ESRIUM

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Deliverable 5.2
Test scenarios and specifications

ESRIUM
SAFE AND EFFICIENT ROADS

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Abstract

ESRIUM is a multi-national project with the common goal to increase the safety and resource efficiency of mobility on the road. The key innovation will be formed by a homogeneous, accurate and recent digital map of road surface damage and road wear. Further addressed as “road wear map”, it will contain unique information, which is of value to multiple stakeholders: road operators will be able to lower the road maintenance effort by optimal planning. Further, road operators will be able to lower road wear and increase traffic safety especially for heavy vehicles: considering the market introduction of partly automated truck fleets and platoons, the precise track of these vehicles can be adjusted by communicating precise routing recommendations in- and cross-lane. Truck fleet operators following these recommendations can receive tolling benefits and increase the general safety for their vehicle fleet. Especially with the increasing levels of autonomy, systems will utilize infrastructure support to handle the requirements of the automated driving task and additional external requests. In ESRIUM, these opportunities are addressed by utilizing C-ITS infrastructure and EGNSS based localization in planning the trajectories of such automated vehicles. Key to the ESRIUM innovation is a precision localization service, which provides reliable locations of road damages and of the vehicles using the roads. Considering a European-level business-case, only Galileo may provide such a service in homogeneous quality, even at very remote locations on the European continent.

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EXECUTIVE SUMMARY

Road damages on highways and freeways lead to numerous construction sites and maintenance operations every year, which cause congestion, increased pollution, and costs. Additionally, road damage also exposes road users to an increased risk of accidents. ESRIUM services shall help reduce the number of construction sites and reduce the associated problems by using digital services for smart road infrastructure utilization and predictive maintenance. By creating virtual road wear maps using artificial intelligence, road damage is to be detected at an early stage and preventive measures for equal and graceful degradation of the surface can be taken. With the help of compatible adaptive ADAS/AD systems and smart routing solutions, vehicles shall receive the necessary routing recommendation information while driving to avoid road damage zones in the form of lane-change manoeuvres or in-lane offsets.

In the context of the ESRIUM project, WP2 “Use Cases and Requirements Analysis” serves to define relevant requirements and specifications as well as to describe the specific use cases for the above-mentioned exemplary services structured around ESRIUM’s business cases. WP5 “Proof of Concept and In-Vehicle Validation” on the other hand, aims to develop, demonstrate, and analyse the specific business case (EBC-002) focusing on the smart routing recommendations and solutions.

Accordingly, the overall objective of WP5 is to demonstrate the benefit of the project outcomes in terms of in-vehicle field demonstrations of the context-aware routing in the form of specific real-life use-case demonstrations. The following specific objectives are pursued also within the scope of the WP5 to help achieve the project goals:

- Help demonstrate the potential business-cases around smart routing recommendations.
- Prepare the test vehicle hardware and software environment for conduction of real-life tests.
- Create proof of concept for in-vehicle usage of strategic routing information in ADAS/AD functions.
- Implementation and testing of the value chain in a simulation environment.
- Real-life implementation and testing of the algorithms on the Austrian test sites.
- Analysis of the overall impact with user acceptance studies.

In order to achieve these goals, four tasks were defined. Task T5.1 focuses on the development and integration of automated driving functions in the test vehicle. The routing recommendations will be implemented and demonstrated on an automated driving demonstrator vehicle from VIF. The simulative development of the driving functions and pre-testing of the functions as part of representative test scenarios are also covered in this task. In Task 5.2, test runs and data collection for the developed value chain around the routing recommendations are defined and executed. The current deliverable is related to this task and aims to introduce the specific scenarios and test conditions of the demonstrations. Task T5.3 focusses on the analysis of the test data. Finally, Task T5.4 focusses on the user acceptance evaluation of the routing recommendations for manually driven trucks.

The four ESRIUM Use Cases were previously defined in the deliverable D2.1. The demonstrations that will be made in the scope of WP5 relates to ESRIUM Use Case 2 (EUC-002) entitled “Routing Recommendations within and between lanes based on the road wear map, provided via C-ITS messages”. The current deliverable document provides a description of the test scenarios as well as the corresponding key performance indicators for the EUC-002, which will be implemented by an automated driving demonstrator vehicle as well as a manually driven truck. This document also builds upon the deliverable D2.2, particularly on the technical requirements related to the end-user vehicle and provides additional details on the testing and demonstration scenarios. The corresponding EUC-002 test scenarios that are being developed also supports the demonstration and evaluation of the

ESRIUM Business Case 2 (EBC-002). In doing so, this deliverable aims to give an overview of the specific test locations, communication message types and the expected vehicle behaviour in response to the infrastructure routing recommendations.

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ACRONYMS USED

Acronym	Explanation
ACC	Adaptive Cruise Control
C-ITS	Cooperative Intelligent Transport Systems
CAV	Cooperative Automated Vehicle
IVIM	In-Vehicle Information Message
LKA	Lane Keeping Assistant
OBU	On-Board Unit
RSU	Road Side Unit
SV	Subject Vehicle. This refers to the demonstration vehicle equipped with automated driving functions and a C-ITS OBU. The SV receives and reacts to the C-ITS messages.
VIF	Virtual Vehicle Research GmbH

SECTION 1: INTRODUCTION

This document contains a description of the test scenarios for the ESRIUM Use Case 2 (EUC-002), entitled "**Routing Recommendations within and between lanes based on the road wear map, provided via C-ITS messages".** There are four main scenario types as part of WP5 to be implemented and tested within the scope of this use case as illustrated in Figure 1. The first scenario type is related to the demonstration and evaluation of in-lane offset recommendation for connected automated vehicles (CAVs). The second scenario type aims to demonstrate routing recommendation in the form of a strategic lane change and lane utilization information for CAVs. In the third scenario, a proof-of-concept implementation of a reference trajectory following utilizing EGNSS will be demonstrated. Finally, the fourth scenario includes strategic lane change recommendations for human driven vehicles and will be demonstrated utilizing trucks and truck drivers according to the ESRIUM business case 2. All use case scenarios utilize the high-accuracy EGNSS service to localize the vehicle relative to a lane in a given road stretch utilizing an HD Map, and particularly in the third scenario, the complete local trajectory recommendation will be used in the scope of the driving function.

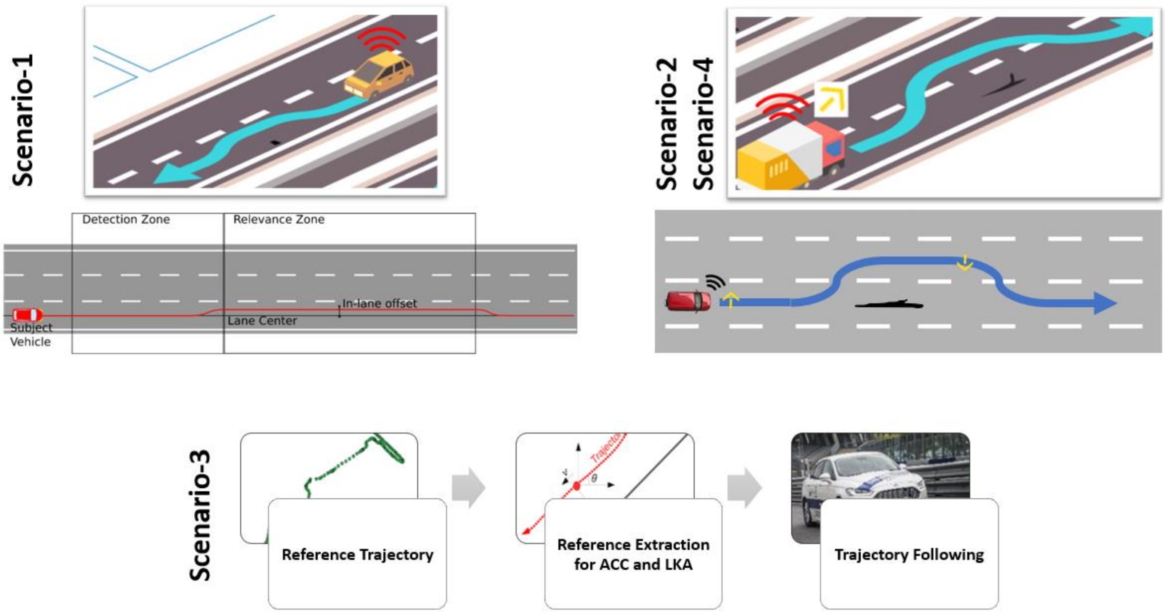

Figure 1: The four scenarios to be implemented in the scope of the EUC-002.

It needs to be pointed out here that the described test scenarios are very first implementations to verify fundamental functionality of the developed routing recommendations. The developed demonstration is not intended for a product release of an automated vehicle. The idea is rather to demonstrate the overall idea in the form of a proof-of-concept implementation and analyze the benefits using the initial results.

SECTION 2: KEY ASSUMPTIONS FOR SUCCESSFUL DEMONSTRATION

The following key assumptions and use-case specific requirements to achieve successful demonstration during the project:

1. C-ITS recommendations in the form of an IVI message (for lane choice and lane offset information) leading to guidance within and in-between lanes are available.
2. C-ITS communication infrastructure and RSUs (Road Side Units) are available.
3. EGNSS receiver and a localization solution on the end-user vehicle is available.

4. The end-user vehicle, which is an automated demonstrator vehicle (from VIF) with adaptable driving functions and is capable of receiving and interpreting IVI messages with an integrated OBU (on-board unit) for triggering the recommended vehicle actions, is available.
5. A conventional end-user vehicle (only for Scenario-4, i.e., EUC-002-SC4) with an integrated OBU and a HMI for displaying the infrastructure recommendations is available.

SECTION 3: NON-GOALS

The following are non-goals in the scope of the corresponding use case scenarios:

1. The conversion of the road wear-map into real-time routing recommendations.
2. Provision of complete route guidance (global trajectory information) via C-ITS messages (except for the Scenario-3, that is EUC-002-SC3, where only a local trajectory information will be utilized).
3. Specific provisions of individual reference paths (local trajectory information) to vehicles, particularly in the sense of managing the vehicle complete traffic.
4. Testing of the routing recommendations in adverse weather conditions.

SECTION 4: TEST ENVIRONMENT CONDITIONS

All tests shall be performed preferably under ideal operational conditions as described below:

1. Dry road conditions.
2. Daylight conditions.
3. No significant wind conditions (ideally less than 10 km/h).
4. No rain, fog, hail, snow and icy conditions.

It is noted that, the described test scenarios will involve the first public trials of a proof-of-concept implementation of an automated vehicle to verify and evaluate the fundamental functionality of infrastructure assisted routing recommendations. Therefore, the testing conditions are chosen as ideal to allow for analysis of the prototype driving functions and the developed value chain from infrastructure to the end-user vehicle.

SECTION 5: TEST TRACKS

The tests shall be conducted on the ALP.Lab Test-site (for Scenario-1 and Scenario-2, that is EUC-002-SC1 and EUC-002-SC2), and the test site for the Scenario-3 (EUC-002-SC3) has to be a closed proving ground. The tests for the Scenario-4 (EUC-002-SC4) will be conducted respectively on the DigiTrans Test-site.

The ALP.Lab Test-site is located in the Graz region, on the motorway A2 between Graz West and Lassnitzhöhe. More than 20 km of the motorway segment are equipped with the state-of-the-art and innovative sensors and communication equipment.

The ALP.Lab Test-site is equipped with gantries in 12 positions. Most of the special sensory equipment is mounted on these gantries. 12 roadside units are mounted on already existing gantries on the ASFINAG Network.

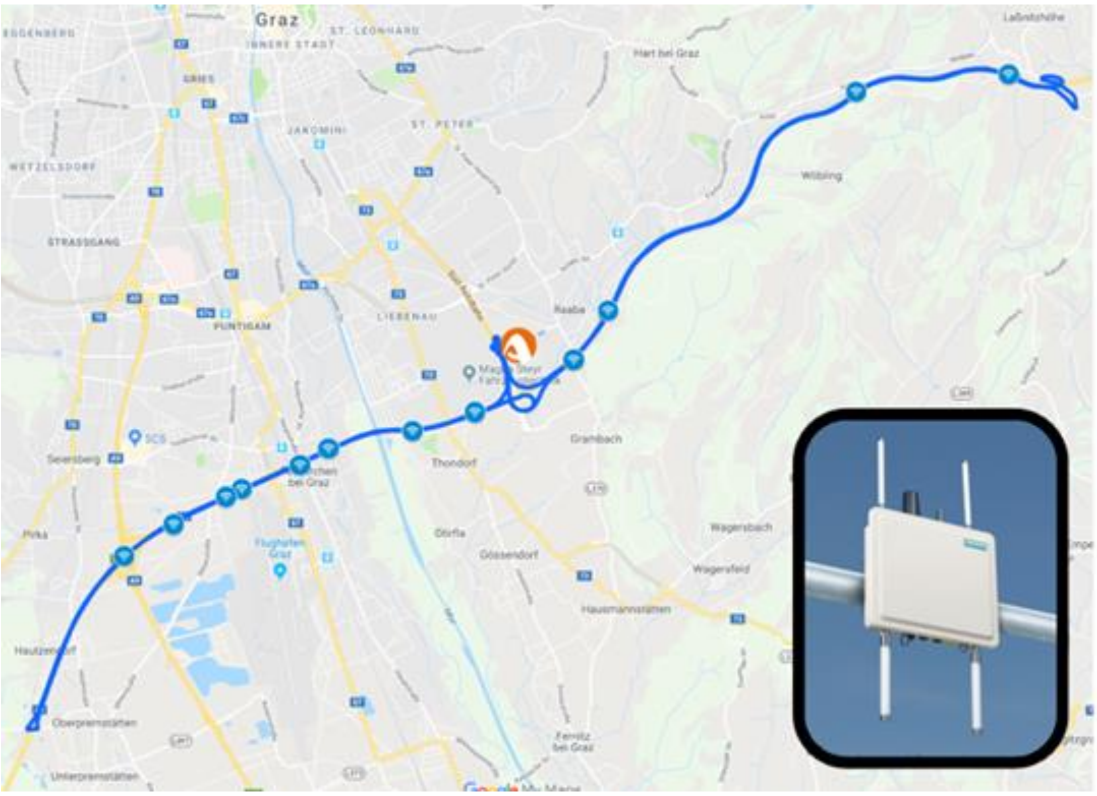

Figure 2: ALP.Lab Test-site illustrated along the Austrian A2 motorway.

Along a stretch of about 1.5 km, traffic data sensor sets have been installed. They cover both driving directions and each of the lanes. In 29 positions, sensory equipment for weather and environmental data is installed. 26 cameras with automatic incident detection are located on the Austrian test site in both driving directions.

In the southern part of the test track radar sensors are installed covering a stretch of around 1.5 km with high resolution. The radar equipment is currently being upgraded in order to support the creation of collective perception messages (CPM) within the next months.

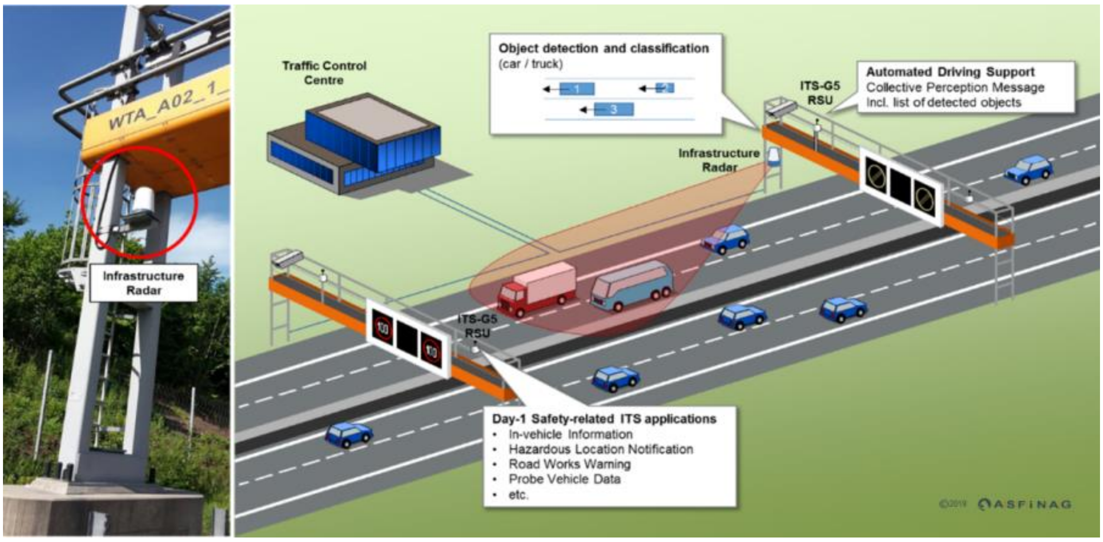

Figure 3: Infrastructure equipped with radar sensors.

Mobile warning trailers are indispensable aids in securing road work areas. The most important features are the display panel and the well-visible warning lights. Approaching vehicles are warned visually by these means. Securing road work zones is essential for traffic safety and for the safety of the workers.

In 2017, ASFINAG has acquired so called IMIS mobile warning trailers. IMIS stands for "Intelligent Mobile Information System". The expanded functions of this new generation of mobile warning trailers are:

- LED graphic panel,
- Remote configuration and remote control by the traffic management center,
- Video camera,
- Support of travel time assessment,
- Traffic detection,
- CB radio warning, and
- Car-to-X communication.

These functions will enable the mobile warning trailers to support even more use cases, especially the roadworks use case as described above.

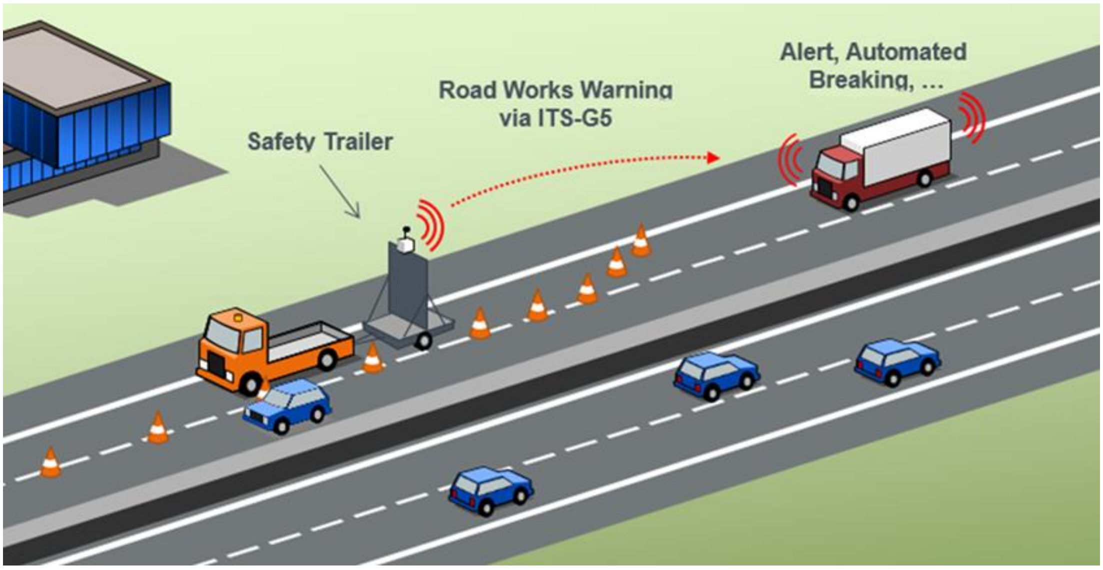

Figure 4: Roadworks zone and mobile warning trailer.

The DENM roadworks warning by the IMIS Trailer is the first ASFINAG C-ITS service already available in the end-user vehicle, as can be seen in the Figure 5.

Figure 5: ITS-G5 equipped vehicle receiving a warning via DENM.

SECTION 6: SPECIFIC USE CASE SCENARIO DESCRIPTIONS

In this section we describe the four specific test scenarios to be implemented in the scope of the use case EUC-002. The main goal of the testing within the scope of WP5 is "**implementation and testing of in-lane offset recommendations and triggered lane-changes under ideal conditions for an SAE level-3 automated vehicle and analyzing the corresponding performances"**.

It needs to be noted here that the four scenarios introduced have levels of complexities low/medium, which represent only a small fraction of the usage cycle of a typical commercial automated driving system. The intention of the WP5, and the corresponding use case demonstrations therein, is to perform proof-of-concept implementations and demonstrations of the specially developed automated driving functions and the infrastructure assisted routing recommendations as conjectured within the ESRIUM project. This is also in accordance with the research focus of the ESRIUM project as well as the fact that the developed automated driving functions themselves are prototype solutions without certification and homologation. Therefore, exhaustive testing of the developed solutions including extreme "edge" conditions is not intended, and not in the scope of the planned testing activities. Testing of some representative edge cases will only be conducted in simulation.

Each of the introduced scenarios will be tested under different parameter configurations such as different in-lane offset values, various ego vehicle velocities (i.e., the vehicle under test driving at different desired speeds), as well as under random traffic conditions. The specific parameter configurations to be utilized are described further in Section 9 below.

The specific tests conducted, and the analysis of the corresponding results will be reported in the upcoming deliverable D5.3 "Test results analysis report" which is due at the end of the project in M36. The simulative development and analysis results corresponding the designed driving functions have recently been published (please see: https://doi.org/10.3390/electronics10172161.)

6.1. Scenario-1 (EUC-002-SC1): In-lane offset recommendations

In this scenario, the test shall be carried out on the ALP.Lab Test-track. According to the scenario, the subject vehicle (SV), shall drive in automated mode (SAE Level-3 equivalent Motorway Chauffeur combining ACC and LKA driving functions) in a detection zone when it receives an IVI message containing a recommended lane-offset information (see Figure 6). Here detection zone refers to the region at which the vehicle must receive the routing recommendation, which need to be conducted in the relevance zone. The C-ITS routing recommendations in the form of IVIM come from an infrastructure RSU and are received by an OBU on the SV, which are then interpreted by the linked automated driving functions. The IVIM also includes the geo-locations of the detection and relevance zones corresponding to the routing recommendation. Before entering the relevance zone (this is the zone, where the recommended action by the IVIM needs to be implemented), the SV adapts the typical LKA task of tracking the center of the existing lane and transitions to driving along the same lane with the given in-lane offset. The SV is expected to drive throughout the relevance zone with the recommended in-lane offset in case traffic conditions permit it. Immediately after leaving the relevance zone the SV is expected to follow the default centerline tracking task unless otherwise recommended.

The vehicle speed shall be between 80km/h and 130km/h (or less if traffic rules in the chosen part of the highway dictates it).

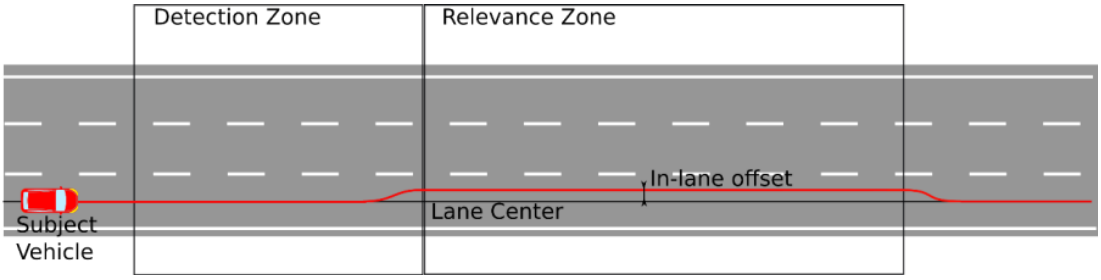

Figure 6: In-lane offset recommendation scenario description for Scenario-1 (EUC-002-SC1).

The lane offset recommendation is broadcast using the free text option in the automated vehicle container of the existing IVI message standard according to TS 103 301 V2.1.1 and ISO 19321: 2020:

- The free text contains the "+" or "-"symbol followed by the offset in centimeters.
- "+" indicates an offset to the right of the lane center.
- "-"indicates an offset to the left of the lane center.

In this scenario the driver steers the SV to the rightmost lane and activates the automated driving mode. Within the detection zone the SV gets via IVIM the routing recommendation in the relevance zone with a pre-defined offset. It will not leave the rightmost lane while driving along the relevance zone with the defined offset from the lane center in automated mode. After leaving the relevance zone the SV will steer back to the center of the lane and on the HMI the information that the test was finished will be displayed.

6.2. Scenario-2 (EUC-002-SC2): Lane change recommendations

In this scenario, the test shall be carried out on the ALP.Lab Test-track. According to the scenario, the SV shall drive in automated mode (SAE Level-3 equivalent Motorway Chauffeur combining ACC and LKA driving functions) in a detection zone when it receives an IVIM containing a set of three relevance zones with instructions to change the lane. For testing purposes, only a change to the left lane is to be demonstrated. Therefore, two specific signs (or pictograms) are required to define such a maneuver.

The lane change recommendation is broadcast using the following two pictograms:

ISO 14823 code	Meaning (lane recommendation)	Pictogram
13 660	Lane Free	
- (Custom)	Clear lane to left	

Table 1: Used pictograms and codes.

The pictograms codes are broadcast in the automated vehicle container of the IVIM. For this specific IVIM, the message contains four zones in its "Geographic Location" container; one detection zone and three consecutive relevance zones as depicted in Figure 7:

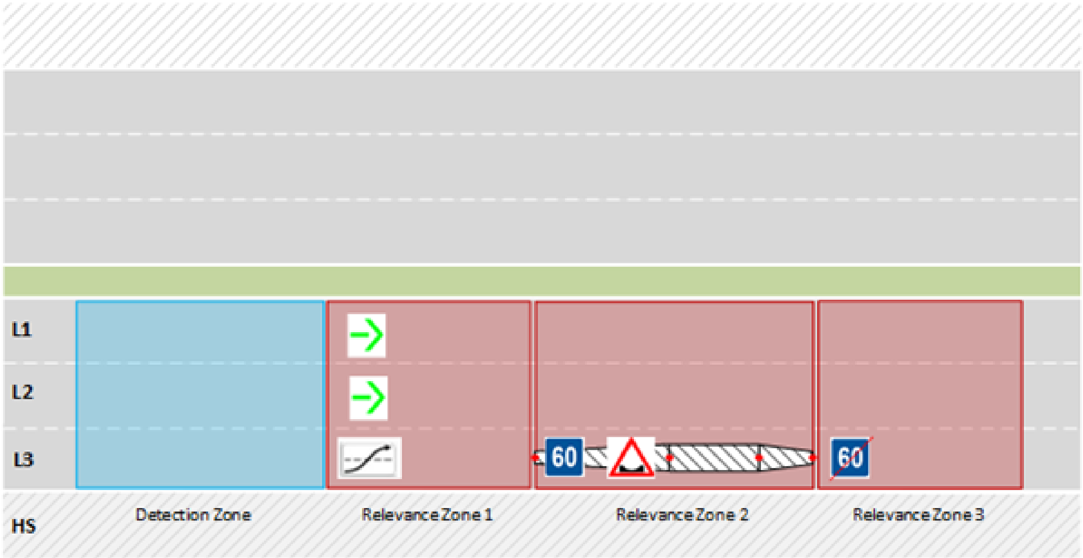

Figure 7: Lane Change recommendation scenario description for Scenario-2 (EUC-002-SC2) and Scenario-4 (EUC-002-SC4). The signs/pictograms for the speed limits and roadworks zones are not part of the routing recommendation message and are shown here for illustration purposes with regards to why the corresponding recommendation may be utilized.

Note that…

- … in Figure 7 the arrows are shown in direction of traffic from "birds' eye view" and not from "drivers' view".
- … relevance zone 1 and 2 also serve as the detection zone for relevance zone 2 and 3 respectively.

Table 2 shows the mapping of the pictograms to the detection zones and relevance zones and to the different lanes.

Detection Zone IDs	Relevance Zone IDs	Applicable Lanes	ISO 14823 Pictogram code
1	11	1, 2	13 660
1	11	3	custom (clear lane to the left)
11	12	1, 2	13 660
12	13	1, 2, 3	13 660

Table 2: Pictogram code for the different relevance zones and lanes.

In this scenario the SV initially drives along the road until it enters the detection zone. In the detection zone, SV receives the IVIM with the above-described information describing the route choice recommendation in the following relevance zones. In the first relevance zone the SV is asked to change to the left lane. Afterwards, during the whole relevance zone 2 the SV is informed to keep to this lane, and therefore should not change to the right lane. In the relevance zone 3 the SV is requested to change to the rightmost lane, depending on the traffic conditions.

During the course of the scenario, the driver is responsible for the safe execution of the lane changes.

6.3. Scenario-3 (EUC-002-SC3): EGNSS-based local lane recommendations

In this scenario, the test shall be carried out at the ÖAMTC (Österreichischer Automobil-, Motorrad- und Touring Club) Fahrtechnikzentrum in Lang/Lebring, which is located about 30 km south of Graz, Austria (see Figure 8). This test track is also part of the Alp.Lab test region. The FT4 section of the proving ground, shown in the figure with a virtual lane overlay, is to be utilized as the test track for the demonstration of this scenario. The FT4 features a straight road section with an approximate usable length of 250 m and width of at least 10 m, allowing modelling of 3 virtual lanes with a width of 3.5m each along the track.

Figure 8: [ÖAMTC Lang/Lebring]() Test Track and FT-4 section to be utilized for the demonstration of Scenario-3 (EUC-002-SC3).

According to the scenario, the SV shall drive in automated mode (SAE Level-3 equivalent Motorway Chauffeur combining ACC and LKA driving functions) along the test track to follow the speed and the trajectory reference as defined from the infrastructure. The reason why this scenario will not be demonstrated on the A2 motorway is the fact that testing of such a driving function on public roads, based only on the EGNSS location information, is not permitted according to the Austrian government's directive on testing of automated functions.

In this scenario no RSU shall be utilized, and rather the C-ITS communication will be emulated with the parsed route recommendation information in the form of a pre-defined reference path.

Normally, such a routing recommendation based on C-ITS should be coming from an RSU utilizing a MAPEM message, which would then be received by the OBU and parsed accordingly for utilization in the automated driving functions on the SV for trajectory following purposes. Having said this, it needs to be pointed out that there is unfortunately no standard message format for transmitting reference trajectories to individual vehicles. Therefore, regardless of involving and RSU and C-ITS, the implementation will be non-standard and ad-hoc. The process flow for the Scenario-3 demonstrations is illustrated in Figure 9.

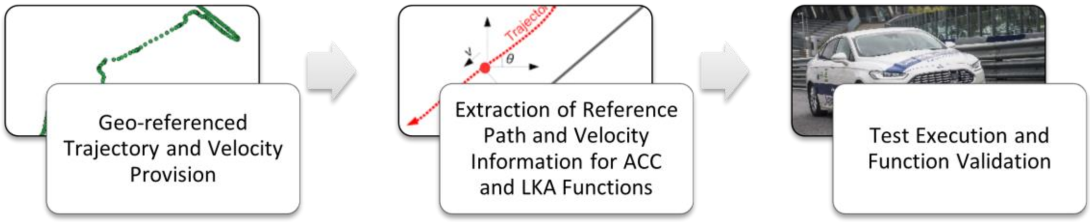

Figure 9: Process flow for EGNSS-based local lane recommendation demonstration for the Scenario-3 (EUC-002-SC3).

It needs to be pointed out here that the EGNNS localization with RTK corrections of the ego vehicle for obtaining highly accurate position measurement plays an important role for achieving good tracking of the reference trajectory. The RTK corrections of the EGNSS receiver will be obtained with RTCM messages either from a C-ITS RSU or an NTRIP mobile server.

6.4. Scenario-4 (EUC-002-SC4): Lane change recommendations – manually driven

This scenario is very similar to Scenario-2 (EUC-002-SC2), except that the test vehicle is not driven by an automated driving function but by a human driver. In this scenario, the test shall be carried out at the DigiTrans Test-track (Upper Austria area).

According to the scenario, the test vehicle shall be driven in a detection zone when it receives an IVI message containing a set of three relevance zones with recommendation to avoid the rightmost lane because of a minor road damage. In relevance zone 1, the driver is informed via a HMI that he shall change the lane to the left, if the vehicle is driving an the rightmost lane. The driver must decide if he can safely follow this recommendation, according to the traffic situation. Afterwards, during the whole relevance zone 2, the driver is informed to keep to this lane, and therefore should not change to the right lane. And in relevance zone 3 he is informed that he can safely change back to the rightmost lane if traffic allows it.

SECTION 7: LOGGED DATA

Data to be logged during the tests corresponds to all the available data on the automated driving demonstrator vehicle and include particularly the following information, among others:

- On-board vehicle inertial sensors (velocity, accelerations, yaw rate),
- Actual positions of control actuators (steering wheel angle, pedal positions),
- Wheel speeds,
- Blinker and button states,
- GNSS/IMU raw data for performance comparison (RTK assisted GNSS localization data),
- EGNSS position, velocity, heading and quality data,
- Object lists of on-board perception sensors (e.g., intelligent camera)

- C-ITS messages and the parsed driving recommendations,
- Planned and driven trajectories (i.e., desired and actual in-lane offset values, planned lane-change trajectory, and the actual vehicle path time history).

These data logs will be recorded and shared by default as Matlab data files (*.mat*), which are easily convertible to .csv data files for the ease of data exchange and interoperability between all the partners. Note that the data logs will be obtained through different parametric configurations as described in Section 9, and possibly with multiple runs of each specific scenario and parameter configuration. However, it is not a goal to perform the tests with regular intervals and in a persistent way to obtain stochastic trends.

SECTION 8: TESTING AND PERFORMANCE CRITERIA

The objective of the tests in WP5 is to evaluate the proof-of-concept implementations of in-lane offset recommendations and triggered lane-changes under ideal conditions for an SAE level-3 automated vehicle, and consequently to analyze the corresponding performance indicators.

The specific performance criteria to be analysed in these test scenarios originate from the corresponding end-user vehicle technical requirements that are described in detail in the deliverable D2.2 “Technical and non-technical user requirements document”. Specifically, technical requirements *ETR-014*, *ETR-015*, …, *ETR-021* define the main performance indicators for the corresponding use case scenarios related to the automated driving end-user demonstrator vehicle. The analysis of these specific set of KPIs for each test is the subject matter of the upcoming deliverable D5.3 that is due in M36.

In addition to the performance criteria defined in the D2.2, the difference between recommended and actual driven trajectory shall be assessed in each of the test scenarios, where possible.

In the case of in-lane offset recommendations, the desired and actual lane offset values will be the key performance indicator under different offset values. Also, performance indicators such as rise-time, and reaction time of the vehicle to the in-lane offset recommendation as the vehicle travels through detection and relevance zones will be analyzed. Moreover, the performance indicators related to the IVI message reception rates and message parsing times will also be investigated.

In the case of lane-change recommendations, planned lane-change trajectory generated by the trajectory planner from the given starting point (defined in the IVI message) shall be compared with the actual vehicle path as a further performance indicator. The distance between the two trajectories shall be measured perpendicular to the centerline of the respective lane. Again, controller specific parameters of the vehicle such as the rise-time and reaction time as well as the IVIM reception statistics will be analyzed.

The evaluation and validation after each test will be performed using the high-accuracy localization data from the EGNSS/IMU reference system as well as the UHDMap® of the test locations.

SECTION 9: PARAMETERS TO BE VARIED

During the execution of the tests of the four scenarios described in Section 6, further variations of the tests are planned to collect multiple repetitions of each scenario under specific parametric configurations. The vehicle data logs, described in Section 7, will be recorded in each of these tests to analyze the respective effect of the parametric configuration on the performance indicators described in Section 8.

The specific parametric configurations that shall be considered for each test scenario are defined indicatively as below:

- In the case of in-lane offset recommendation *(EUC-002-SC1)* the in-lane offset values should be varied. Within a relevance zone, the test should be repeated with
    a. 10cm positive and/or negative in-lane offset,
    b. 20cm positive and/or negative in-lane offset,
    c. 30cm positive and/or negative in-lane offset.

  These different offset values can be implemented separately or as part of the same routing recommendation with multiple relevance zones, each with different offset values as described above.
- In the case of the lane change recommendation (EUC-002-SC2), the lane change scenarios will include a double lane change maneuver through the relevance zones. This corresponds to avoidance of a roadworks zone of a single blocked lane with a limited length through a relevance zone. Also, consecutive lane changes from rightmost to left most will be implemented and tested.
- In the case of the trajectory recommendation (EUC-002-SC3), different reference trajectories such as double lane change and consecutive lane switches at different velocities will be tested.
- The tests shall be repeated at different traffic densities/traffic volumes, where applicable. This shall also result in different responses of the trajectory planner function, which will eventually lead to different ego-vehicle paths in each run.
- We note that extreme traffic situations can only be tested in simulation in order to ensure safety.
- The tests shall be repeated multiple times at each parametric configuration, where possible.
- The user acceptance tests that shall be conducted in the scope of lane change recommendation-manually driven (EUC-002-SC4) scenario, specially instrumented trucks with ITS-G5 OBUs will be utilized to measure the response of several truck drivers to the lane change recommendations along a fixed route followed by questionnaires.

SECTION 10: CONCLUSION

This document provided detailed descriptions of the test scenarios as well as the corresponding key performance indicators for the ESRIUM Use Case 2 (EUC-002) demonstrations that shall be conducted within the scope of WP5. This document also builds upon the deliverable D2.2, particularly on the technical requirements related to the end-user vehicle and provides additional details on the testing and demonstration scenarios. Specifically, we have defined the testing requirements, assumptions, test locations, and the scenario specifics including the respective IVIM infrastructure routing recommendation message content, the script of the expected automated driving vehicle behavior as well as the KPIs and performance evaluation criteria. The required automated driving functions, which are capable of performing the recommended/instructed maneuvers shall be developed first in simulation and then will be implemented on an automated driving demonstrator vehicle for conducting the real-life demonstrations of the ESRIUM use case 2 (EUC-002) and collect specific performance data. The corresponding vehicle tests and demonstration of the complete value chain are planned to be performed within the last year of the project in 2023, though the development-specific tests will already start in 2022. The demonstrations and evaluation results of the collected data shall also help and support the evaluation of the ESRIUM Business Case 2 (EBC-002).

It is noted here that the test scenarios described in this document utilize the specially designed routing recommendations in the form of IVIM and aim to demonstrate and analyze their effect on the end-user vehicles, both for automated driving as well as manually driven vehicles. The demonstrations do not include and depend on the availability of a road wear map, to be developed in the scope of WP4 “Wear Map Creation, Integration and Upkeeping”. While such a wear map would be the main input at the infrastructure side for the generation of real time routing recommendations for the oncoming traffic, how this could be done as such, is outside the scope of the current analysis.

The specific implementation details of the vehicle integration and setup, as well as the driving function verification tests to be conducted on the demonstrator vehicle as part of the WP5 will be reported in the next upcoming deliverable D5.1.