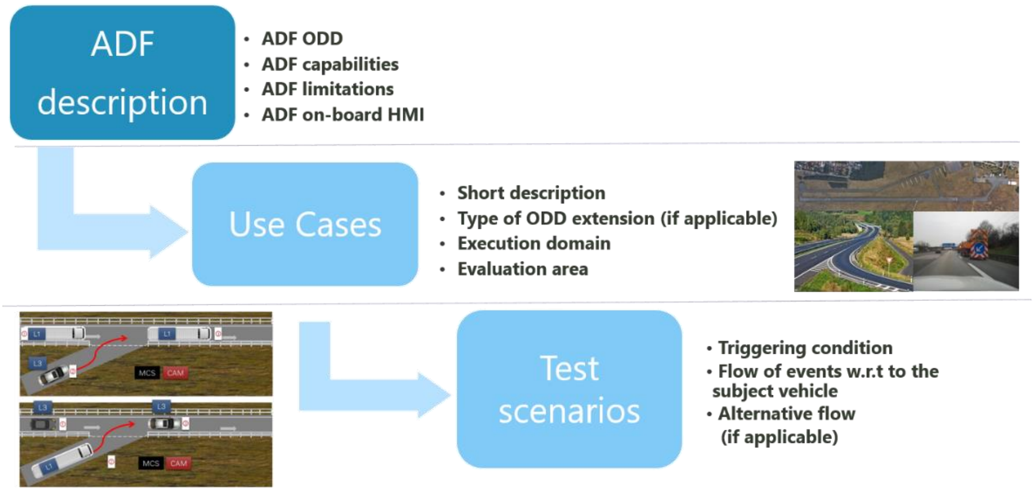

Figure 5: From ADF description to test scenarios

3.1.1 From Use Cases to Test scenarios

As discussed in [13], test scenarios are the base for scenario-based validation and verification of an ADS. Following the guidelines by the draft ISO/DIS 34502 [7], each test scenario shall be described starting from a triggering "event" or a triggering condition and then a set of alternative events' flows shall be reported. In our case, that trigger can be either an ODD condition change (e.g. weather deterioration) or an activation of a specific road ODD condition, (e.g. road on-ramp entry, tunnel entry) or a specific traffic interaction with another road user (e.g. a cut-in vehicle or a crossing intention message received via V2X), or a driving manoeuvre initiated by the ego-vehicle (e.g. a take-over of the leading vehicle).

Note: Based on the adopted methodology, describing (staged) test scenarios for test tracks is straight forward. However, for the Hi-Drive experiments including real-world driving, the test scenarios cannot easily be defined that way, because there is no possibility of conducting pre-defined test scenarios on open roads. A possible approach could be to interpret them as those conditions that can be detected in the data and that render the scenario interesting for investigation/evaluation later in effects' evaluation activities.

Few additional considerations follow:

- A "trigger" is here loosely defined as a driving environment condition change, e.g. ODD dynamic attributes, actions by other traffic agents which then activates an action by the automated vehicle; w.r.t to open road tests, we are using the term "trigger" in a not strict manner: in reality, no actual trigger is activated, changing of conditions simply do or do not occur.
- When two very similar UCs are merged, test scenarios are also merged by keeping the superset of their union.
- Re-editing of test scenarios is performed in order to align the collected information with the test scenario format required by the UC template (see sec. 3.2).

3.2 UC/Test scenarios description template

A template is proposed that is composed of one table that hosts the information about the UCs and associated test scenarios to be supported by each ADS under test (ODD extension type to be provided if applicable). Template elements are outlined in Tab. 2.

Tab. 2 UC & Test scenarios template elements

Index	Item	Notes
1	UC class	predefined classes, see below
2	UC ID	-
3	UC Title	-
4	UC short description	-
4.1	UC test scenarios	-
4.2	UC test scenarios sketch	optional
4.3	ID of integrated Enabler	per UC
4.4	Type of ODD extension per UC	per UC, only if applicable predefined classes, see below
4.5	SuT limitations for this particular UC	optional, e.g., maneuvers not supported, known hazardous situations/unsafe control actions to be avoided if available from prior testing, fail-cases based on simulation testing
4.6	UC execution domain	predefined classes, see below
4.7	UC evaluation domain	predefined classes, see below

The template makes use of the following pre-defined types:

1. Four ADF types are considered, namely Motorway, Urban, Rural and Parking.

2. Six classes of Hi-Drive UCs have been considered based on the road environment namely: Motorway, Motorway-to-Urban, Urban, Rural, Cross-Border, Parking.

3. Based on the ODD specification input collected from all Hi-Drive ADS owners, 12 types of ODD extension were identified across the 27 Hi-Drive ADF instances:

1. new type of road environment (e.g. urban)
2. on-ramp
3. off-ramp
4. temporary or special road structure/road hazard
5. challenging environmental condition (heavy rain or snow)
6. challenging road condition (deteriorate lane markings, shadows on road surface)
7. new type of traffic agent (vehicle or VRU)
8. visibility blockage due to traffic buildings or road furniture or other vehicle[1]
9. increased level of traffic volume
10. GNSS interruption
11. traffic light
12. cross-border

4. Based on Hi-Drive Operations planning, three types of UC execution domain have been considered:

- Open Road
- Test Track
- Virtual

5. Based on Hi-Drive preliminary evaluation planning, four types of test scenario evaluation domain have been considered:

- AD Performance (e.g. CAV interaction with other road users)
- AD availability (ODD extension)
- User (e.g. System-User interaction)
- Impacts (e.g. on safety, efficiency, society).

3.3 Criteria for UCs grouping

As depicted in Figure 6, several grouping criteria have been applied to the pool of UCs collected by the ADS owners in order to come up with the final ADF-agnostic Hi-Drive UC catalogue clusters per ADF type.

High-level grouping criteria (UCs coming from different ADFs):

- A UC catalogue per ADF type will be provided.

[1] presence of another vehicle obscuring FoV is not technically an ODD condition but part of the scenario; however we decided to include it here as there is no field to describe challenging traffic actors' topology in the scene.

- UC grouping is enabler-agnostic (different technology enablers may support the same UC); ODD extension or AD performance enhancement through the enabler is what matters, not the technology behind the effect).
- UC catalogue shall host all these UCs that we want to study in Hi-Drive either because they influence the ADS under test or the user, or because they are interesting for enabler-related development and evaluation work. In that sense we have not excluded UCs corresponding to prototype vehicles with L2- or even manually driven since these will be part of enabler related activities. This also implies that in such cases there is no ODD extension, so that cell should be N/A.

Low-level grouping criteria (UC context):

- In order to avoid many slightly different UCs, grouping of similar UCs (similar target and ODD context) under a merged UC is performed. The goal is to create a UC catalogue where each UC is semantically distinct from another.
- Splitting of an abstract UC (e.g. urban driving) into more detailed UCs (e.g. urban driving on straight road segment versus turning in an intersection) is recommended as we try to be specific on the driving situations we want to study. In particular, we differentiate among:
  - AV-to-VRU and AV-to-vehicle interaction if we believe logged data will support such kind of actor-based analysis (more suitable for the test tracks experiments).
  - cooperative/non-cooperative ADFs since studying the ODD defragmentation through connectivity is an important project objective
  - signalized/non-signalized intersections since they represent quite different traffic context.
  - driving manoeuvres if needed (lane keeping vs. overtaking).

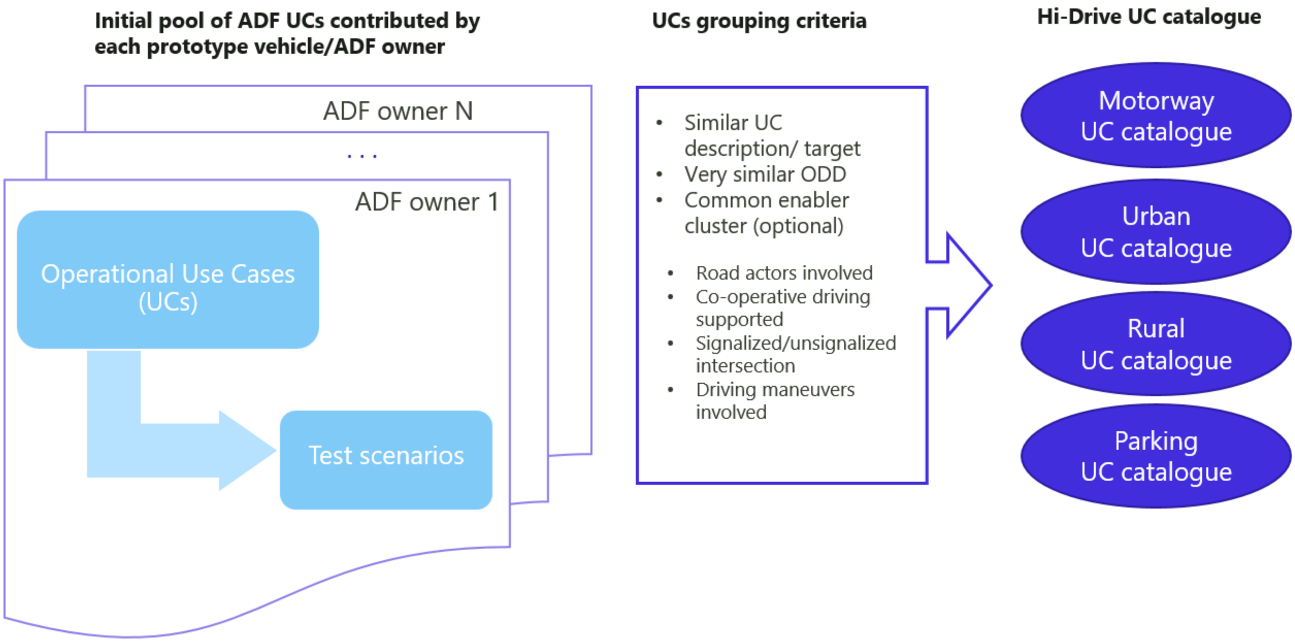

Figure 6: Hi-Drive UC catalogue generation

4 UC catalogue overview

Following the template described in sec. 3.2, from the 31 Hi-Drive ADS described, 71 UCs were contributed by the 20 Hi-Drive vehicle owners. These have been analysed and then grouped in order to create the proposed Hi-Drive UC and Associated test scenarios' catalogue. The 31 final Hi-Drive UCs of this catalogue were clustered into 16 UC clusters and in particular, Hi-Drive UC catalogue defines:

- 6 Motorway UC clusters based on 39 initial UCs by 15 vehicle owners;
- 6 Urban clusters based on 26 initial UCs by 14 vehicle owners;
- 3 Rural clusters based on 4 initial rural UCs by 3 vehicle owners;
- 1 Parking cluster out of 2 parking UCs by 3 vehicle owners.

An overview of UC clusters formed as part of the Hi-Drive UC catalogue is given in Tab. 3. We may observe that a large number of UCs include connectivity as technology enabler impelmenting some type of cooperative driving via V2X e.g. Motorway (Cooperative lane merging/exiting/overtaking + Handling an event notification), Urban (Cooperative non-signalized intersection transit with early AD reaction to V2N) and Rural (Cooperative overtaking via V2V). More details as well as the full list of Hi-Drive UCs and test scenarios catalogue can be found in upcoming Hi-Drive deliverable D3.1 [12].

Tab. 3 UC & Test scenarios template elements

UC class	UC title	Number of UCs
Motorway	Cooperative lane merging/exiting/overtaking (8)	8
	Lane merging / exiting /interchange / lane changing	5
	Motorway driving (different challenging scenarios)	5
	AD system identifies challenging operational domain condition or recognizes driver state	4
	Special or temporary road infra crossing	2
	Handling an event notification about an event in the range of 0.5-2kms ahead	2
Urban	Cooperative non-signalized intersection transit with early AD reaction to V2N	5
	Cooperative signalized intersections transit via V2I	1
	Cooperative urban driving (no intersections) - handling an event notification (about 0.2-2kms ahead)	2
	Urban canyon driving	1
	Urban driving - straight segment	5
	Urban driving -non signalized intersections	2
Rural	Driving in 2-directional rural road section	1
	Cooperative overtaking via V2V	1

	Arctic uninterrupted driving against specific conditions	2
Parking	Automated Valet Parking	2

4.1 Overview of collected ADFs vs. targetted ODDs

Focusing on the types of ODD extension supported by the Hi-Drive ADF instances, Tab. 4 includes details showing number of UCs supported per ADF type and per type of ODD extention.

Tab. 4 ODD extension types that are supported by the Hi-Drive ADFs

	ADF Type				Total number of UCs
ODD extension	Motorway	Urban	Rural	Parking	
New type of road environment (e.g. urban)	0	1	1	0	2
On-ramp	8	1	0	0	9
Off-ramp	6	0	0	0	6
Temporary or special road structure or road hazard	5	8	0	0	13
Challenging environmental condition (heavy rain or snow)	1	5	1	0	7
Challenging road condition (e.g. deteriorate lane markings)	2	7	1	0	10
New type of traffic agent (vehicle or VRU)	1	7	0	1	9
Visibility blockage due to traffic buildings or road furniture or other vehicle	2	1	1	0	4
Increased level of traffic volume	1	4	0	0	5
GNSS interruption	3	2	0	1	6
Traffic light	1	2	0	0	3
Cross-border	1	0	1	0	2

5 Conclusions

In this paper a methodology for operating scenarios and Operational Domain specification that supports scenario-based evaluation of Connected Automated Driving (CAD) applications, targeting both AD availability and AD performance, as developed in the EU-funded project Hi-Drive, were presented. This work included:

a) SuT ODD specification suitable for AD technical evaluation, where ODD attributes are tagged as either relevant to (nominal) ODD performance tests or to (extended) ODD defragmentation tests.

b) A methodology for SUT test scenarios definition. Complementary info on the type of the challenging ODD conditions to be tested (if applicable), the applicable test environment and the evaluation domain is also included to each test scenario description. Finally, a grouping of use cases and ODD extension types is proposed leading to the creation of the Hi-Drive UC and Test scenarios catalogue.

The ultimate goal of the UC catalogue methodology proposed was to provide a test scenarios basis that will allow the project to demonstrate how AD functions' ODDs can be extended to avoid locally occuring fragmentations. The authors believe that the UC catalogue derived (soon to be made publicly available as Hi-Drive deliverable D3.1) can be useful outside Hi-Drive, supporting ongoing activities on CAD functions' scenario-based description, testing and evaluation and it proves the Hi-Drive broad test scenario coverage.

Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006664. The sole responsibility of this publication lies with the author(s). The author(s) would like to thank all partners within Hi-Drive for their cooperation and valuable contribution.

6 Abbreviations

ADF	Automated Driving Function
ADS	Automated Driving System
OD	Operational Domain
ODD	Operational Design Domain
SUT	System Under Test
UC	Use Case

7 References

[1] L3Pilot Deliverable D7.3: Pilot evaluation results, https://l3pilot.eu/fileadmin/user_upload/Downloads/Deliverables/L3Pilot-SP7-D7.3-Pilot_Evaluation_Results-v1.1-for_website.pdf.

[2] L3Pilot Deliverable D7.4: Impact evaluaiton results, https://l3pilot.eu/fileadmin/user_upload/Downloads/Deliverables/Update_14102021/L3Pilot-SP7-D7.4-Impact_Evaluation_Results-v1.0-for_website.pdf.

[3] ASAM OpenODD concept project, Concept paper, https://www.asam.net/index.php?eID=dumpFile&t=f&f=4544&token=1260ce1c4f0afdbe18261f7137c689b1d9c27576, accessed in Sept 2022.

[4] BSI PAS 1883, Operational Design Domain (ODD) taxonomy for an automated driving system (ADS) - Specification, 2020.

[5] AVSC00002202004, Automated Vehicle Safety Consortium, AVSC Best Practice for Describing an Operational Design Domain: Conceptual Framework and Lexicon, SAE Industry Technologies Consortia, 2020.

[6] Catapult MUSICC project, Design considerations for ODD ontology, https://1hir952z6ozmkc7ej3xlcfsc-wpengine.netdna-ssl.com/wp-content/uploads/2021/01/Design-considerations-for-ODD-ontology.pdf.

[7] The draft EU Implementing Regulation, Ares(2022)2667391. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02019R2144-20220706, accessed in Sept 2022.

[8] SAE J3016, SAE J3016™ Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,, 2021.

[9] ISO/DIS 34502, Road vehicles -Scenario-based safety evaluation framework for Automated Driving Systems, 2021.

[10] L3Pilot Deliverable D4.3: Evaluation plan, https://l3pilot.eu/fileadmin/user_upload/Downloads/Deliverables/Update_07102021/L3Pilot-SP3-D3.4-Evaluation_plan-v1.0_for_website.pdf.

[11] https://report.asam.net/the-relation-between-test-case-and-scenario, accessed in Sept 2022.

[12] Hi-Drive deliverable D3.1 "Use cases definition and description", document in preparation, to appear soon in publicly available project results, please refer to https://www.hi-drive.eu/downloads/.

[13] https://report.asam.net/the-relation-between-test-case-and-scenario, accessed in Sept 2022.