Rail to Digital automated up to autonomous train operation

D42.1 – Collection of test cases and validation criteria

Collection of test cases and validation criteria for autonomous movement of tramways in depot demonstrator.

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REPORT CONTRIBUTORS

Name	Company	Details of Contribution
Dusan Patrick Klago	STR	Collection of test cases (operational) for demonstrators in the Oslo depot and operational rules for these use cases.
Nacho Celaya Vela	CAF	Collection of test cases (technical) for demonstrators in Oslo. Definition of acceptance and validation criteria.
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EXECUTIVE SUMMARY

- Context and objectives

  The selected test cases and validation criteria provide the basis for a test plan and procedures to validate the autonomous movements of the modified tramway during demonstrator in Work Package (WP) 42.

  The interaction between operational rules, operational use cases, technical enablers resulted in a list of test cases list.

  Acceptance criteria and the reasonable validation of the expected outcomes from testing of the selected use cases will be integrated into the execution plan and procedures for the WP42 demonstrator in Oslo.

  Input and experience from WP40 and WP41, related to the demonstration of remote control of the tram in Oslo, helped to specify the test case for autonomous manoeuvring.

  The selection of the test cases has been thoroughly evaluated by Sporveien Trikken and CAF, companies responsible for the execution of the demonstrator in Oslo. The final list has been reviewed by UITP. This selection of the test case reflects the technical possibilities provided by modifications on the vehicles for the demonstration.

- Scientific/Technical approach or methodology

  The starting point for this deliverable was the collection and review of the routines and procedures used to manage and regulate tramway operations in Oslo. Deliverable D41.1 (Collection of the test cases for remote driving)[3] also provided valuable input to D42.1.

  The high-level operational use cases from deliverable D40.1 were input to this task, elaborated further, and adjusted to technical possibilities and TRL6[1] for autonomous tramways.

  Deliverable D 6.6 has been used as reference for the additional technical evaluation of test cases in WP42. Input from D6.6 has been relevant for the evaluation of the technological readiness for the autonomous movements demonstrator and for the selection of acceptance criteria in WP42. [2]

  All rules, requirements, and prerequisites for tramway operations at Sporveien Trikken in Oslo are listed in Annex 1.[1]

- Main (scientific) findings/conclusions from the deliverable

  It has been concluded that the technical solutions' readiness and the existing technological progress, allow us to prepare relevant test cases and a testing plan for the demonstrator in WP42.

- Deliverable status - further R&I is needed.

  The deliverable fully covers the project scope required for this task. However, many technical solutions may and will be subject to further research and development projects in the future

[1] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

e.g., R2DATO phase 2 and 3 - see the list of the use cases with a suggestion for the optional test cases in wave 2 - 3[1].

The progress and development of new IT solutions, especially AI, can open new possibilities for autonomous functions in the tramway operations.

Although selection of test cases for commercial areas is not part of this deliverable, and further analysis and research need to be done, many of the test cases for restricted areas are relevant for future tests definitions in combined traffic and commercial operations.

ABBREVIATIONS AND ACRONYMS

AC	Alternative Current
APS	Auxiliary power supply
ATO	Automatic Train Operation
AUTO	Automatic
BCU	Brake control unit
CAF	Construcciones y Auxiliar de Ferrocarriles
CAN	CAN Standard Bus
CCTV	Closed Circuit Television
CCU	Central control unit
CERES	CAF Remote Control Centre
COMMS	Communication
DATO	Digital Automated up to autonomous Train Operation
DC	Direct Current
DCM	Desk Control Module
DCU	Door control unit
EED	Emergency egress device
GMS	Global System for Mobile Communications
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
HSCB	High Speed Circuit Breaker
HUD	Head up display
HV	High voltage
HVAC	Heating Ventilation and Air Conditioning

IPM	Incident Prevention Module
LED	Light Emitting Diode
LOZ	Localization System
MCB	Magnetic Circuit Breaker
MAX	Maximum
MED	Medium
MIN	Minimum
MQTT	Message Queuing Telemetry Transport
OR	Operation Rule
OCC	Operation control center
R2DATO	Rail to Digital Automated up to autonomous Train Operation
PA	Passenger Alarm
PAS	Passenger Address System
PER	Perception System
PIS	Passenger Information System
PLC	Programmable Logic Controller
PPP	Pis Pas Pa System
PRM	Person with Reduced Mobility
PTT	Push to Talk
SL18	Tramway type used in Oslo and for demonstrator
SS1	Safety Switch 1
SS2	Safety Switch 2
STR	Sporveien Trikken AS
TCMS	Train Control and Monitoring System
TCU	Traction control unit
TL	Train Line
TRL	Technology readiness level
UITP	International Association of Public Transport
UC	Use Case
V2X	Vehicle to (2) Everything

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1 INTRODUCTION

Deliverable 42.1 **Collection of Test Cases and Validation Criteria** is part of Work Package (WP)42 **Tramway Autonomous Movements in Depot Demonstrator.** WP42 is part of the demonstrator cluster and urban light rail trains Work packages (WPs), aiming at the selection and analysis of specific operational test cases and their development. The deliverable defines test scenarios and test cases acceptance criteria for validating test results. The definition of detailed KPIs is also included in this task.

The deliverable outlines activities and the test plan for the task 42.3 **Demonstration Phase.** Two trams (model SL18 of the Sporveien fleet) have been modified at the CAF factory in Zaragoza. Further modifications for autonomous functions will be done at Sporveien' s premises in Oslo.

The selection and analysis of specific operational use cases, together with their transformation into test cases for demonstration, is the main focus of this deliverable.

The test cases for the demonstrator in Oslo have been carefully selected for testing autonomous functions and demonstrating them up to TRL6 in WP42.

Main contributions to this task within the R2DATO project are coming from WP6 task 6.6 **Specification of ATO Functions for Trams** and from WP8 **Safety Analysis & Risk Assessment**. Task 42.1.will interface with WP10 **Development and Validation of ATO Functions for Trams**.

In order to align definitions across the deliverables and work packages, a short extract from D40.1 explaining the definitions of operational rules, operational use cases, future operational use cases, technical use cases, and test cases is included in this deliverable.

Operational rules for non-commercial areas (an area within the tram network restricted to public access, primarily used for vehicle maintenance and parking - depots) regulate the tram operations related to parking and shunting of the vehicles in and out of depots, pre-start control and verification of the vehicle' s functions before operation. This also covers all movements within defined areas – shunting from parking spots, transfer to workshops, to the wheel lathe line, to the washing line and back to parking. The operational rules in Sporveien Trikken in Oslo consist of procedures, regulations, routines, and requirements for both operations, vehicles, and staff. Based on the list of operational rules, operational use cases were identified.

Operational use cases group operational rules of the same nature into the operational rule clusters in the existing operational environment.

Future operational use cases are defined by the analysis of operational rules and existing operational use cases. They cover not only the existing operational environment, but also the future operational environment, with potential requirements for future autonomous movements of the trams in both depots and commercial areas. The list is basically a database of operational use cases which, after being correlated with technical use cases, provides the basis for the test cases selection[1]. The operational use case overview also includes typical representatives of incidents, accidents, and collisions experienced in daily operations[1]

Technical use cases should cover requirements and expectations for automation and autonomy of the operational use cases for remote driving and autonomous movements. They cover areas of potential deployment of automation and autonomy, with the possibility of a demonstration within the R2DATO project. This includes all aspects from remote driving operations and control to autonomous movements of the test vehicles in the depots at Sporveien Trikken in Oslo.

Test cases are selected operational and technical use cases to be demonstrated **throughout** the project lifetime. This basically means the testing and validation of technological solutions with the aim to further design, modify, and integrate appropriate systems. The main focus is on further development of autonomous driving functions up to Technology Readiness Level (TRL) 6.

The final product of this deliverable is a carefully selected list of test cases for a demonstrator in Work Package (WP) 42 and a description of logical functions that could be autonomized at this stage. The correlation between operational rules, use cases, safety requirements, and test cases is part of this deliverable.

Technical limitations and technology development at the time of the demonstrator limit the automation of some operational rules and use cases. This results in not all operational use cases being transferred to test cases. An important note is that one technical use case usually covers more operational use cases.

The Sporveien Trikken depot at Holtet, Oslo (the main demonstrator area with outdoor tracks suitable for testing) and Sporveien Trikken depot at Grefsen, Oslo (a backup demonstrator area with indoor tracks suitable for testing) have been chosen for the demonstrator locations. This has also been taken into consideration for the selection of the test cases.

2 AUTONOMOUS MOVEMENTS DEMONSTRATION

2.1 TESTING STRATEGY AND TEST CASES

2.1.1 Operational rules and use cases

Similarly, as was the case with the remotely controlled vehicle, test cases for autonomous movements are based on Sporveien' s operational rules and operational use cases. The collection of use cases covers both restricted areas and commercial service operations.

Methodology for selection of the operational use cases:

- → The collection of use cases, based on Sporveien Trikken' s operational rules, driver's handbook, and operational experience was verified and justified together with UITP and compared with the main European tramway operators.
- → The selection of the most relevant use cases and the search for maximum harmonization between operators.
- → The design and implementation of the necessary technical enablers, and their integration into vehicles and the test and validation environment have taken operational experience into consideration.
- → The demonstration in different operational contexts
    - The depot in the scope of the R2DATO Phase 1 and the testing and demonstrator in commercial service as the intended scope for R2DATO phase 2.

Operational use cases are grouped according to areas of applicability:

- → Depot
- → Depot and commercial service areas
- → Commercial service areas

And further divided based on the nature of the use case and the activity or situation they are related to:

- → Wakeup and communication establishment
- → Startup preparations, control, and verification
- → Operations and driving in the depot and from the depot
- → Detecting and recognizing signs and signals
- → Driving in the urban context in commercial areas
- → Weather conditions and influence on driving style
- → Management of point machines and switches
- → Interface with infrastructure
- → Driving plan and communication with passengers
- → Operations in degraded mode
- → Operations under deviation situation in traffic or on infrastructure
- → Operation experience based on collisions and accidents

A full overview of the operational use cases and accidents representattives can be find in:

[1] Appendix 1 - *Operational use case Sporveien*

2.1.2 Test Cases for demonstrator in WP 42 - Methodology of Selection

The final list of test cases is a correlation between operational use cases suitable for automation or autonomation and technical use cases. Technical use cases describe the technical and technological possibilities of existing solutions for autonomous technology at the time of the demonstrator.

The test case selection in D42.1 was designed to be the first step for further expansion of testing from restricted areas to rural areas and commercial operations in waves 2 and 3 of the R2DATO project.

The main objective of WP42 is to verify and validate autonomous functions, both static and dynamic. These functionalities bring a wide range of possibilities for improving operation for the final user and provide benefits in the form of safer operations, a reduction of collisions and accidents, more efficient operations both in depot and commercial areas.

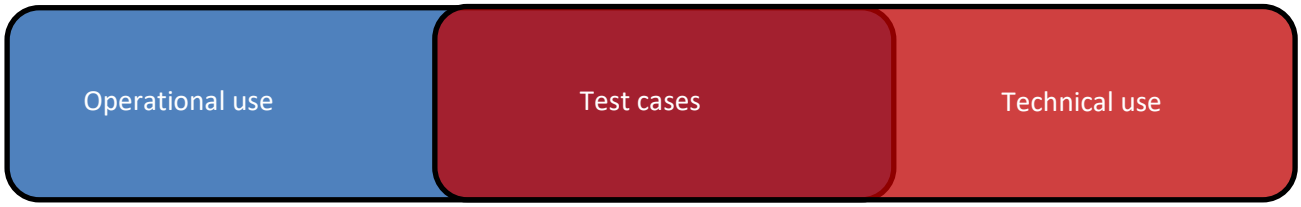

Figure 1: Correlation between operational and technical use cases.

2.1.3 Testing setup and demonstration

There will be a communication layer dedicated to sending and receiving tram commands for autonomous operation. These commands replace the local driver's commands, becoming a new input source for the existing functions and sub-systems on the train. Some examples of these autonomous commands may include:

- → Vehicle wake-up
- → Vehicle preparation for operations
- → Execution of all pre-driving commands
- → Travel from A to B
- → Vehicle shutdown

Two vehicles from an existing fleet, already used for remote-controlled driving, will be further retrofitted to perform autonomous manoeuvring and execution of the previously described functions. There will again be two perspectives for vehicle validation:

- → Integration validation of the new equipment and non-regression.
- → Functional validation of the newly integrated functions.

The first perspective has already been addressed by focusing on the modifications in the vehicle installations.

The test case called *Integration Test,* shall be designed to validate this integration and ensure that it does not have a negative impact on previously tested functions and sub-systems on the vehicle.

The functional validation of the new integrated functions will be done through *Functional Test* for autonomous movements.

2.1.4 Integration Tests

The purpose of this test group is to check the correct operation and functionality of the electrical circuits implemented in the test units for the R2DATO project.

This is to check both the circuits and part of the PLC program (TCMS). The proposed actions should yield the described results, thus verifying the wiring of the circuits, including TCMS inputs and outputs and part of the PLC software.

The scope of this testing includes electrical auxiliaries and safety supervision.

2.1.5 Functional Tests

The purpose of this test is to check the correct operation and functionality of autonomous movements under the testing and verification driving systems implemented in test units for the R2DATO project. The tramway will be in motion during this test sequence.

2.2 SELECTED TEST CASES AND ACCEPT CRITERIA

2.2.1 Test cases for restricted areas

Selected test case and detailed description

→ **Pre-departure check preparation for operations**
- Vehicle wake-up
- Control checklist

→ **Travel from A to B autonomous shunting**
- Acoustic signal, detection of possible objects in or near the track
- Acceleration and driving from A to B
- Detecting all static and dynamic objects
- Deceleration in response to potential collision risks with objects in the driving profile or when approaching the final destination

→ **Shutdown and autonomous parking**
- Parking the vehicle in the dedicated position
- Shutting down the vehicle to selected sleep mode

2.3 DESCRIPTION OF LOGICAL FUNCTIONS[2]

The following section is taken from **D6.6 Specification for autonomous operations for tramways** and covers the logical functions needed to operate a tram. For the sake of clarity, the list of logical functions has been grouped into eight clusters as illustrated in Figure 2. These clusters are:

→ **Tram Preparation:** This is a cluster of all functions related to the preparatory work to be done in the unit by the driver, maintenance staff, or Operation and Control Centre before the tram is assigned to a service or to recovery in case of failure.

→ **Tram Subsystem Management:** This is a cluster of all logical functions tackling tram subsystems. Most of these functions are executed via the Train Control and Monitoring System (TCMS) by a driver or an Automatic Train Operation (ATO) module.

- → **Monitor Tram Conditions:** This is a cluster of all logical functions that monitor the tram status during operations or maintenance tasks and report to the driver or to the Operation and Control Centre (OCC) the condition of different tram elements to ensure the correctness of the tram unit.
- → **Perception:** This is a cluster of the logical functions related to the detection of the tram' s relation with surrounding elements. They serve to detect events that could cause a undesired operational condition. Traditionally, they are done by the tram driver or operator staff using their senses.
- → **Tram movement:** This is a cluster of the logical functions related to tram movement in the depot, shunting and operation. These functions include not only the traction and brake functionalities but also the management of speed limits, adhesion management, stopping points, itinerary and providing relevant information to the driver about the itinerary, among others.
- → **Communications with Passengers:** This is a cluster of functions tackling communications between the passengers and the Operation and Control Centre (OCC) or the driver.
- → **Events Management:** This is a cluster of functions related to unexpected events that could happen within the tram and on the tracks close to the tram's position. It also describes the actions taken to address them.
- → **Infrastructure Data Management:** This is a cluster of functions to update the infrastructure information which may affect tram operation.

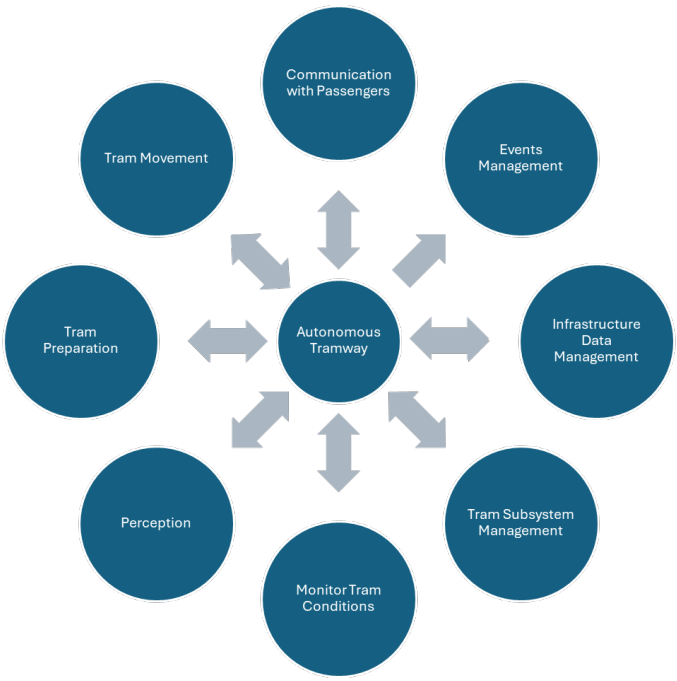

Figure 2: Logical functions clustering

2.3.1 Logical Functions needed for Operational Use Cases[2]

2.3.1.1 Operational use cases **Pre-departure check preparation for operations**

Logical Functions
Tram Preparation • Check out/Check in vehicle • Remove stop shoes • Request tram hold • Manage appropriate and safe conditions • Authorize Staff Responsible movements • Protect collection devices and catenary • Manage electrical energy for traction • Manage energy supply for auxiliaries • Provide remote control • Request video • Provide video stream • Define mission • Set routes • Dispatch orders • Determine ATO state • Register autonomous tram unit • Provide vehicle database • Be identified as an autonomous tram • Determine/verify and transmit JP data • Determine/verify and transmit MP data • Determine mission data • Manage mission execution • Trigger events • Receive anomalies in task or mission execution • Maintain tram physically immobilized • Set stop shoes if necessary • Supervise emergency brake chain test • Forbid start **Tram Subsystem Management** • Manage climatization • Manage windscreen cleaning • Manage exterior lighting • Manage the bell • Manage tram modes • Manage cab control

Logical Functions
Monitor Tram Conditions • Manage reporting • Supervise trams • Monitor fire alarms • Monitor tram unit failures • Monitor pantograph • Monitor battery protection mode • Measure tram speed • Provide UTC time • Receive status reports • Monitor trams • Transmit driving anomalies • Transmit tram location periodically **Perception** • Detect obstacles • Check if the surroundings (except signalling) oppose departure • Detect persons struck by a tram • Localize vehicle (track/direction/position/heading) • Detect railway agents on or along the tracks • Detect vehicle or buffer stop on the same track **Tram Movement** • Manage journey • Perform shunting • Provide acceleration • Provide Brake Command for Parking Braking • Provide Brake Command for Service Braking • Provide Brake Command for Holding Braking • Provide Brake Command for Emergency Braking • Acquire realized braking effort • Detect sliding • Apply and release braking forces • Check ad hoc brake release • Stop exactly at the intended location • Respect JP Timing Points and Optimize consumption • Control initial traction effort • Calculate expected traction effort • Determine maximum authorized speed • Regulate traction and braking effort • Detect that the final stopping point has been reached • Change running direction • Manage communication exchanges with the driver

Logical Functions
• Monitor speed and distance • Supervise runaway movement • Transmit supervision orders • Transmit Emergency Stop • Manage stopping points and passing points • Command Emergency Brake **Events Management** • Assist troubleshooting • Manage tram incidents

Table 1: Pre-departure check and preparation for operations

Automatized function in green
Remote functions or partianlly automatized in orange
Manual functions in tram in red

2.3.1.2 Operational use case - **Travel from A to B autonomous shunting**

Logical Functions
Tram Preparation • Check-out/Check-in vehicle • Remove stop shoes • Request tram hold • Manage appropriate and safe conditions • Authorize Staff Responsible movements • Protect collection devices and catenary • Manage electrical energy for traction • Manage energy supply for auxiliaries • Provide remote control • Request video • Provide video stream • Define mission • Set routes • Dispatch orders • Determine ATO state • Register autonomous tram unit • Provide vehicle database • Be identified as an autonomous tram • Determine/verify and transmit JP data • Determine/verify and transmit MP data • Determine mission data • Manage mission execution • Trigger events • Receive anomalies in task or mission execution

Logical Functions
• Maintain tram physically immobilized • Set stop shoes if necessary • Supervise emergency brake chain test • Forbid start **Tram Subsystem Management** • Manage climatization • Manage windscreen cleaning • Manage exterior lighting • Manage the bell • Manage tram modes • Manage cab control **Monitor Tram Conditions** • Manage reporting • Supervise trams • Monitor fire alarms • Monitor tram unit failures • Monitor pantograph • Monitor battery protection mode • Measure tram speed • Provide UTC time • Receive status reports • Monitor trams • Transmit driving anomalies • Transmit tram location periodically **Perception** • Detect obstacles • Check if the surroundings (except signalling) oppose departure • Detect persons struck by a tram • Localize vehicle (track/direction/position/heading) • Detect railway agents on or along the tracks • Detect vehicle or buffer stop on the same track **Tram Movement** • Manage journey • Perform shunting • Provide acceleration • Provide Brake Command for Parking Braking • Provide Brake Command for Service Braking • Provide Brake Command for Holding Braking • Provide Brake Command for Emergency Braking • Acquire realized braking effort • Detect sliding

Logical Functions
• Apply and release braking forces • Check ad hoc brake release • Stop exactly at the intended location • Respect JP Timing Points and Optimize consumption • Control initial traction effort • Calculate expected traction effort • Determine maximum authorized speed • Regulate traction and braking effort • Detect that the final stopping point has been reached • Change running direction • Manage communication exchanges with driver • Monitor speed and distance • Supervise runaway movement • Transmit supervision orders • Transmit Emergency Stop • Manage stopping points and passing points • Command Emergency Brake **Events Management** • Assist troubleshooting • Manage tram incidents

Table 2: Logical functions needed for Travel from A to B shunting

Automatized function in green
Remote functions or partianlly automatized in orange
Manual functions in tram in red

2.3.1.3 Operational use case – **Shuttdown and parking**

Logical Functions
Tram Preparation • Check out/Check in vehicle • Request tram wake-up • Supervise tram wake-up • Manage Tram Preparation Staff requests • Authorize Staff Responsible movements • Protect collection devices and catenary • Manage electrical energy for traction • Manage energy supply for auxiliaries • Provide remote control • Request video • Provide video stream • Remove stop shoes

Logical Functions

- Manage appropriate and safe conditions
- Manage Remote Driver requests
- Request tram hold
- Maintain tram physically immobilized
- Set stop shoes if necessary
- Supervise emergency brake chain test
- Forbid start

Tram Subsystem Management

- Manage windscreen cleaning
- Manage exterior lighting
- Manage the bell
- Manage tram modes

Monitor Tram Conditions

- Supervise trams
- Monitor fire alarms
- Monitor pantograph
- Monitor battery protection mode
- Measure tram speed
- Provide UTC time
- Monitor trams
- Transmit tram location periodically

Perception

- Detect obstacles
- Check if the surroundings (except signalling) oppose departure
- Detect persons struck by a tram
- Localize vehicle (track/direction/position/heading)
- Detect railway agents on or along the tracks
- Detect vehicle or buffer stop on the same track

Tram Movement

- Drive tram remotely
- Perform shunting
- Provide Brake Command for Parking Braking
- Provide acceleration
- Provide Brake Command for Service Braking
- Provide Brake Command for Holding Braking
- Acquire realized braking effort
- Detect sliding
- Provide Brake Command for Emergency Braking
- Apply and release braking forces
- Check ad hoc brake release
- Process remote driving commands

Logical Functions
• Monitor speed and distance • Command Emergency Brake • Transmit Emergency Stop • Determine maximum authorized speed • Supervise runaway movement **Events Management** • Assist troubleshooting

Table 3: Logical functions needed for Shutdown and parking

Automatized function in green
Remote functions or partianlly automatized in orange
Manual functions in tram unit in red

2.4 DEMONSTRATOR LOCATION

2.4.1 Holtet depot

The same location for the demonstrator of autonomous movements was selected as for remotely operated tram demonstrator. Depot's outdoor facility is an important advantage for testing and demonstrating of autonomous movements. The outdoor environment provides an opportunity to test and validate equipment under various weather, light, and external conditions. This is crucial for validating the perception sensors and equipment. The decision is based on experience from previous testing and demonstrations.

Holtet depot is not occupied during the daytime, more or less from 6 am to 6 pm, and provides an opportunity for multiple test scenarios and is equipped with an advanced signalling system, which is being set in operation in the beginning of 2025.

The location of the operation center for autonomous movements will also be on Holtet in existing operations manager' s office. The office has a sufficient IT network and connections, and a view of the tracks dedicated to the demonstrator. The office has been selected as the best location for conducting autonomous operation tests and demonstrations. A small workshop at the depot will be used for both parking and minor repairs or installations. The depot is covered by CCTV cameras, which will help to provide a complete overview of the area during all project activities.

Figure 3: Holtet depot and tracks intended for demonstration.

2.5 KPI

To assess the validity of the solution, it is essential to highlight that there are two perspectives to address. The basis for KPIs in this deliverable was taken from D41.1 Test Cases for Remote Driving[3] and updated with KPIs related to autonomous driving.

2.5.1 KPIs for Non-Innovative Developments[3]:

On the one hand, there are go-no-go validation tests. For example, everything related to the integration of new equipment, electrical installation, and non-regression which can be easily quantified within the protocols to be carried out in the project.

2.5.2 KPIs for Innovative Developments[3]:

However, the goal of the project itself is not only to develop but also to optimize and make the proposed solution reliable. In this regard, two categories of KPIs can be distinguished: qualitative, related to user experience, solution validity, etc., and quantitative, related to the parameterization of the subsystems involved in the development or the measurable impact they generate for the end user.

Thus, an initial list has been compiled that will be updated and discussed throughout the project to assess the maturity and satisfaction level of the proposed solution. This list can be applied to each previously described test case but also serves as a guide for the future development of new cases.

KPI	Type	Explanation	Measurement criteria
System integration without impact on existing vehicle	Technical	Evaluate if the protocols proposed for validating the installation in an existing vehicle and its non-regression are successful.	Yes / No
Solution quality for the operations	User Experience	Rating of the solution's quality for the remote operator	1...5*
System availability	Technical	Failure rate	Failure rate
Improvement of the reaction time	Reaction time	Rection time improvement in daily operations in the depot	%
Productivity improvement in depot operations	Productivity	Improvement in production and operation productivity at user facilities and in commercial operations	%
Reduction in accidents and incidents in the traffic	Ratio	Expected reduction in accidents and incidents in the traffic due to use of autonomous technology	%
*1 is poor and 5 is excellent			

Table 4: KPIs

3 CONCLUSIONS

The deliverable covers test cases for the demonstrator in WP42. The test cases are based on operational and technical use cases selected from tramways operational rules in Oslo.

The selection of the test cases reflects today's status of technical solutions and possibilities. Not all operational cases can be automated for remote driving operations due to technological limitations.

We expect to update and further develop the test plan as we progress along the project and evaluate outcomes from the demonstrator.

It might be necessary to investigate the possibility of changing operational rules for tramway operations (in Oslo). This could increase the level of automation and possibilities for implementing autonomous solutions in tramway operation, for example, initially in the form of Advanced Driver Assistance System.

Brief summary of the deliverable:

→ Selected testcase (test clusters)

- Pre-departure check preparation for operations
- Travel from A to B autonomous shunting
- Shutdown and autonomous parking

→ The objective of creating a list of test cases, outline a test plan, assess the testing site and provide a basis for risk analysis for the demonstrator is fully accomplished;

→ The list of use cases in annex 1 also provides a good overview of requirements and expectations for autonomous driving (up to TRL6) and contributes to an innovative approach to creating operational rules in a technologically new environment;

REFERENCES

[1] Operational use cases Sporveien

[2] R2DATO D6.6 - Specification autonomous operations for tramways

[3] R2DATO D41.1 – Collection of use cases for remote operation

ANNEX 1 - OPERATIONAL USE CASES SPORVEIEN

Annex 1 provides a full overview of operational use cases identified in Sporveien' s regular operations, both in the depot (restricted area) and in commercial service (urban context). The Use cases collection is based on regular operation as well as deviations and accidents. They capture the interface with infrastructure and other traffic participants, planning and communication with the public transport provider and passengers. Weather conditions and driving in degraded mode are also included.

Some of the use cases will be part of test cases in wave 1 of R2DATO, while others are planned to be part of testing and verification in waves 2 and 3 of R2DATO. There are indeed some use cases that are difficult to automate or autonomize, and we need to be open to making changes in operational rules as well.

Some of the use cases are expected to arise with the introduction of autonomous technology. Even though they do not exist at the moment, we think it is important to include them in the overview.

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.01	Startup and preparation	Find a vehicle for the operation either the same day or next day	Depot	Depot personal	Select	Correct vehicle is selected for operation	TBD
UCO.01.02	Startup and preparation	Important in connection with manoeuvring and visit to the vehicle CCTV cameras can be integrated in solution	Depot	Autonomous	Autonomous	Correct vehicle is selected for operation	Yes
UCO.01.03	Startup and preparation	Correct vehicle must be selected and connected for remote driving or autonomous movements	Depot	Autonomous	Autonomous	Correct vehicle is selected for operation and connected for remote driving or autonomous manoeuvring	Yes
UCO.01.04	Startup and preparation	Initiate data communication	Depot	Autonomous	Autonomous	Data communication start and communication with vehicle is establish	Yes
UCO.01.05	Startup and preparation	Perform video streaming	Depot	Autonomous	Autonomous	Video streaming is initiated and is stable	Yes
UCO.01.06	Startup and preparation	Check vehicle status - red marked is not allowed to be used in the operations	Depot	Driver	Control	Vehicle that has not permission to be used in operation is not selected	No
UCO.01.07	Startup and preparation	Check vehicle status - yellow marked - some outstanding files, it must be checked if the vehicle can be used in operations	Depot	Driver	Control	Vehicle that has not permission to be used in operation is not selected	No
UCO.01.08	Startup and preparation	Check vehicle status - maintenance due date - if any of maintenances is overdue, vehicle cannot be used in the operations	Depot	Driver	Control	Vehicle that has not permission to be used in operation is not selected	No
UCO.01.09	Startup and preparation	Activate turnkey	Depot	Driver	Activate	Vehicle is set in active modus by turnkey	Yes
UCO.01.10	Startup and preparation	Start vehicle self-test	Depot	Driver	Activate	Vehicle self-check is initiated and run with no interferences	Yes
UCO.01.11	Startup and preparation	Control of alarms on TCMS-HMI monitors or alarm lamps on driver desk	Depot	Driver	Control	Vehicle that has outstanding alarms is not selected for operations	Yes
UCO.01.12	Startup and preparation	Check if switch iron for manual operation of the switches is on place (in time self-test is running)	Depot	Driver	Control	Vehicle with missing or faulty equipment is not selected for operations	No
UCO.01.13	Startup and preparation	Check if broom for cleaning of the switches is on place (in time self-test is running)	Depot	Driver	Control	Vehicle with missing or faulty equipment is not selected for operations	No
UCO.01.14	Startup and preparation	Check if shovel is on place (in time self-test is running)	Depot	Driver	Control	Vehicle with missing or faulty equipment is not selected for operations	No
UCO.01.15	Startup and preparation	Check seal on the first aid kit box (in time self-test is running)	Depot	Driver	Control	Vehicle with missing or faulty equipment is not selected for operations	No
UCO.01.16	Startup and preparation	Check seal on fire extinguisher (in time self-test is running)	Depot	Driver	Control	Vehicle with missing or faulty equipment is not selected for operations	No
UCO.01.17	Startup and preparation	Press "high-voltage connection"	Depot	Driver	Activate	Connection to high voltage is working as expected	Yes
UCO.01.18	Startup and preparation	Take up pantograph (execute automatically)	Depot	Driver	Activate	Pantograph is working as expected	Yes
UCO.01.19	Startup and preparation	Automat switch closes	Depot	Driver	Automatic	Automatic function - must close as expected	Yes
UCO.01.20	Startup and preparation	Activate HVAC function and check if heating is functional on HMI – “Klima”	Depot	Driver	Activate	HVAC is working as expected	Yes
UCO.01.21	Startup and preparation	Check the radio communication with Tetra radio	Depot	Driver	Control	Communication is established and is stable	No

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.22	Startup and preparation	Activate brakes	Depot	Driver	Control	Brakes are fully operation, and vehicle can be used in operations	Yes
UCO.01.23	Startup and preparation	Push and release red "mushroom" button (driving is not allowed in case of alarm AL4154)	Depot	Driver	Control	No alarms detected	Yes
UCO.01.24	Startup and preparation	Activate and check "Deadman function" (driving is not allowed in case of alarm AL4158)	Depot	Driver	Control	No alarms detected	Yes
UCO.01.25	Startup and preparation	Put driving control to emergency brake position (driving is not allowed in case of alarm AL4155 or AL4156)	Depot	Driver	Control	No alarms detected	Yes
UCO.01.26	Startup and preparation	Check emergency lights	Depot	Driver	Control	Emergency lights are working as expected	Yes
UCO.01.27	Startup and preparation	Check functionality of mirror cameras	Depot	Driver	Control	Camera mirrors are working as expected no delay in video and no blurring	TBD
UCO.01.28	Startup and preparation	Activate and deactivate doors and check if image from mirror cameras changes	Depot	Driver	Control	Doors and camera mirrors are working as expected no delay in video and no blurring	TBD
UCO.01.29	Startup and preparation	Repeat start up procedure and control for the C2 if necessary	Depot	Driver	Control	N/A	N/A
UCO.01.30	Startup and preparation	Confirm start up procedure finished and OK	Depot	Driver	Confirm	Checklist for startup control is signed or confirmed manually or digitally	No
UCO.01.31	Preparation for driving	Service switch control (inside lights) - turn on	Depot	Driver	Control	Inside lights are working as expected	TBD
UCO.01.32	Preparation for driving	Front lights check	Depot	Driver	Control	Front lights are working as expected	TBD
UCO.01.33	Preparation for driving	Activate light test with switch on the left panel	Depot	Driver	Control	Activation is working as expected	TBD
UCO.01.34	Preparation for driving	Turn all outside lights on	Depot	Driver	Control	Outside lights are working as expected	TBD
UCO.01.35	Preparation for driving	Outside control of the lights	Depot	Driver	Control	Outside lights are working as expected	TBD
UCO.01.36	Preparation for driving	Check inside of the vehicle for graffiti and damages	Depot	Driver	Control	No damages or graffiti detected inside in the vehicle	No
UCO.01.37	Preparation for driving	Check outside of the vehicle for graffiti and damages	Depot	Driver	Control	No damages or graffiti detected outside on the vehicle	No
UCO.01.38	Preparation for driving	Check proper visibility	Depot	Driver	Control	Visibility is sufficient for driving; no visibility obstacles are detected	TBD
UCO.01.39	Preparation for driving	Check window wipers and liquid	Depot	Driver	Control	Equipment is working as expected	Yes
UCO.01.40	Preparation for driving	Download driving plan for the actual route	Depot	Driver	Download	Driving plan is download without any mistakes and is operational	TBD
UCO.01.41	Preparation for driving	Download red announcement for in the traffic	Depot	Driver	Download	Red announcements are downloaded without any mistakes and is operational	No
UCO.01.42	Preparation for driving	Download green announcement for in the traffic	Depot	Driver	Download	Green announcements are downloaded without any mistakes and is operational	No
UCO.01.43	Preparation for driving	Unattended vehicle must be programmed to comply with all traffic, road regulations railway regulation under driving	Depot	Autonomous	Autonomous	Presumption for permission to operate unattended vehicle	TBD
UCO.01.44	Preparation for driving	Check that all doors are closed	Depot	Driver	Control	Doors are closed and are working as expected	Yes
UCO.01.45	Driving from the depot	Set the vehicle in the driving modus	Depot	Driver	Activate	Driving modus on the vehicle is activated	TBD
UCO.01.46	Driving from the depot	Detect any obstacles around the vehicle before driving	Depot	Driver	Detect	Object that could be in the driving profile are detected	TBD
UCO.01.47	Driving from the depot	Initialize acoustic signal before driving	Depot	Driver	Activate	Bell rings before any movements of the tram are initiated	TBD

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.48	Driving from the depot	Inform operation central about driving from depot	Depot	Driver	Communicate	Operational central is inform and confirm, that vehicle can start operations	No
UCO.01.49	Driving from the depot	Start driving from the depot	Depot	Driver	Accelerate	All conditions for driving out form depot are fulfilled	No
UCO.01.50	Driving from the depot	Identify position of the switch at exit from the depot	Depot	Driver	Identify	Tram is able to identify switch that determines movement and direction of driving	TBD
UCO.01.51	Driving from the depot	Change the switch position for exit from depot	Depot	Driver	Activate	Switch is changed in desired direction	TBD
UCO.01.52	Driving from the depot	Detect any obstacles - statical and dynamical in and around exit track	Depot	Driver	Detect	Object that could be in the driving profile are detected	TBD
UCO.01.53	Driving from the depot	Analyse dynamical objects and if their direction is in conflict with the tram	Depot	Driver	Analyse	Potential danger form moving obstacles is calculated and evaluated	TBD
UCO.01.54	Driving from the depot	Detect tramways on the main track	Depot	Driver	Detect	Tram in the same track is detected	TBD
UCO.01.55	Driving from the depot	Communicate your position to other trams on the same track in the driving direction	Depot	Autonomous	Autonomous	Communication with another tram is established and is stable	TBD
UCO.01.56	Driving from the depot	Detect if signaling is blinking yellow and which traffic rules to enforce in different situations	Depot	Driver	Detect	Signal is detected and appropriate action is activated (accelerate / decelerate)	TBD
UCO.01.57	Driving from the depot	Accelerate and start operation on selected line	Urban	Driver	Accelerate	Acceleration is working as expected	R2DATO wave 2-3
UCO.01.58	Signs and signaling	Detect sign and signaling on the daytime	Urban	Driver	Detect	Signal is detected correctly	TBD
UCO.01.59	Signs and signaling	Detect sign and signaling on the nighttime	Urban	Driver	Detect	Signal is detected correctly	TBD
UCO.01.60	Signs and signaling	Detect and recognize signal and signs in the depot in reduced visibility	Urban	Driver	Detect	Signal is detected correctly	TBD
UCO.01.61	Signs and signaling	Detect Fixed traffic light signals and take appropriate action	Urban	Driver	Detect	Signal is detected correctly	TBD
UCO.01.62	Signs and signaling	Establish communication with traffic signals for potential priority driving	Urban	Autonomous	Autonomous		R2DATO wave 2-3
UCO.01.63	Signs and signaling	Detect main light signaling (common with Metro) - 4,3 or 1 light and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.64	Signs and signaling	Detect urban light signaling (common with Metro) - 3 or 2 lights and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.65	Signs and signaling	Detect E-sign and stop at the correct distance from the sign	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.66	Signs and signaling	Detect security guard (human being) that form arms as a T - that means STOP IMMEDIATELY	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.67	Signs and signaling	Detect security guard (human being) that waves one arm to signal ***DRIVE TOWARDS ME***	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.68	Signs and signaling	Detect POLICE MAN (human being) signaling START DRIVING	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.69	Signs and signaling	Detect POLICE MAN (human being) signaling STOP	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.70	Signs and signaling	Detect V signaling and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.71	Signs and signaling	Detect track crossing signaling and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.72	Signs and signaling	Detect point machine light signaling with 3 lights and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.73	Signs and signaling	Detect point machine cube (dots) light signaling and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.74	Signs and signaling	If cube signal is out of drift vehicle must get permission for to pass from TLS	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.75	Signs and signaling	Detect shunting signaling and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.76	Signs and signaling	Detect traffic signs for tramways	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.77	Signs and signaling	Detect speed limit sign and adjust speed or take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.78	Signs and signaling	Detect tramway orientation poles - indication of short track, station border, track field and detection, middle point (crash point in curves) - take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.79	Signs and signaling	Inform other trams in the same track when entering track fields and detection field	Urban	Autonomous	Autonomous	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.80	Signs and signaling	Inform other trams in the same track when exiting track fields and detection field	Urban	Autonomous	Autonomous	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.81	Signs and signaling	Detect stop marking for stopping at tramway stops and platforms	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.82	Signs and signaling	Detect ATP sign and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.83	Signs and signaling	Detect TETRA radio border sign and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.84	Signs and signaling	Detect other signs relevant for tramways and take action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.85	Signs and signaling	Detect temporary signals and signs for tramway traffic regulation in deviation situation	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.86	Signs and signaling	Detect temporary signaling for daytime signaling - flag and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.87	Signs and signaling	Detect temporary signaling for daytime signaling - person regulating traffic and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.88	Signs and signaling	Detect locked point machine which can consider as stop signal if locking restrict switch changing	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.89	Signs and signaling	Detect temporary signaling for nighttime signaling - red light and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.90	Signs and signaling	Detect temporary signaling for nighttime signaling - person regulating traffic with lights and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.91	Signs and signaling	Detect signs and signaling for general road traffic	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.92	Signs and signaling	Detect signals for public transport and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.93	Signs and signaling	Detect signals with priority for public transport	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.94	Signs and signaling	Stop vehicle as close possible as to stop marking to get priority	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.95	Signs and signaling	Driving when crossing another track - yield as general traffic rules if driving is not regulated by signals or signs	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.96	Signs and signaling	Driving out for loops - yield traffic on the main track if driving is not regulated by signals or signs	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.97	Signs and signaling	Driving through the signal that is in Stop - take contact with TLS and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.98	Signs and signaling	Work in and near tracks - take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.99	Driving in urban context	Identify constantly repositioning of the vehicle and transit information to TLS	Urban	Driver	Communicate		R2DATO wave 2-3
UCO.01.100	Driving in urban context	Detect surroundings and identify changes to previous driving	Urban	Driver	Detect		R2DATO wave 2-3
UCO.01.101	Driving in urban context	Establish connection with public CCTV systems for better identification of potential dangers	Urban	Driver	Autonomous		R2DATO wave 2-3
UCO.01.102	Driving in urban context	Adjust driving style to external conditions and operation requirements	Urban	Driver	Adjust	Driving style is adjusted to outside conditions	R2DATO wave 2-3
UCO.01.103	Driving in urban context	Detect statical obstacles in the tracks and take action	Urban	Driver	Detect	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.104	Driving in urban context	Detect statical obstacles close to track and identify potential collision with dynamic vehicle envelope	Urban	Driver	Detect	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.105	Driving in urban context	Detect statical obstacles close to track and identify potential collision with dynamic vehicle envelope	Urban	Driver	Detect	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.106	Driving in urban context	Detect parked vehicles close to track and identify potential collision with dynamic vehicle envelope (middle collisions)	Urban	Driver	Detect	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.107	Driving in urban context	Identify any objects connected through v2x and establish communication	Urban	Driver	Autonomous	Communication with other object with v2x equipment is established and stable	R2DATO wave 2-3
UCO.01.108	Driving in urban context	Detect dynamic obstacle in the track and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.109	Driving in urban context	Detect dynamic obstacle near the track and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.110	Driving in urban context	Identify any potential conflict with dynamic envelope of the vehicle	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.111		Calculate potential risk for any conflict with intended driving direction and vehicle dynamic envelope	Urban	Driver	Autonomous	Risk is calculated and appropriate action is taken	R2DATO wave 2-3
UCO.01.112	Driving in urban context	Identify persons	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	TBD
UCO.01.113	Driving in urban context	Identify position and direction of the person movement	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	TBD

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.114	Driving in urban context	Identify unusual behaviour of the pedestrians and analyse potential collision with vehicles dynamic envelope	Urban	Driver	Autonomous	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.115	Driving in urban context	Person warning with bell ringing and braking if necessary	Urban	Driver	Activate	Warning sign secure avoidance of accident or collision	Yes
UCO.01.116	Driving in urban context	Person warning in imminent danger with horn and braking if necessary	Urban	Driver	Activate	Warning sign secure avoidance of accident or collision	R2DATO wave 2-3
UCO.01.117	Driving in urban context	Identify and report on overgrown vegetation that can come in conflict with dynamical envelope of the vehicle	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.118	Driving in urban context	Identify animals	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.119	Driving in urban context	Identify position and direction of the animal movement	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.120	Driving in urban context	Identify scooters	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.121	Driving in urban context	Identify position and direction of the scooter movement	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.122	Driving in urban context	Identify motorcycles	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.123	Driving in urban context	Identify position and direction motorcycles movement	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.124	Driving in urban context	Identify ambulance, police or fire department cars	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.125	Driving in urban context	Identify position and direction of ambulance, police or fire department cars	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.126	Driving in urban context	Establish v2x communication with ambulance, police or fire department cars	Urban	Driver	Autonomous	Communication with emergency vehicles via v2x equipment is established and stable	R2DATO wave 2-3
UCO.01.127	Driving in urban context	Identify busses	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.128	Driving in urban context	Identify position and direction of the buss movement	Urban	Driver	Identify	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.129	Driving in urban context	Identify bus stop close to track	Urban	Driver	Activate	Performed action is compliant with respective situation and nature of the obstacle	R2DATO wave 2-3
UCO.01.130	Driving in urban context	Warning with bell or horn and braking if necessary	Urban	Driver	Activate	Warning sign secure avoidance of accident or collision	R2DATO wave 2-3
UCO.01.131	Driving in urban context	Detected other trams in the same track near and communicate your position with another vehicle	Urban	Driver	Autonomous	Communication with other trams with v2x equipment is established and stable	R2DATO wave 2-3
UCO.01.132	Driving in urban context	Adjust driving style in predefined areas with higher accidents danger	Urban	Driver	Adjust	Correct driving style is used in areas with predefined dangers	R2DATO wave 2-3
UCO.01.133	Driving in urban context	Adjust driving style in city areas with narrow sidewalks	Urban	Driver	Adjust	Dangerous situation is avoided and eliminated	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.134	Driving in urban context	Adjust driving style in city areas with pedestrian crossings	Urban	Driver	Adjust	Dangerous situation is avoided and eliminated	R2DATO wave 2-3
UCO.01.135	Driving in urban context	Adjust driving style in city areas when driving through roundabouts	Urban	Driver	Adjust	Dangerous situation is avoided and eliminated	R2DATO wave 2-3
UCO.01.136	Driving in urban context	Use indicators when swinging form one driving field to another	Urban	Driver	Activate	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.137	Driving in urban context	Use right indicators when exiting roundabouts	Urban	Driver	Activate	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.138	Driving in urban context	Use left indicators when exiting stops	Urban	Driver	Activate	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.139	Driving in urban context	Detect barriers position when driving through crossings with road barriers	Urban	Driver	Detect	Dangerous situation is avoided and eliminated	TBD
UCO.01.140	Driving in urban context	Detect barriers (train boom) before temporary tram-track (Norsk: KLATRESPOR), and lower speed accordingly	Urban	Driver	Detect	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.141	Driving in urban context	Detect stop in traffic, turn on emergency lights, and inform TLS	Urban	Driver	Detect	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.142	Driving in urban context	Identify and analyse potential danger situation and take action - vehicle signals, reduce speed, stop	Urban	Driver	Identify	Dangerous situation is avoided and eliminated	R2DATO wave 2-3
UCO.01.143	Driving in urban context	Use ringing signal primarily in city areas	Urban	Driver	Activate	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.144	Driving in urban context	Use horn signaling in urban areas	Urban	Driver	Activate	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.145	Driving in urban context	Use both bell and horn signal in urban areas	Urban	Driver	Activate	Correct action is taken, and equipment is working as expected	R2DATO wave 2-3
UCO.01.146	Driving in urban context	Prevent traffic jams in the tramway lines, communication between vehicles	Urban	Driver	Communicate	Traffic jams are prevented	R2DATO wave 2-3
UCO.01.147	Weather and external conditions	Detect driving / weather conditions and adjust driving style to the external conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.148	Weather and external conditions	Detect rain and adjust driving style to driving conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.149	Weather and external conditions	Detect reduced visibility and adjust driving style to driving conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.150	Weather and external conditions	Detect water in the track above secure level for passing	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.151	Weather and external conditions	Detect snow and adjust driving style to driving conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.152	Weather and external conditions	Detect snow in the track above secure level for passing	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.153	Weather and external conditions	Detect rail status - icy, slippery conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.154	Weather and external conditions	Apply sanding when necessary to the conditions of the track	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3
UCO.01.155	Weather and external conditions	Detect ice on the catenary	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.156	Weather and external conditions	Detect reduce daylight and switch to night modus	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.157	Weather and external conditions	Detect dangerous external condition that can influence safe driving - hails, storm, wind, extreme weather	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3
UCO.01.158	Weather and external conditions	Detect reduced visibility due to sunlight influencing cameras resolution	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	TBD
UCO.01.159	Weather and external conditions	Detect high temperature and danger for rails buckles appearance	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.160	Weather and external conditions	Detect leaves in track and risk for slippery conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3
UCO.01.161	Weather and external conditions	Detect newly cut grass or watering in track green areas - risk for slippery conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3
UCO.01.162	Weather and external conditions	Detect new asphalt that comes to the track - danger for slippery conditions (De-railing)	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3
UCO.01.163	Weather and external conditions	Detect salt water / snow in the tracks - danger for slippery conditions	Urban	Driver	Detect and adjust	Driving style adjusted to weather conditions	R2DATO wave 2-3
UCO.01.164	Weather and external conditions	Recognition of all signals and signs in reduced visibility due to weather conditions	Urban	Driver	Identify	Signal and signs recognized in reduced vision conditions	TBD
UCO.01.165	Management of point machines	Identify position of the point machine and driving direction	Urban	Driver	Identify	Switch identified and ready for use	TBD
UCO.01.166	Management of point machines	Confirm that driving direction is correct and aligned with driving plan	Urban	Driver	Control	Correct driving direction to be selected in the right driving direction	R2DATO wave 2-3
UCO.01.167	Management of point machines	Detect other trams in operation in the track and position in relation to the switch	Urban	Driver	Autonomous	Other vehicles are detected and danger for collision eliminated	R2DATO wave 2-3
UCO.01.168	Management of point machines	Establish communication with other trams in the area	Urban	Driver	Autonomous	Communication with other trams with v2x equipment is established and stable	R2DATO wave 2-3
UCO.01.169	Management of point machines	Identify vehicle position in relation to point machine to be crossed and send information to other vehicles	Urban	Driver	Autonomous	Other vehicles are detected and danger for collision eliminated	R2DATO wave 2-3
UCO.01.170	Management of point machines	Confirm the area around the switch is clear of other vehicles	Urban	Driver	Confirm	No interference with other vehicles in the intended driving direction	R2DATo wave 2-3
UCO.01.171	Management of point machines	Change the switch to required direction	Urban	Driver	Activate	Switch is changed to desired direction	TBD
UCO.01.172	Management of point machines	Confirm entering and exiting of the point machine protected area to other vehicles in the range of XXX meters	Urban	Driver	Autonomous	Protection field for driving over switch is secured	R2DATO wave 2-3
UCO.01.173	Interface to infrastructure	Check and register infrastructure clearance in relation to vehicle dynamic envelope	Urban	Driver	Autonomous	No interference with infrastructure in driving profile	R2DATO wave 2-3
UCO.01.174	Interface to infrastructure	Check and register top of rail to vehicle clearance	Urban	Driver	Autonomous	No interference with bottom of the vehicle and infrastructure	R2DATO wave 2-3
UCO.01.175	Interface to infrastructure	Check and register quality of the track (maintenance requirements) - wear down, cracks other damages	Urban	Driver	Autonomous	Driving style adjusted to track conditions	R2DATO wave 2-3
UCO.01.176	Interface to infrastructure	Check and register quality of the catenary (maintenance requirements)	Urban	Driver	Autonomous	Driving style adjusted to catenary conditions	R2DATO wave 2-3
UCO.01.177	Interface to infrastructure	Check and register catenary for FROST and bad connection	Urban	Driver	Autonomous	Driving style adjusted to catenary conditions	R2DATO wave 2-3
UCO.01.178	Interface to infrastructure	Check and register voltage in the catenary and report deviations	Urban	Driver	Control	Level of high voltage detect and registered	R2DATO wave 2-3
UCO.01.179	Interface to infrastructure	Lubricate the flanges where required	Urban	Driver	Lubricate	Flanges are lubricated at the right place	R2DATO wave 2-3
UCO.01.180	Interface to infrastructure	Lubricate the rails where required	Urban	Driver	Lubricate	Tracks are lubricated at the right place	R2DATO wave 2-3
UCO.01.181	Interface to infrastructure	Detect temporary track switch and drive according to regulations	Urban	Driver	Adjust	Temporary switch is detected and driving style adjusted accordingly	R2DATO wave 2-3
UCO.01.182	Interface to infrastructure	Detect temporary track barrier and drive according to regulations	Urban	Driver	Adjust	Temporary barrier is detected and driving style adjusted accordingly	R2DATO wave 2-3
UCO.01.183	Interface to infrastructure	Detect overload in catenary - disconnect to be reconnected after 10-15 seconds and take appropriate action	Urban	Driver	Detect	Overload in catenary is detected and tram is disconnected - connected after 1-15 seconds	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.184	Interface to infrastructure	Adjust driving style if signaling is out of drift on urban tracks	Urban	Driver	Detect	Driving style adjusted after driving conditions through non-functional signal systems	R2DATO wave 2-3
UCO.01.185	Driving plan passengers' communication	Follow driving schedule and plan for selected line	Urban	Driver	Control	Driving schedule is followed and no delays in operations	R2DATO wave 2-3
UCO.01.186	Driving plan passengers' communication	Delays in the schedule shall not picked up on the cost of safety	Urban	Driver	Control	Safe operation despite delays	R2DATO wave 2-3
UCO.01.187	Driving plan passengers' communication	Voice information to the passengers about the next stop	Urban	Driver	Communicate	Passengers are informed about next stop	R2DATO wave 2-3
UCO.01.188	Driving plan passengers' communication	Identify if no other tramways are present at the stop / platform. It is only one tram that shall stop at planform at the same time unless otherwise defined	Urban	Driver	Identify	Clearance for entering station is confirmed	R2DATO wave 2-3
UCO.01.189	Driving plan passengers' communication	Decelerate when approaching platform	Urban	Driver	Decelerate	Vehicle enters station in appropriate speed	R2DATO wave 2-3
UCO.01.190	Driving plan passengers' communication	Identify stopping signal for passengers and initiate stopping at tram stop	Urban	Driver	Communicate	Stop signal from passengers is identified and tram stop at requested station	R2DATO wave 2-3
UCO.01.191	Driving plan passengers' communication	Identify late stopping signal from passengers and determine if stopping is too late for the stop in question	Urban	Driver	Communicate	Correct decision is taken and tram either stop or continues through station	R2DATO wave 2-3
UCO.01.192	Driving plan passengers' communication	Identify passengers at the platform requesting stop at the tram stop and initiate stopping at the stop	Urban	Driver	Identify	Passengers at the station are identified and tram stops at the station	R2DATO wave 2-3
UCO.01.193	Driving plan passengers' communication	Stop at the stop line at the platform	Urban	Driver	Stop	Tram stops at stop mark	R2DATO wave 2-3
UCO.01.194	Driving plan passengers' communication	Identify which doors shall be open at the actual platform	Urban	Driver	Activate	Correct doors are opened at the station	R2DATO wave 2-3
UCO.01.195	Driving plan passengers' communication	Confirm that all doors that shall be open are at platform area	Urban	Driver	Control	No doors are open outside of platform	R2DATO wave 2-3
UCO.01.196	Driving plan passengers' communication	Release the doors (except blocked doors at actual platform)	Urban	Driver	Activate	Correct doors are released	R2DATO wave 2-3
UCO.01.197	Driving plan passengers' communication	Open the doors (except blocked doors at actual platform)	Urban	Driver	Activate	Correct doors are opened	R2DATO wave 2-3
UCO.01.198	Driving plan passengers' communication	Leave the necessary time for passengers to and out and in the vehicle	Urban	Driver	Adjust	No passenger are left at the station and no passengers debarking vehicle remain in the vehicle	R2DATO wave 2-3
UCO.01.199	Driving plan passengers' communication	Check the clearance in the doors before closing the doors	Urban	Driver	Detect	No obstacles are in the doors before closing	R2DATO wave 2-3
UCO.01.200	Driving plan passengers' communication	Identify if doors are blocked on purpose by i.e. teenagers, and how long to wait before enforcing *FORCE CLOSING OF DOORS*	Urban	Driver	Identify	Inform passengers about that willing blocking of the doors is not allowed	R2DATO wave 2-3
UCO.01.201	Driving plan passengers' communication	Close the doors	Urban	Driver	Activate	Doors are closed	TBD
UCO.01.202	Driving plan passengers' communication	Block the doors	Urban	Driver	Activate	Doors are blocked	TBD
UCO.01.203	Driving plan passengers' communication	Leave platform as soon as all passengers are on board and doors er close, use shortest possible time	Urban	Driver	Accelerate	Vehicle exit station in orderly way	R2DATO wave 2-3
UCO.01.204	Driving plan passengers' communication	Detect stop in traffic and inform passengers	Urban	Driver	Communicate	Obstacle in driving is correctly detected and passengers are informed	R2DATO wave 2-3
UCO.01.205	Driving plan passengers' communication	Detect situation that requires evacuation of the passengers	Urban	Driver	Coordinate	Situation that requires evacuation is correctly detected	R2DATO wave 2-3
UCO.01.206	Driving plan passengers' communication	Inform passengers about evacuation of the vehicle	Urban	Driver	Communicate	Passengers are informed about evacuation	R2DATO wave 2-3
UCO.01.207	Driving plan passengers' communication	Stop vehicle at place suitable for evacuation situation in case situation allows that	Urban	Driver	Stop	Vehicle stops at suitable areas for evacuation	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.208	Driving plan passengers' communication	Start evacuation of the passenger with announcement to the passengers	Urban	Driver	Communicate	Evacuation starts in orderly manor	R2DATO wave 2-3
UCO.01.209	Driving plan passengers' communication	Open doors necessary for evacuation of the passenger	Urban	Driver	Activate	Doors for evacuation are opened	R2DATO wave 2-3
UCO.01.210	Driving plan passengers' communication	Detect ill person on board and report - take appropriate action	Urban	Driver	Identify	Ill person om board is correctly detected	R2DATO wave 2-3
UCO.01.211	Driving plan passengers' communication	Detect criminal incident on board and report - take appropriate action	Urban	Driver	Identify	Criminal act om board is correctly detected	R2DATO wave 2-3
UCO.01.212	Driving plan passengers' communication	Take action if receiving bomb threat	Urban	Driver	Identify	Terror act om board is correctly detected	R2DATO wave 2-3
UCO.01.213	Depredated modus	Identify and react to any alerts, alarms and technical information for the vehicle	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	R2DATO wave 2-3
UCO.01.214	Depredated modus	D category fails to be recorded, and operation continues	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	TBD
UCO.01.215	Depredated modus	C Category fails to be recorded, and vehicle shall return to the depot after finishing ongoing route	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	TBD
UCO.01.216	Depredated modus	B Category fails to be recorded - continue operation to next stop and inform traffic manage about failures	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	TBD
UCO.01.217	Depredated modus	A category fails to be recorded, evacuate vehicle and inform traffic manager about situation	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	TBD
UCO.01.218	Depredated modus	Detect deviation situation, report and take appropriate action	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	R2DATO wave 2-3
UCO.01.219	Depredated modus	Identify other conditions of the vehicle that requires driving in degraded mode	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	R2DATO wave 2-3
UCO.01.220	Depredated modus	Detect failure on the tramway systems and take appropriate action	Urban	Driver	Identify	Alarm or alert is identified correctly, and appropriate action is taken	R2DATO wave 2-3
UCO.01.221	Deviation situations	Detect incidences related to accident, deviation or irregularity - take appropriate action	Urban	Driver		Incidents are correctly identified, and appropriate action is taken	R2DATO wave 2-3
UCO.01.222	Deviation situations	Data from perceptions sensors documenting incident occurrence	Urban	Autonomous	Autonomous	Data are collected and transferred	TBD
UCO.01.223	Deviation situations	Identification of accidents trough v2x or perception data	Urban	Autonomous	Autonomous	Incidents are correctly identified, and appropriate action is taken	R2DATO wave 2-3
UCO.01.224	Deviation situations	Sudden stop in danger situation take appropriate action and reporting	Urban	Driver	Stop	Vehicle stops and dangerous situation is avoided	R2DATO wave 2-3
UCO.01.225	Deviation situations	Detect fire on board (internal and external)	Urban	Driver	Detect	Fire om board is correctly detected	R2DATO wave 2-3
UCO.01.226	Deviation situations	Fire om board is reported to emergency units	Urban	Driver	Coordinate	Emergency units are informed about fire om board	R2DATO wave 2-3
UCO.01.227	Deviation situations	Fire om board is reported to emergency units	Urban	Driver	Coordinate	Fire om board is extinguished	R2DATO wave 2-3
UCO.01.228	Deviation situations	Fire om in the driving area is detected and reported to emergency units	Urban	Driver	Coordinate	Fire correctly detected and emergency units informed	R2DATO wave 2-3
UCO.01.229	Deviation situations	Detect sparking under the vehicle and take appropriate action	Urban	Driver	Detect	Sparks er correctly detected and appropriate action is taken	R2DATO wave 2-3
UCO.01.230	Deviation situations	Detect sparking in upper parts the vehicle and take appropriate action	Urban	Driver	Detect	Sparks er correctly detected and appropriate action is taken	R2DATO wave 2-3
UCO.01.231	Deviation situations	Detect derailment	Urban	Driver	Detect	Derailment is correctly detected	R2DATO wave 2-3
UCO.01.232	Deviation situations	Send report about derailment to emergency units	Urban	Driver	Communicate	Derailment is reported to emergency units and OC	R2DATO wave 2-3
UCO.01.233	Deviation situations	Identify single track deviation and take appropriate action	Urban	Driver	Identify	Single track is identified	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.234	Deviation situations	Detect signs for deviation in traffic and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.235	Deviation situations	Detect temporarily traffic signals and take appropriate action	Urban	Driver	Detect	Performed action is compliant with respective signal or sign	R2DATO wave 2-3
UCO.01.236	Deviation situations	Establish contact with traffic regulator (TV) and take required action	Urban	Driver	Communicate	Contact is established and stable	R2DATO wave 2-3
UCO.01.237	Deviation situations	Communicate your position to other trams waiting for driving on single track (substitute for pins)	Urban	Autonomous	Autonomous	All trams in the area are informed about a vehicle on single track	R2DATO wave 2-3
UCO.01.238	Deviation situations	Identify unexpected deviation in the traffic	Urban	Driver	Identify	Unexpected deviation is correctly detected and reported to OC	R2DATO wave 2-3
UCO.01.239	Deviation situations	Establish contact with traffic central and take required action	Urban	Driver	Establish	Contact is established and stable, required action is correctly performed	R2DATO wave 2-3
UCO.01.240	Deviation situations	Identify nearest suitable loop or crossing track for turning and take appropriate action	Urban	Driver	Identify	Possibility for avoidance of the deviation in the traffic is identified and coordinated with OC	R2DATO wave 2-3
UCO.01.241	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.242	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.243	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.244	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.245	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.246	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.247	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.248	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.249	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.250	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.251	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.252	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.253	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.254	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.255	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.256	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.257	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.258	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.259	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.260	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3

Id number	Activity group	Activity description	Area	Actors	Actions	Outcome	Demonstrator
UCO.01.261	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Communicate via v2x and avoid collision	R2DATO wave 2-3
UCO.01.262	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.263	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.264	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.265	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.266	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.267	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.268	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.269	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Avoid	Obstacle detected and collision avoided	R2DATO wave 2-3
UCO.01.270	Accidents	Collision with a police car (civil not in Police colours) with light warning on	Urban	Driver	Avoid	Communicate via v2x and avoid collision	TBD
UCO.01.271	Accidents	See Annex 2 - Accidents and collision use cases Oslo	Urban	Driver	Stop	Derailment detected and tram stopped	R2DATO wave 2-3