Testing & evaluation

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Testing Methods

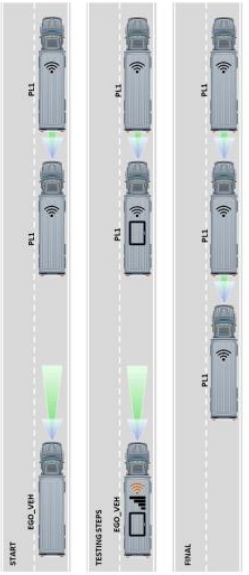
- Once the scenario allocation has finished, the next step is to execute and evaluate in the testing platforms available in each project.
- The first step is to define a coordination criteria and then execution and evaluation.
- Each project have their own test environment with very specific characteristics but those are divided in four main test methods:
  - Virtual Testing
  - XiL Testing
  - Proving Ground Testing
  - Field Testing

Test Coordination (Platooning)

- In this phase, the target group decides de order of the allocated scenarios. This step provides the necessary flexibility in the execution of the tests.

Test Methodology	Test Goal
Virtual Testing	Validation of V2V communication software modules with synthetic data from simulation environment.
XiL-based Testing	Validation of V2V communication devices (hardware and software) with other onboard platforms and/or vehicle.
Proving Ground Testing	Validation of the complete integrated V2V communication in the vehicle, with other vehicles on test track.

ENSEMBLE

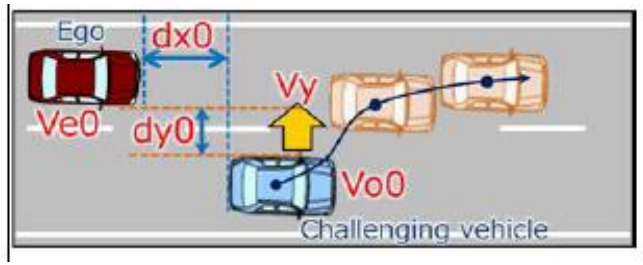


Test Coordination (TJC and HWP)

- In this phase, the target group decides de order of the allocated scenarios. This step provides the necessary flexibility in the execution of the tests.

Test Methodology	Test Goal
Virtual Testing	Virtual simulation is used to verify and validate the functional reactions and behaviour of the system, regarding the dynamic part of the scenarios
XiL Testing	Test with synthetic data to the TJC system already placed in a physical platform, this test will give us a better feedback of the behaviour of our decision making and control algorithms.
Proving Ground Testing	Proving ground is reproducing a realistic scenario but without possibility of controlling all the parameters like weather conditions.
Field Testing	This method will demonstrate the proper assessment in real driving conditions.

ALKS Regulation

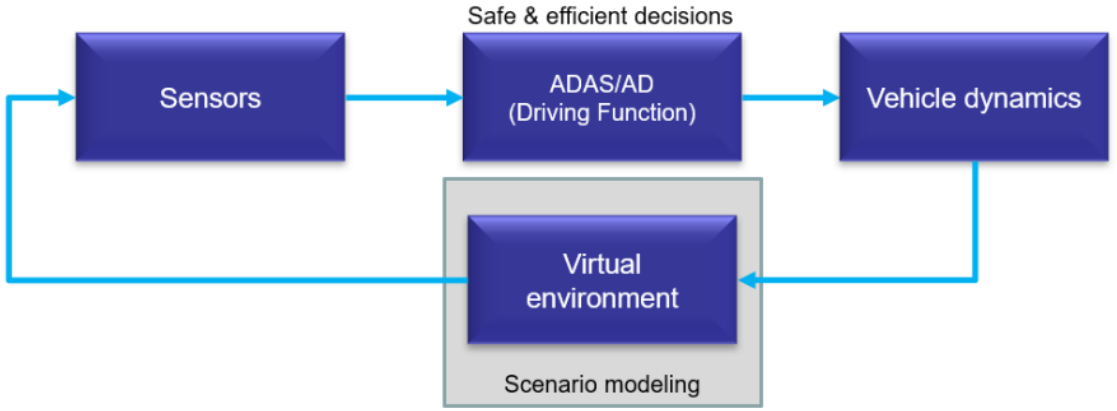


Initial condition	Initial velocity	**Ve0**	Ego vehicle velocity
		Ve0-Vo0	Relative velocity
	Initial distance	**dy0**	Latteral distance[x]
		dx0	Longitudinal distance
Vehicle motion	Lateral motion	**Vy**	Lateral velocity

[x]Latteral distance
ex) Lane width : 3.5 [m]
Vehicle width:1.9 [m]
Driving in the center of the lane
dy=1.6 [m]

Virtual Testing

- Objective:
  - It helps to understand the possible behaviours and outcomes of a system in a virtual setting that we can directly control, with much higher efficiency compared to real world testing.
- Test Method description:
  - A top-level overview is reflected by this blocks:
    - Driving function
    - Vehicle Dynamics
    - Sensors
    - Virtual Environment



Virtual Testing

Preparation

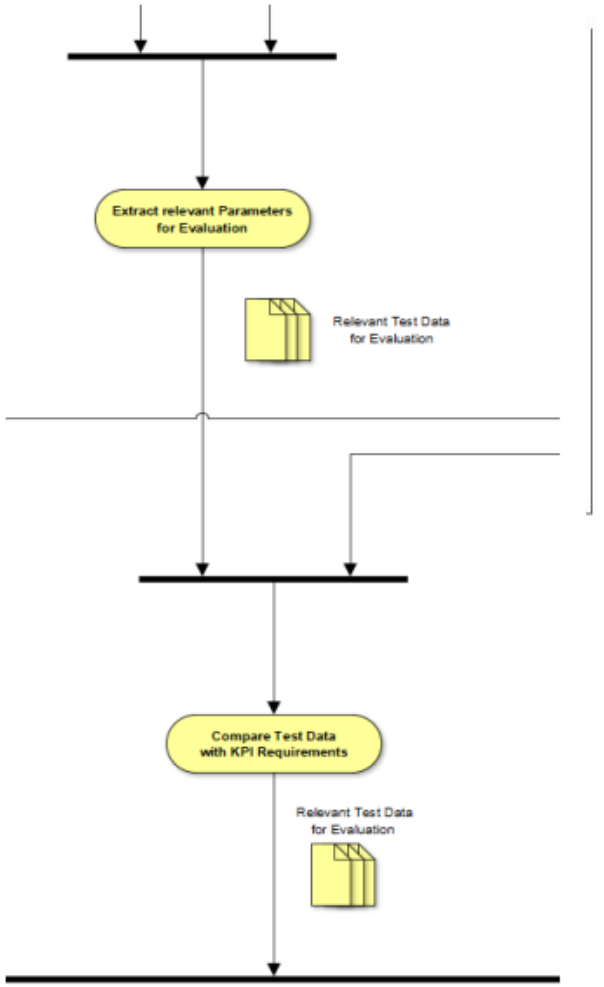
- Setup needed resources (HW/SW)
- Setup needed interfaces and plant models
- Setup needed metrics to determine KPIs

Execution

- Validate virtual components (plant models)
- Conduct virtual tests:
  - Executed and monitored
  - Test data is stored

Evaluation

- Test data is post processed to extract:
  - Metrics
  - Compare test data with KPI requirements

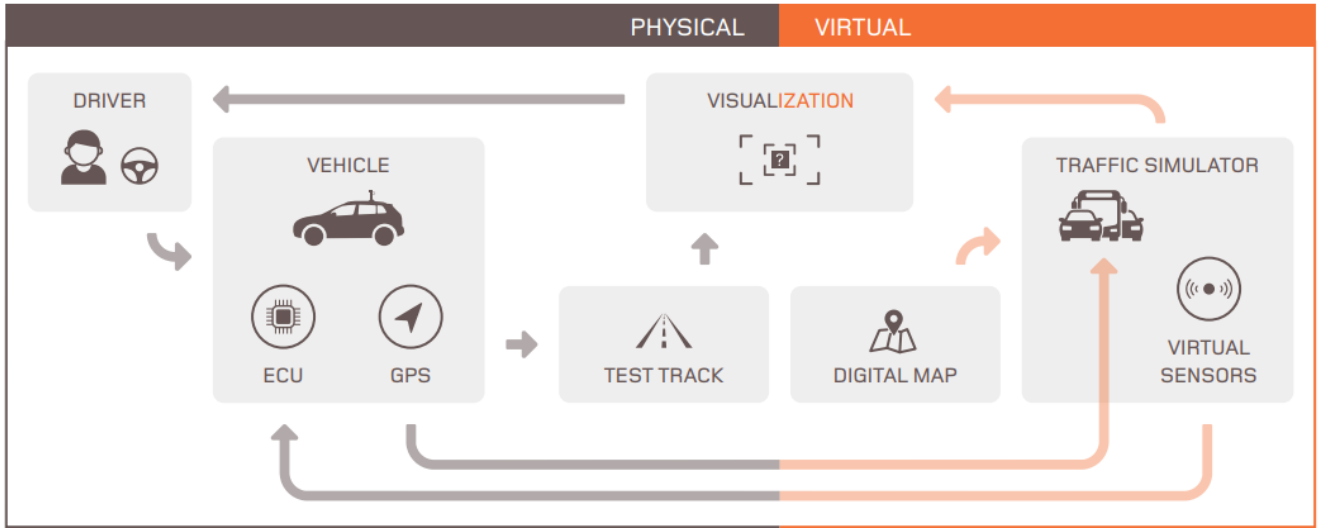


Virtual Testing (linked projects)

Video: Virtual Validation

XiL Testing

- Objective:
  - This method allow the broading of the testing coverage matrix as well as more complex and dangerous test scenarios in test tracks in a more efficient manner.
- Test Method description:
  - There are two main setups:
    - Driver In the Loop
    - Vehice in the loop



XiL Testing

Preparation

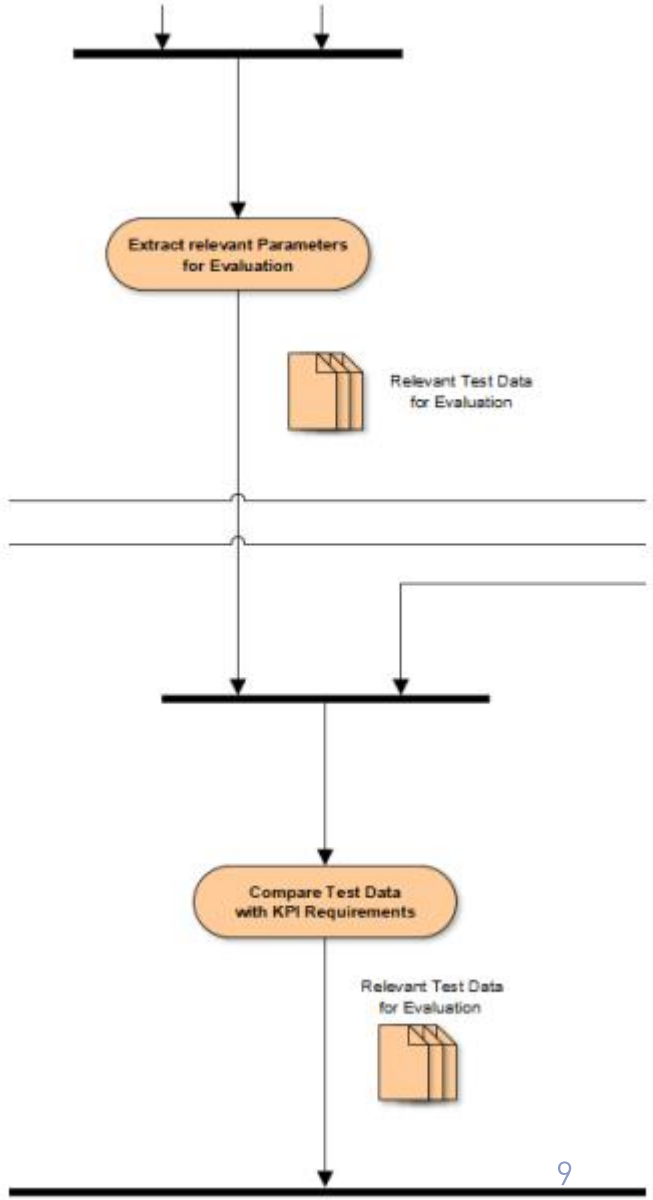
- Validation of components
- Identificaiton of readiness of test cases
- Consideration of KPI for parameter selection.

Execution

- This step executes the test under the defined conditions
- It takes more time than virtual validation and is more complex

Evaluation

- Extract relevant parameters for evaluation
- Compare test data with KPI requirements

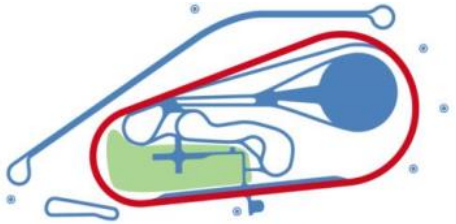


XiL Testing (linked projects)

Video Testing 2: XiL

Proving Ground Testing

- Objective:
  - Full system performance can be evaluated in these real-world environments while this is not feasible in Virtual testing or XiL-based testing because of their limitations.
- Test Method description:
  - This method is divided in two parts
    - Generation of capabilites / limitations for selection of scenarios and allocation part of the proces
    - Execution of allocated scenarios in test tracks.



Proving Ground Testing

Preparation

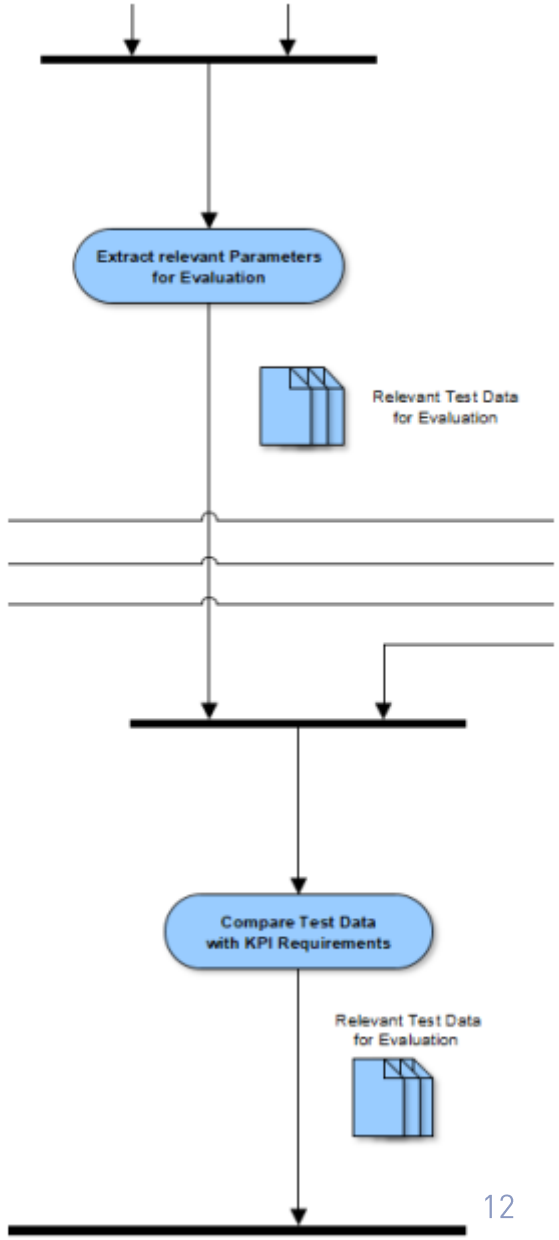
- Vehicle under test equipment
- Infrastucture equipment (dummies, GNSS station, …)
- Test cases from concrete scenarios

Execution

- Conduct proving ground tests
- Store the data

Evaluation

- Extract relevant parameters for evaluation
- Compare test data with KPI requirements

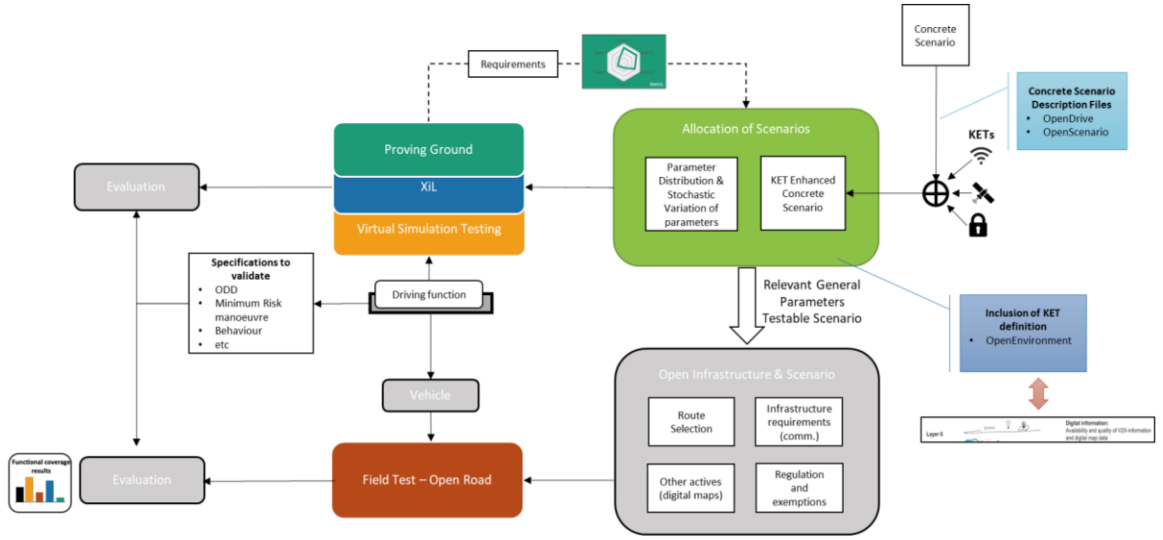


Proving Ground Testing (linked projects)

Video PG Testing

Field Testing

- Objective:
  - Field testing expose systems to a wide variety of real-world conditions related to ODD that would not be feasible with established closed test tracks or simulated approaches.
- Test Method description:
  - It's defined based on following topics:
    - Route selection method
    - Infrastructure requirements
    - Driving function dependencies
    - Regulation and exemptions



Field Testing

Preparation

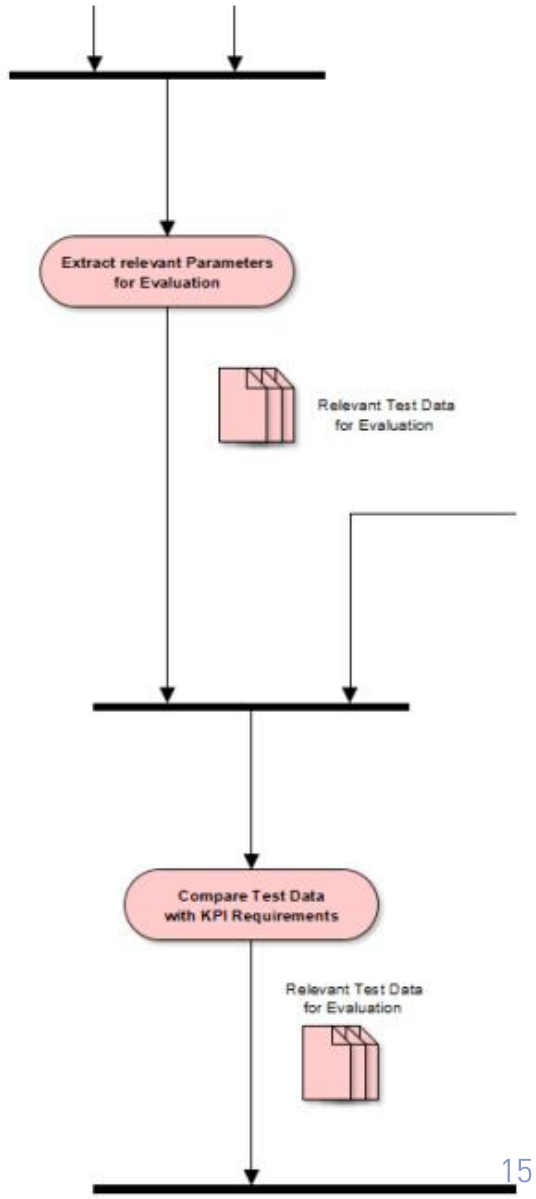
- Route selection method
- Vehicle test equipments

Execution

- Conduct field testing
- Field monitoring during its execution
- Store the data

Evaluation

- Extract relevant parameters from identified scenarios during field testing.
- Compare test data with KPI requirements



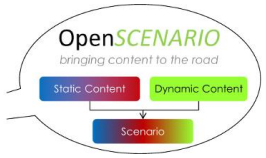
Formats and Interfaces

- Common interfaces and data formats are necessary to **combine international** approaches, tools and methods

Scenario Description

- OpenScenario
- OpenDrive
- OpenCRG

OpenDRIVE
managing the road ahead



Simulation and Testing

- Open Simulation Interface
- Functional Mock-up Interface

ASAM

Measurement Data

- OMEGA Format from VVMethods