HEADSTART

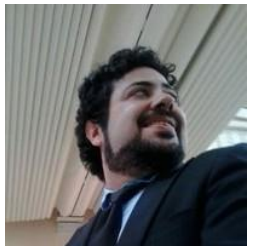
Harmonised European Solutions for Testing Automated Road Transport

Methodology and Process

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824309.

Agenda

- ✓ Álvaro Arrúe – Applus IDIADA
- ✓ Nicolas Wagener – Institute for Automotive Engineering RWTH Aachen University
- ✓ Bernhard Hillbrand – Virtual Vehicle



Agenda

- ✓ Introduction
- ✓ The HEADSTART Week
- ✓ HEADSTART‘s Overall Methodology
- ✓ HEADSTART‘s Process

Introduction

Webinar rules:

- ✓ Webinar is being recorded
- ✓ Slides and recording will be published on the HEADSTART Website
- ✓ Questions will be discussed after each presentation
  - Remember the slide number if you have a specific questions

Introduction

✓ Goal of this Meeting?

➔ **Get external expert feedback on the HEADSTART Methodology and Process**

✓ Feedback will be integrated by refinement of the methodology and processes

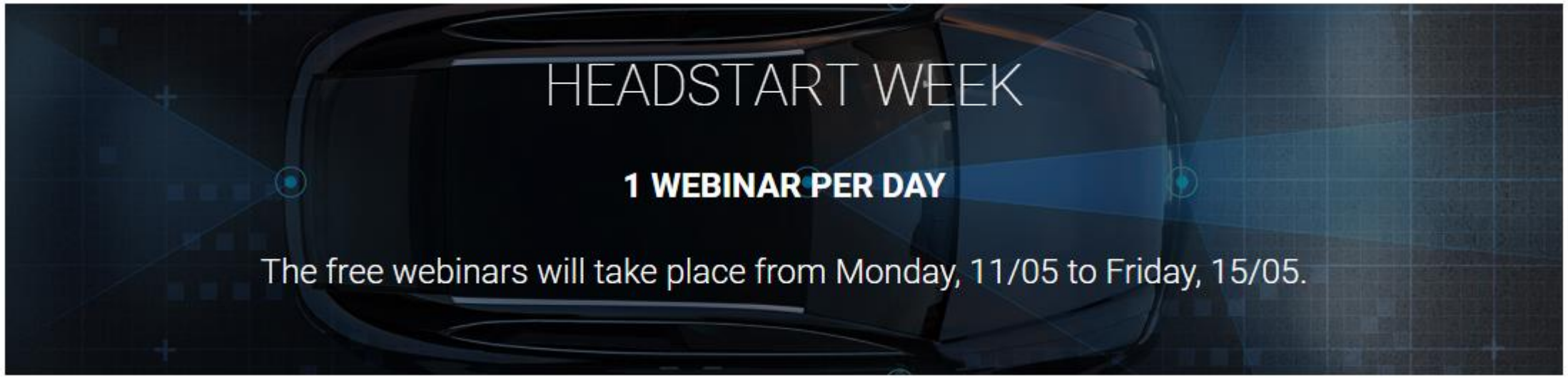
HEADSTART

Harmonised European Solutions for Testing Automated Road Transport

The HEADSTART Week!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824309.

The HEADSTART week!



- ✓ HEADSTART project is organizing a week full of webinars, starting from Monday, 11/05 up to Friday, 15/05.
- ✓ These webinars will be interactive sessions engaging participants with questions and discussions.

The HEADSTART week!

- ✓ All participants will have the opportunity to discuss and find out more about:
  - HEADSTART methodology, which has harmonized different European initiatives and included Automated Driving key enabling technologies;
  - HEADSTART selected use cases (Truck platooning and Traffic Jam Chauffeur);
  - How the validation methodology will be applied;
  - How to validate the AD driving function;
  - How the KETs will be handled;
  - Cybersecurity as a transversal topic which has a great impact in CAD functions validation

The HEADSTART week!

✓ 4 Webinars: Different days for your convenience!

Monday

Tuesday

Thursday

Friday

The HEADSTART week!

- ✓ Webinars are **free** and **independent.**
- ✓ This means that the participants are able to attend the webinars they prefer.
- ✓ As HEADSTART, our recommendation is to attend all webinars, so as to have a full overview of the project.
- ✓ **To register and find out more information** about each webinar, please **visit our webpage**

www.headstart-project.eu/headstart-wee

Stay connected with HEADSTART

- ✓Visit HEADSTART website

  www.headstart-project.eu

- ✓Follow our Social Media:

  - @HEADSTART_EU
  - HEADSTART-PROJECT
  - HEADSTART project (Group)
  - @HeadstartEUproject

- ✓Reach us via an e-mail:

  info@headstart-project.eu

- ✓Sign up to our newsletter:

  https://lists.iccs.gr/wws/subscribe/headstart-news

- ✓Get in touch with our partners

Thank you!

Any questions?

Álvaro Arrúe

Project Manager, Connected and automated driving

Alvaro.arrue@idiada.com

HEADSTART

Harmonised European Solutions for Testing Automated Road Transport

The Overall Methodology in the HEADSTART Project

11/05/2020

Nicolas Wagener (ika), Patrick Weißensteiner (Virtual Vehicle), Jean-Baptiste Coget (VEDECOM)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824309.

Agenda

- ✓ Overall Methodology
- ✓ Scenario Selection and Relevance Metrics
- ✓ Allocation of Scenarios
- ✓ Testing

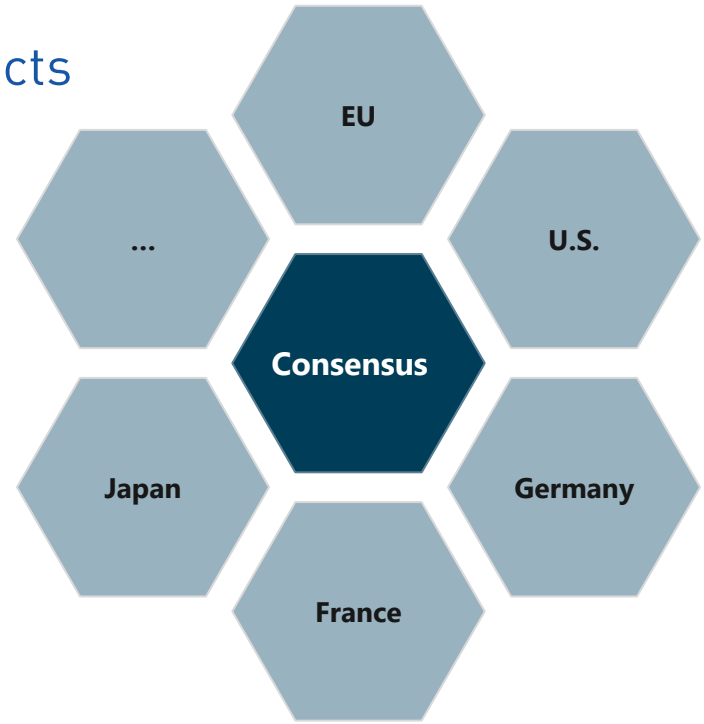
Overall Methdology

Where does the HEADSTART Methodology come from?

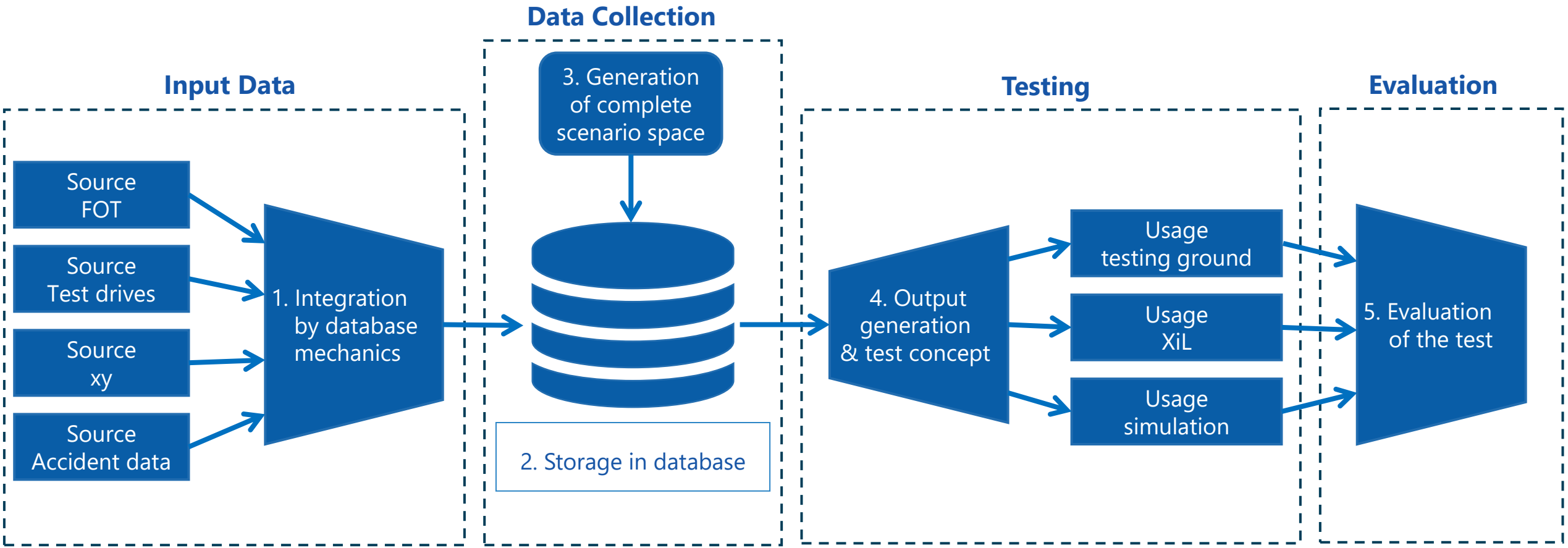
Overall Methdology

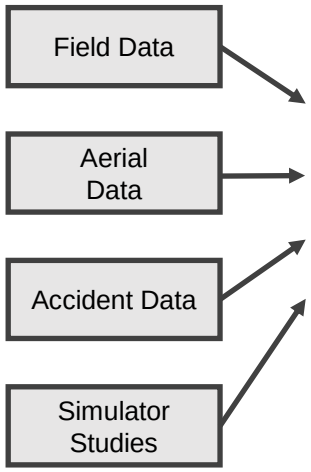
Where does the HEADSTART Methodology come from?

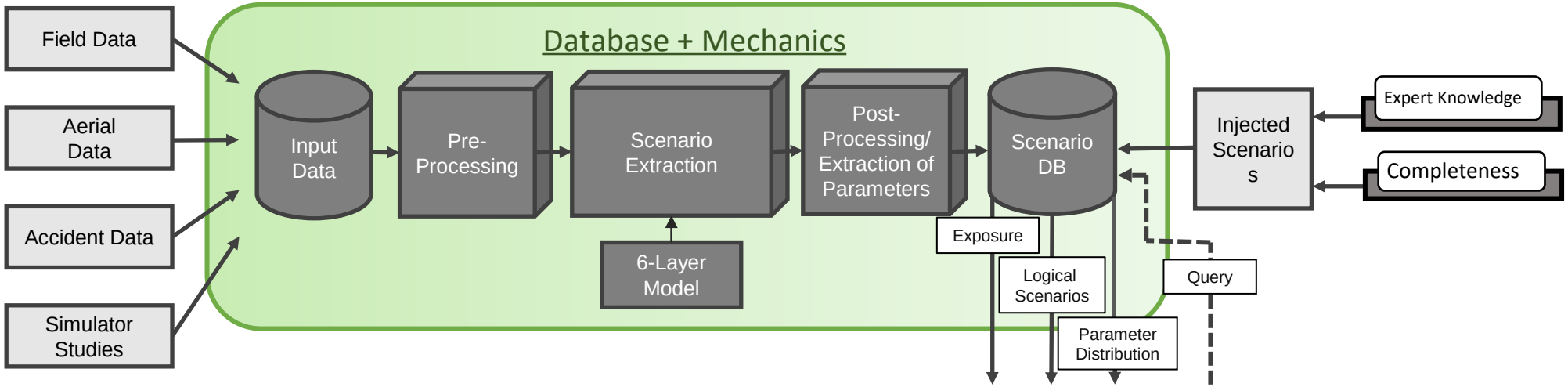
- ✓ State of the art analysis of international and national projects
- ✓ **Harmonization** of present and past projects
- ✓ Utilizing **common databases** to analyse data
- ✓ Testing of selected **relevant scenarios**

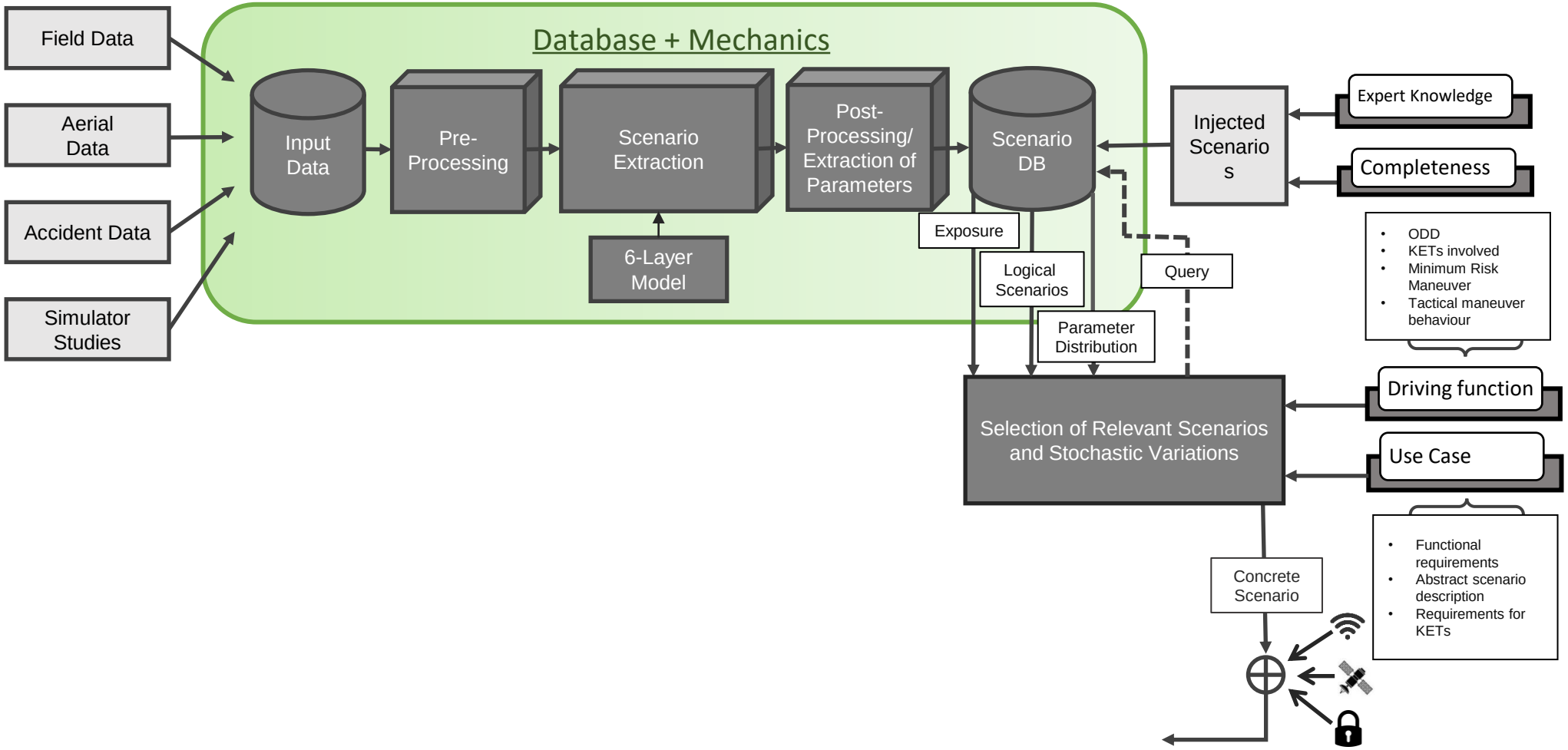


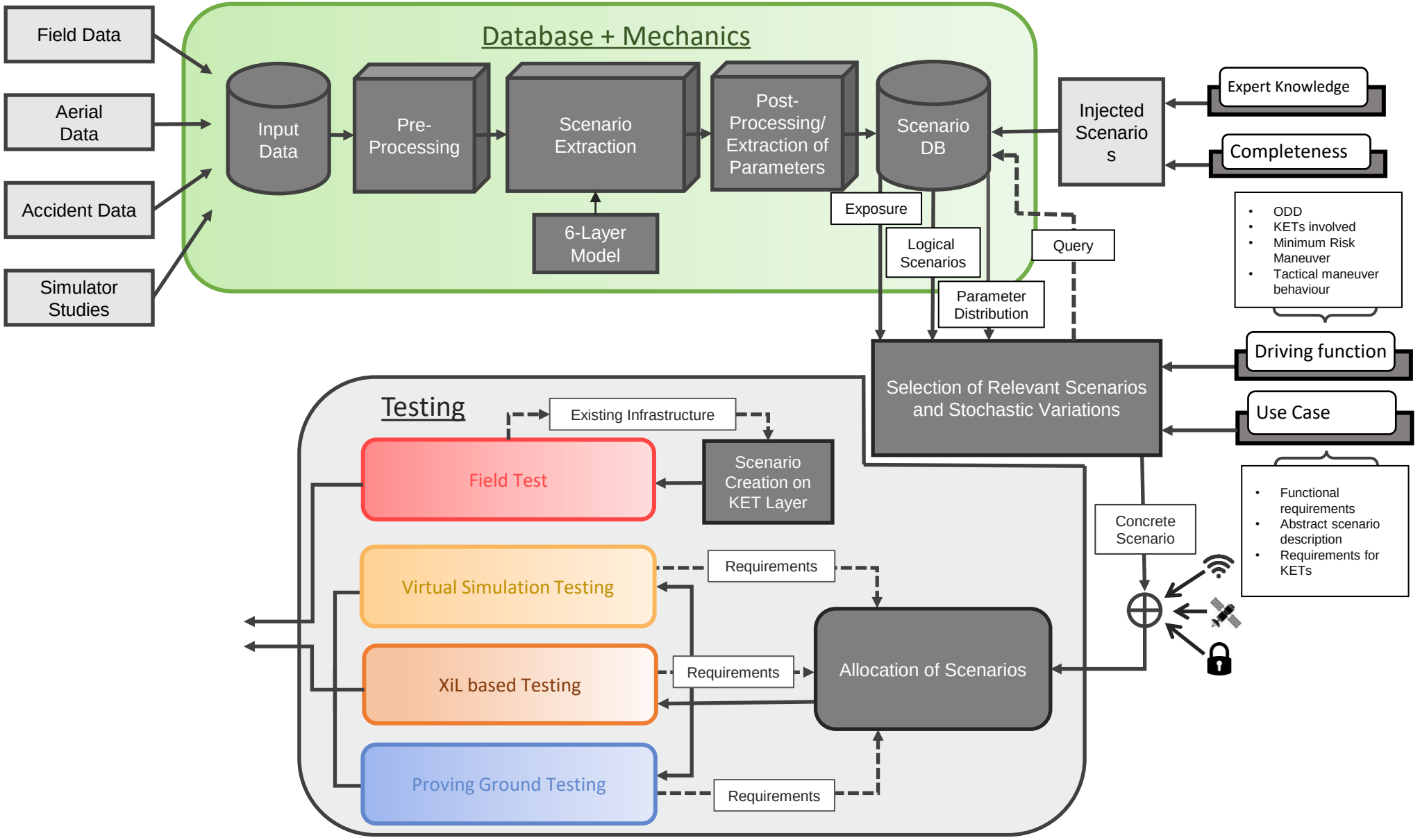
Overall Methdology

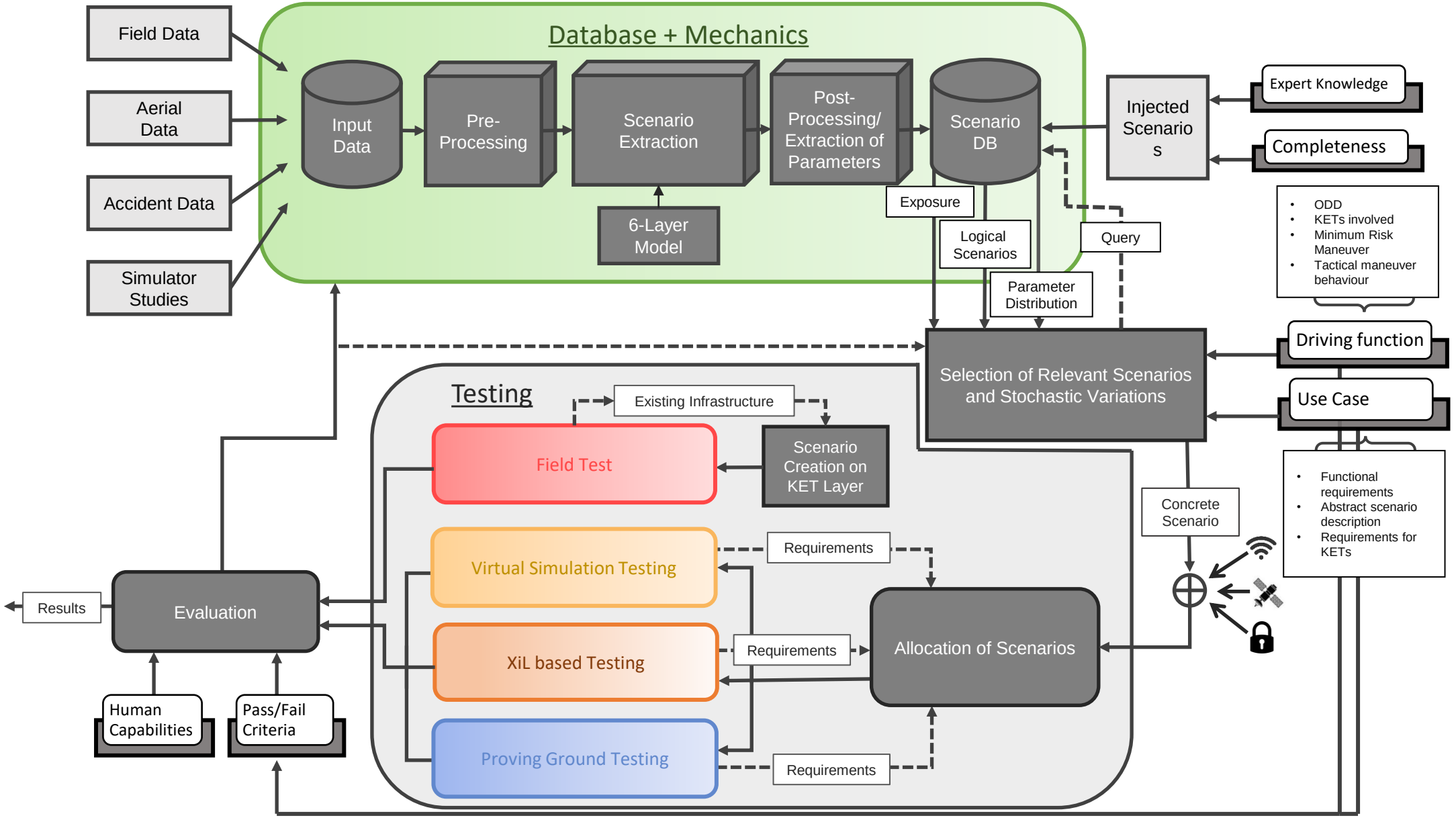



Field Data
Aerial Data
Accident Data
Simulator Studies

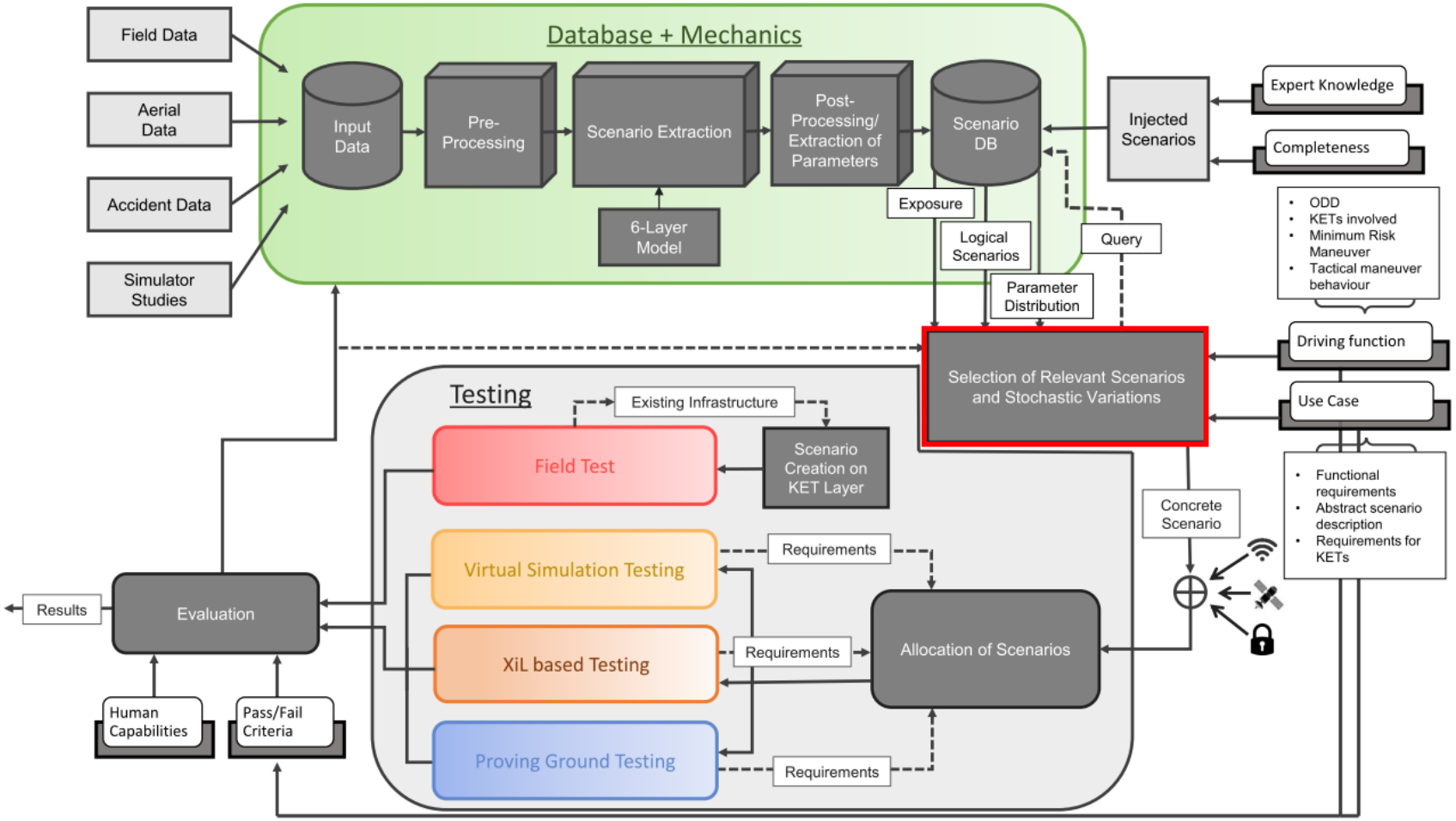

Field Data
Aerial Data
Accident Data
Simulator Studies
Database + Mechanics
Input Data
Pre-Processing
Scenario Extraction
6-Layer Model
Post-Processing/ Extraction of Parameters
Scenario DB
Exposure
Logical Scenarios
Parameter Distribution
Query
Injected Scenarios
Expert Knowledge
Completeness


Field Data
Aerial Data
Accident Data
Simulator Studies
Database + Mechanics
Input Data
Pre-Processing
Scenario Extraction
6-Layer Model
Post-Processing/ Extraction of Parameters
Scenario DB
Exposure
Logical Scenarios
Parameter Distribution
Query
Injected Scenarios
Expert Knowledge
Completeness
ODD
KETs involved
Minimum Risk Maneuver
Tactical maneuver behaviour
Driving function
Use Case
Selection of Relevant Scenarios and Stochastic Variations
Concrete Scenario
Functional requirements
Abstract scenario description
Requirements for KETs


Field Data
Aerial Data
Accident Data
Simulator Studies
Database + Mechanics
Input Data
Pre-Processing
Scenario Extraction
Post-Processing/ Extraction of Parameters
Scenario DB
6-Layer Model
Exposure
Logical Scenarios
Parameter Distribution
Query
Injected Scenarios
Expert Knowledge
Completeness
ODD
KETs involved
Minimum Risk Maneuver
Tactical maneuver behaviour
Driving function
Use Case
Functional requirements
Abstract scenario description
Requirements for KETs
Selection of Relevant Scenarios and Stochastic Variations
Concrete Scenario
Testing
Existing Infrastructure
Field Test
Scenario Creation on KET Layer
Virtual Simulation Testing
Requirements
XiL based Testing
Requirements
Proving Ground Testing
Requirements
Allocation of Scenarios


Field Data
Aerial Data
Accident Data
Simulator Studies
Database + Mechanics
Input Data
Pre-Processing
Scenario Extraction
6-Layer Model
Post-Processing/ Extraction of Parameters
Scenario DB
Exposure
Logical Scenarios
Parameter Distribution
Query
Injected Scenarios
Expert Knowledge
Completeness
ODD
KETs involved
Minimum Risk Maneuver
Tactical maneuver behaviour
Driving function
Use Case
Selection of Relevant Scenarios and Stochastic Variations
Functional requirements
Abstract scenario description
Requirements for KETs
Concrete Scenario
Testing
Existing Infrastructure
Field Test
Scenario Creation on KET Layer
Virtual Simulation Testing
Requirements
XiL based Testing
Requirements
Proving Ground Testing
Requirements
Allocation of Scenarios
Evaluation
Results
Human Capabilities
Pass/Fail Criteria

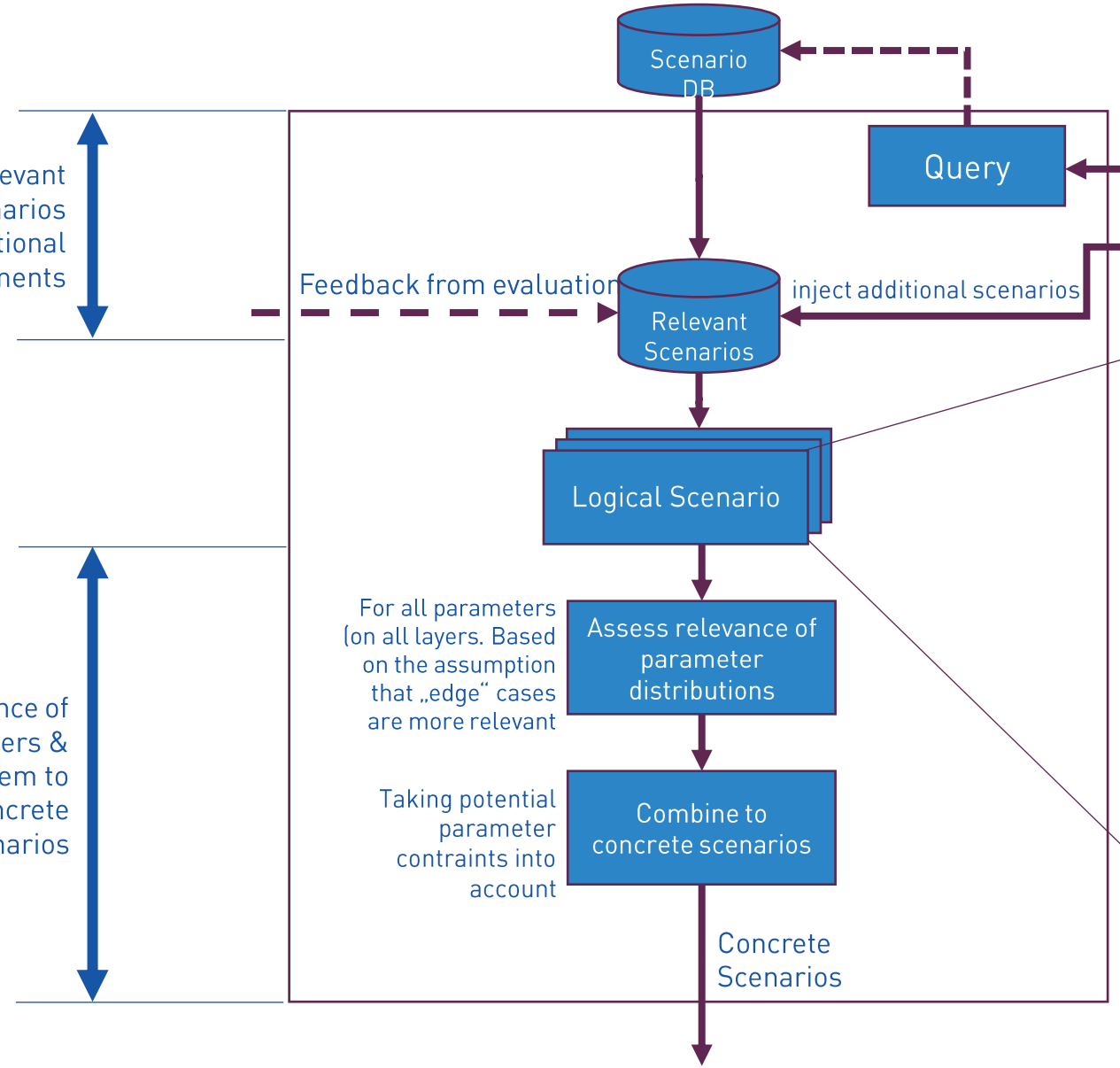
Scenario Selection



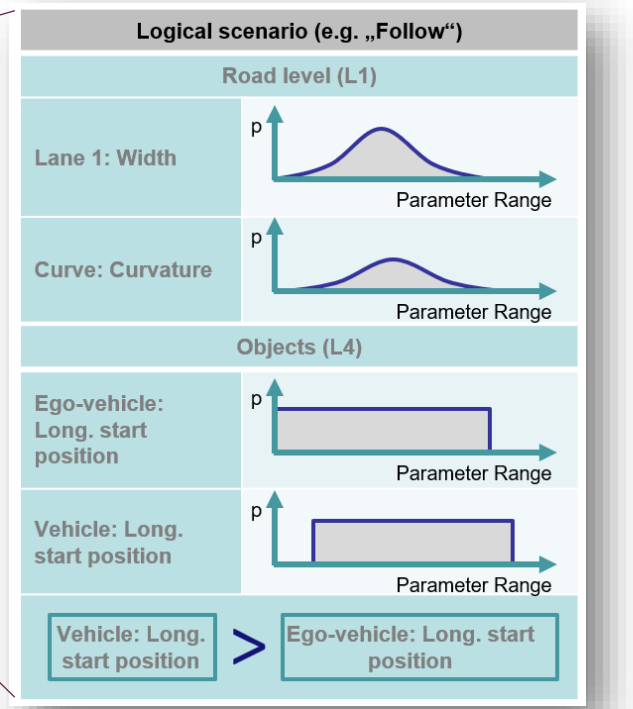
Scenario Selection

Filter all relevant logical scenarios based on functional requirements

Define relevance of parameters & combine them to form concrete scenarios

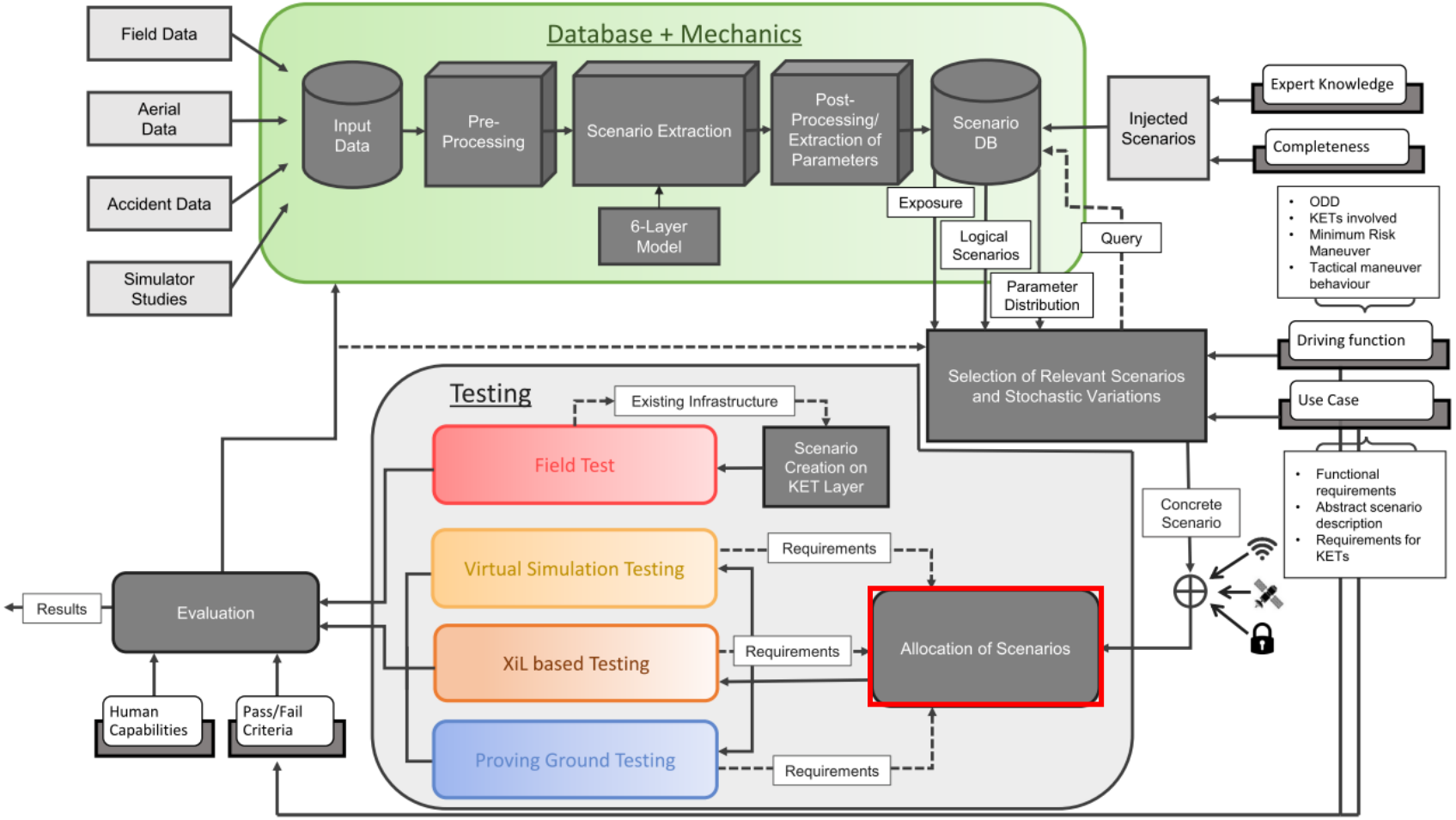


Driving function
- Functional requirements
  - Main pillars:
    - ODD
    - OEDR
    - Tactical Maneuver Behaviour



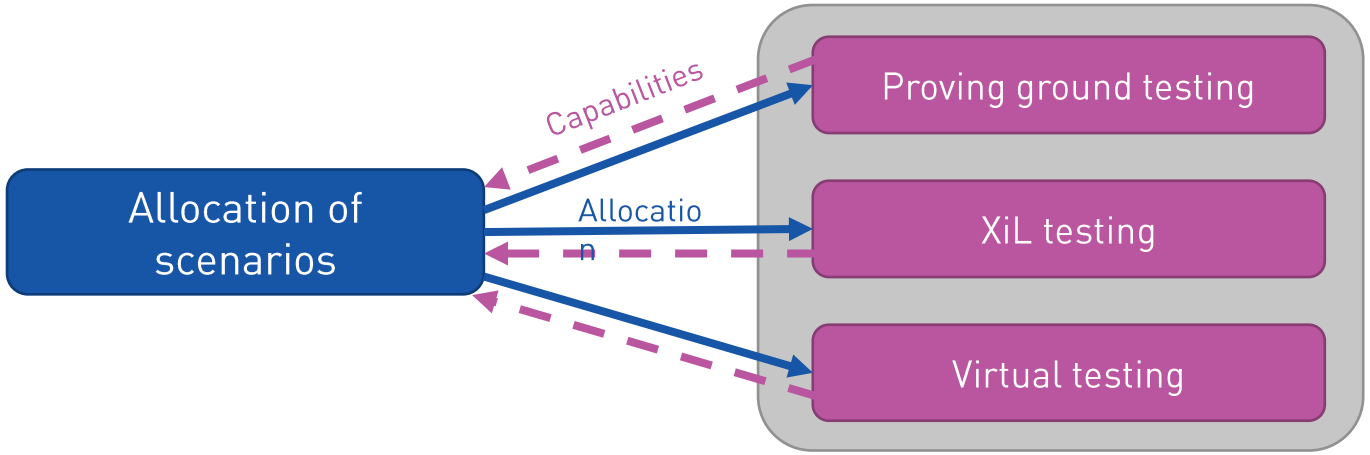
Source: Scenario for Development, Test Validation of Automated Vehicles (Menzel, Bagschik, Maurer, 2018)

Scenario Allocation



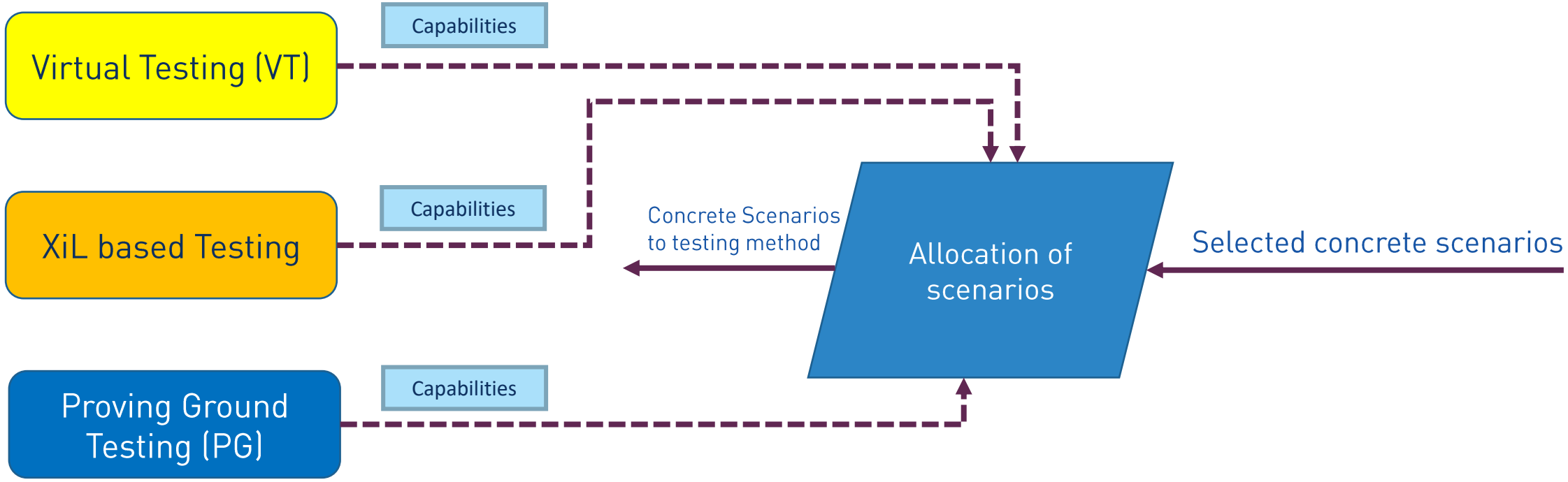
Scenario Allocation

- ✓ Each test instance has its advantages and restrictions
- ✓ Safety, testing cost, testing time and other parameters must be taken into account in the allocation process
- ✓ **Objective** ➔ Define how to allocate the selected concrete scenarios to each test method to find the "best fit"



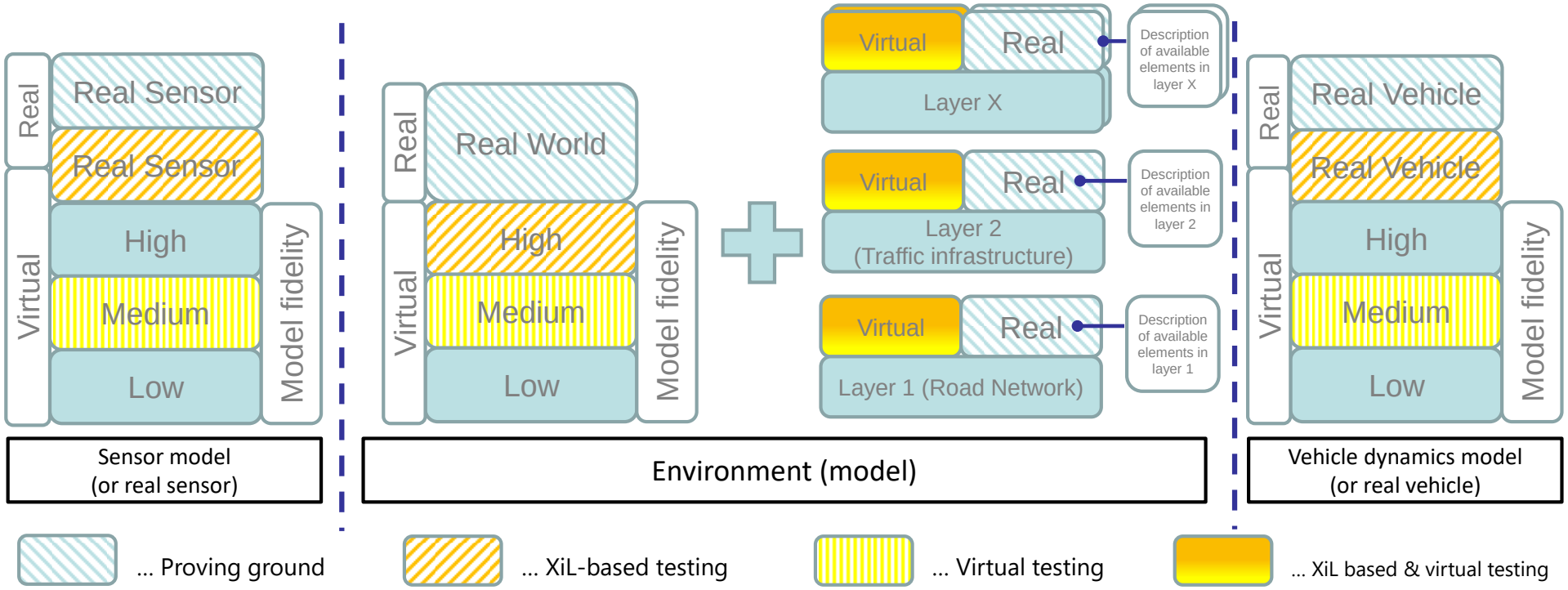
Scenario Allocation

- ✓ To efficiently allocate the scenarios to the test method, the capabilities of each test method needs to be defined
- ✓ This includes, amongst other things, available elements at the PG, simulations models and their fidelity as well as XiL test beds



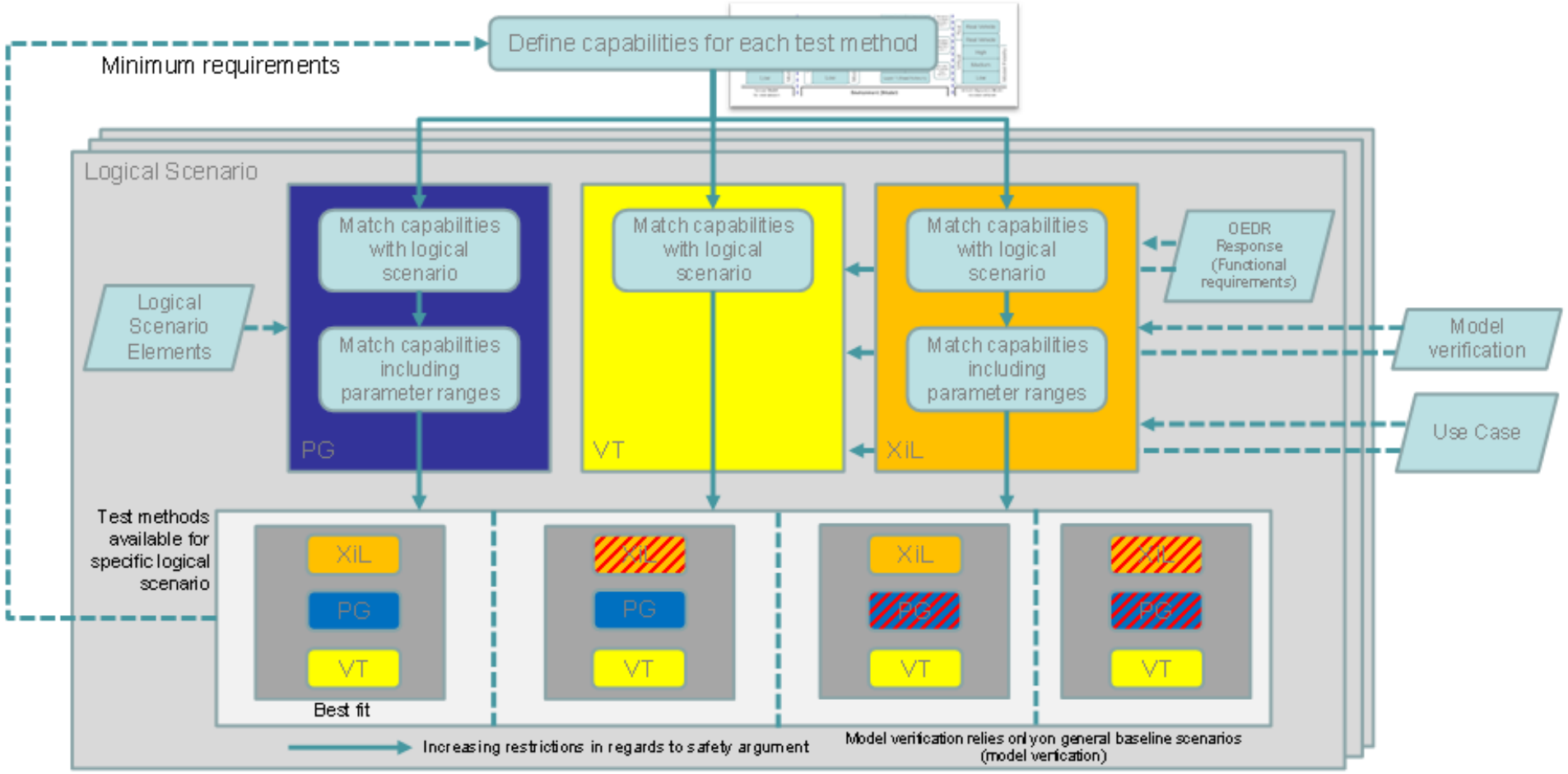
Scenario Allocation

- ✓ Definition of the capabilities for “Sensor”, “Environment” and “Vehicle Dynamics”
- ✓ Use of the map of capabilities:

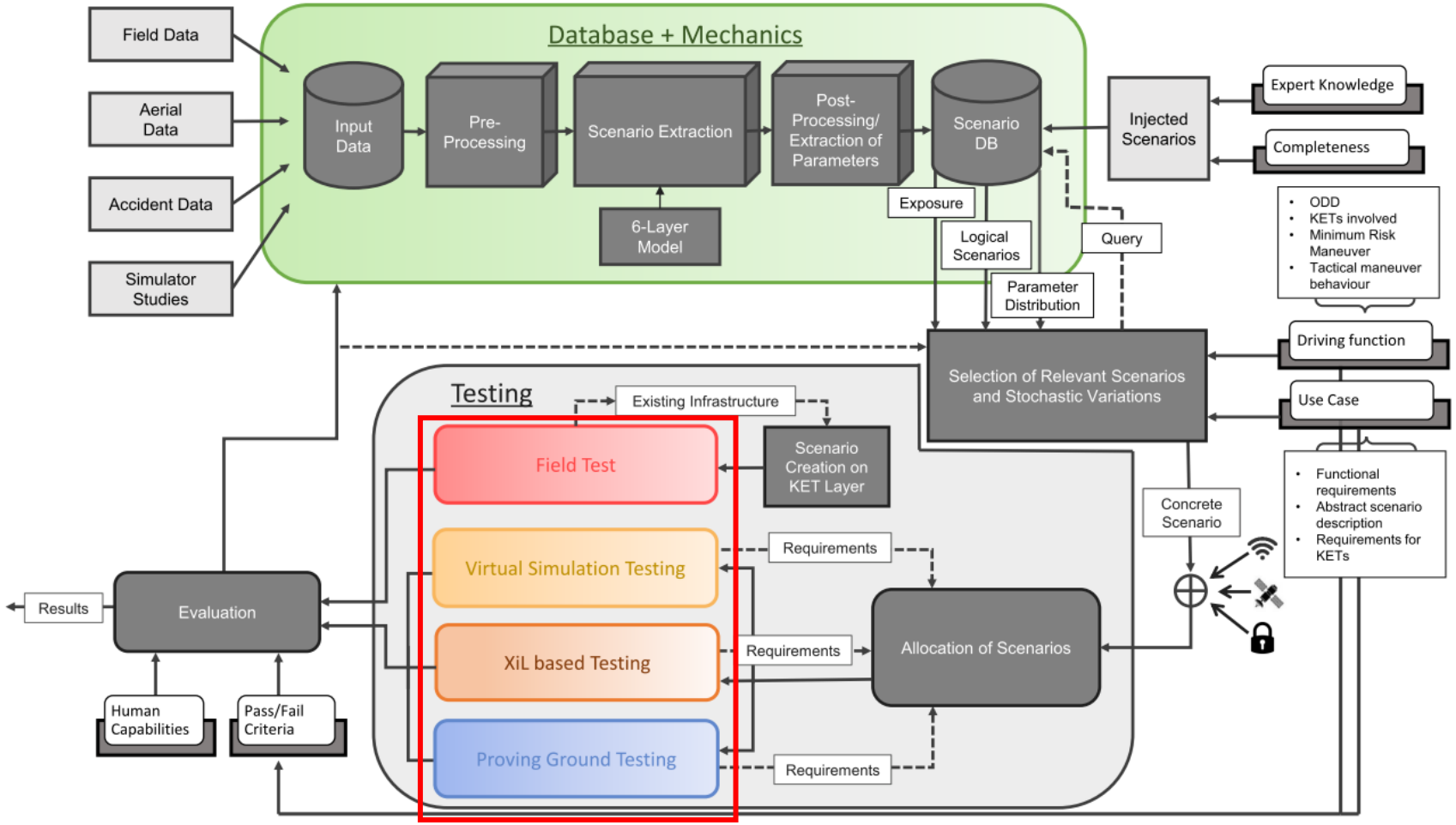


Scenario Allocation

✓ Match the scenarios with the capabilities of the test method to find the best fit



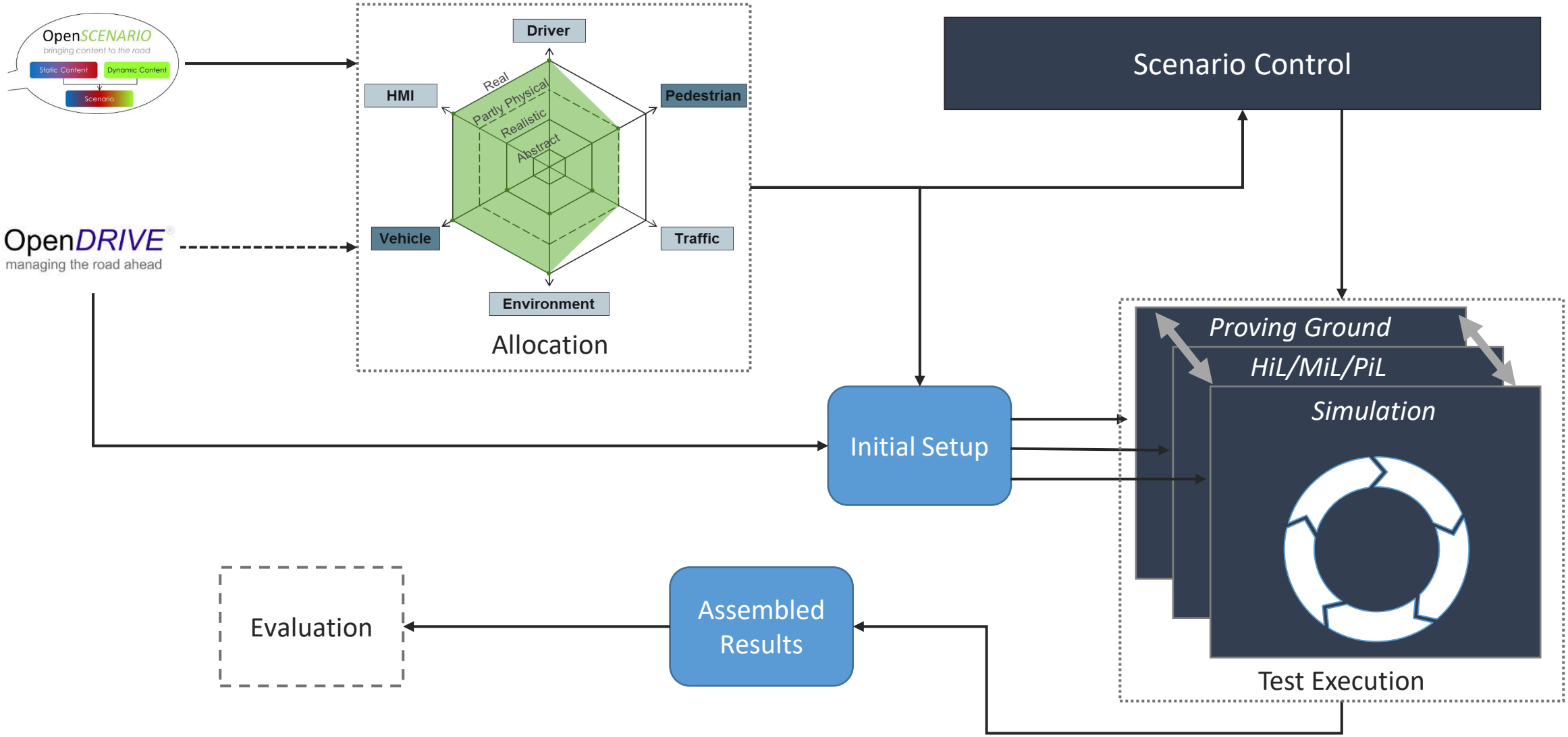
Test Execution



Scenario Execution

- ✓ Testing Facilities
  - Proving Grounds
  - Simulation
  - XiL – Based
  - Field Operational Tests
- ✓ Unified Interfaces
  - Open Simulation Interface (OSI)
  - Functional Mock-up Interface (FMI)
- ✓ Open Standards
  - OpenSCENARIO
  - OpenDRIVE
  - OpenCRG

XiL-Based Testing



Summary

- ✓ The HEADSTART Methodology is a living process
  - Need for expert input to refine the methodology
- ✓ Keep the Methodology harmonized and applicable for different databases
- ✓ More detailed process will be introduced in the next presentation

Thank you!

Any questions?

Nicolas Wagener

Institute of Automotive Engineering

RWTH Aachen

Nicolas.wagener@ika.rwth-aachen.de

HEADSTART

Harmonised European Solutions for Testing Automated Road Transport

HEADSTART Process

Webinar 11th May 2020

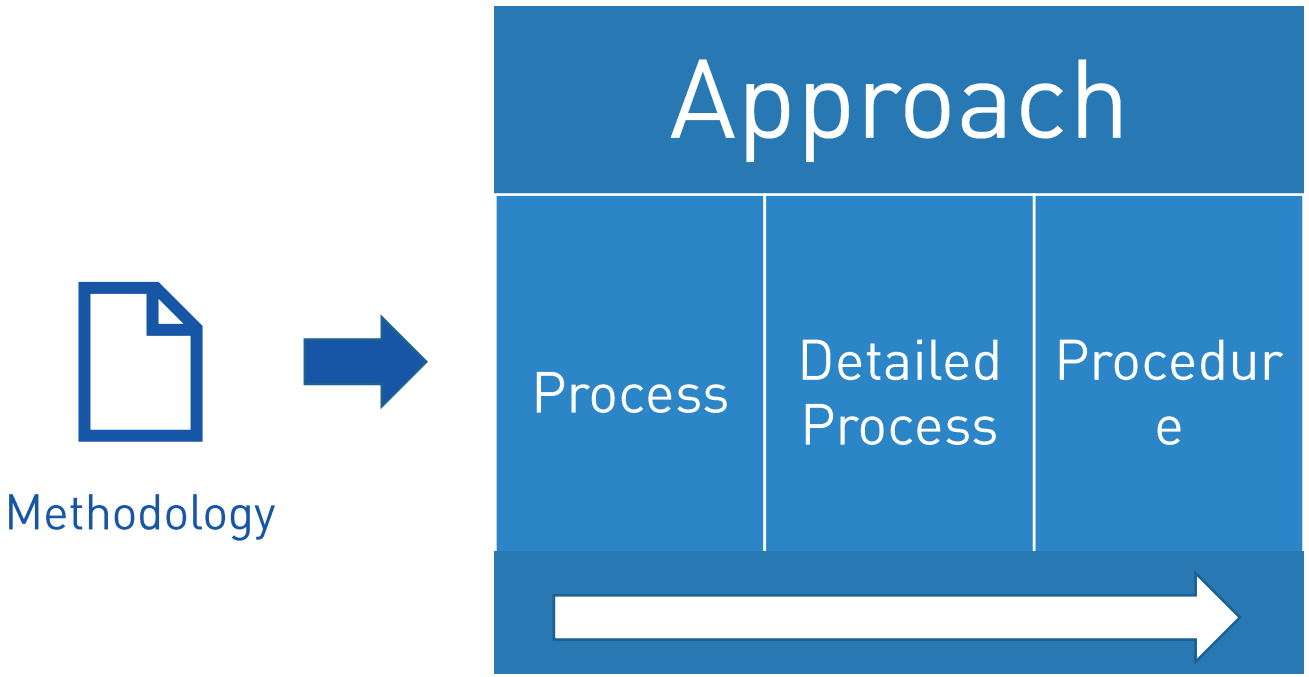
Bernhard.Hillbrand@v2c2.at

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824309.

Source: https://blog.triaster.co.uk/blog/procedure-vs-process-what-is-the-differ

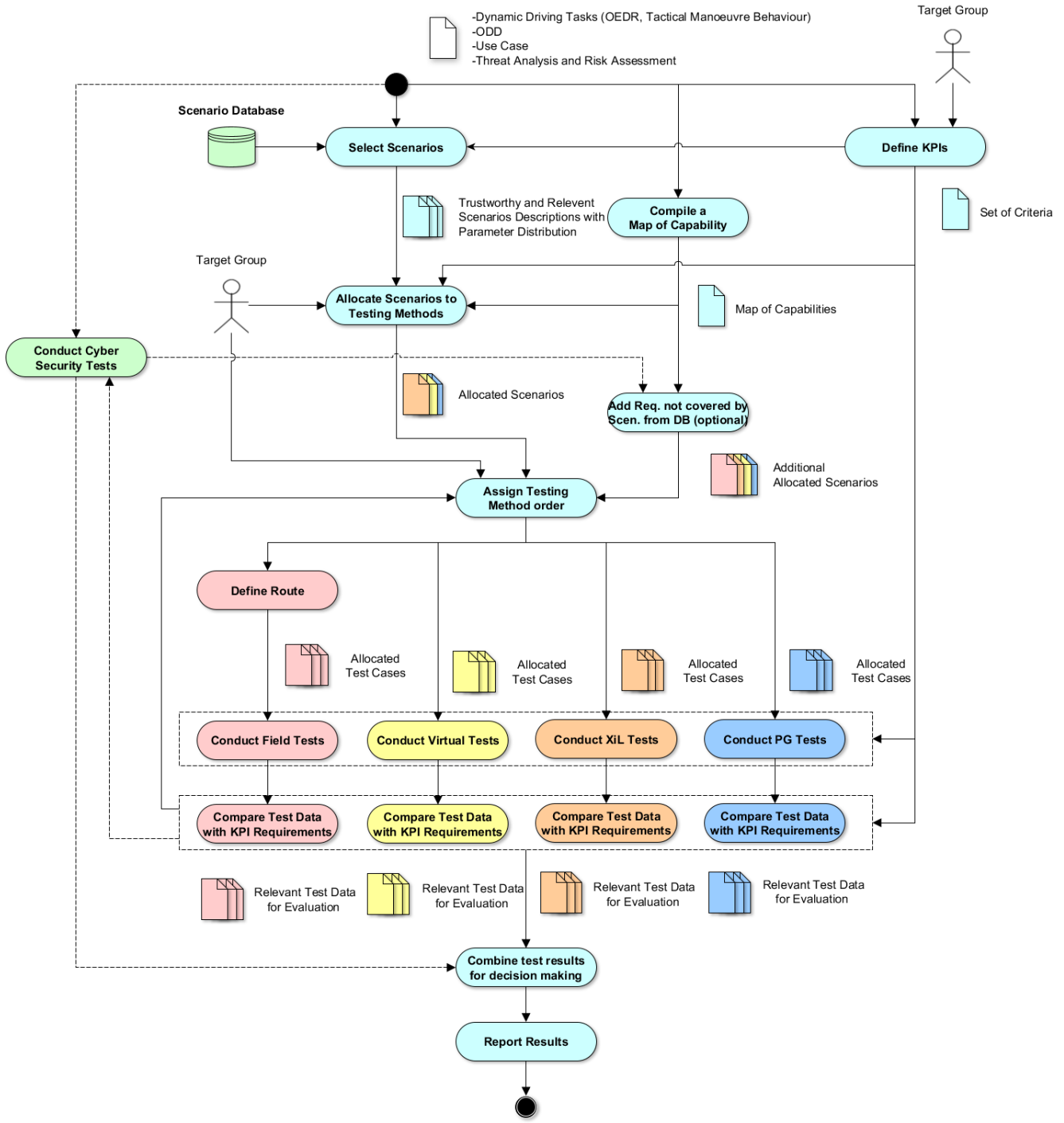
Approach

- ✓ **A process** is a set of interrelated or interacting activities which transforms inputs into outputs. It's about **what to do.**
- ✓ **A procedure** is a specified way to carry out an activity or a process. It's about **how to do it.**



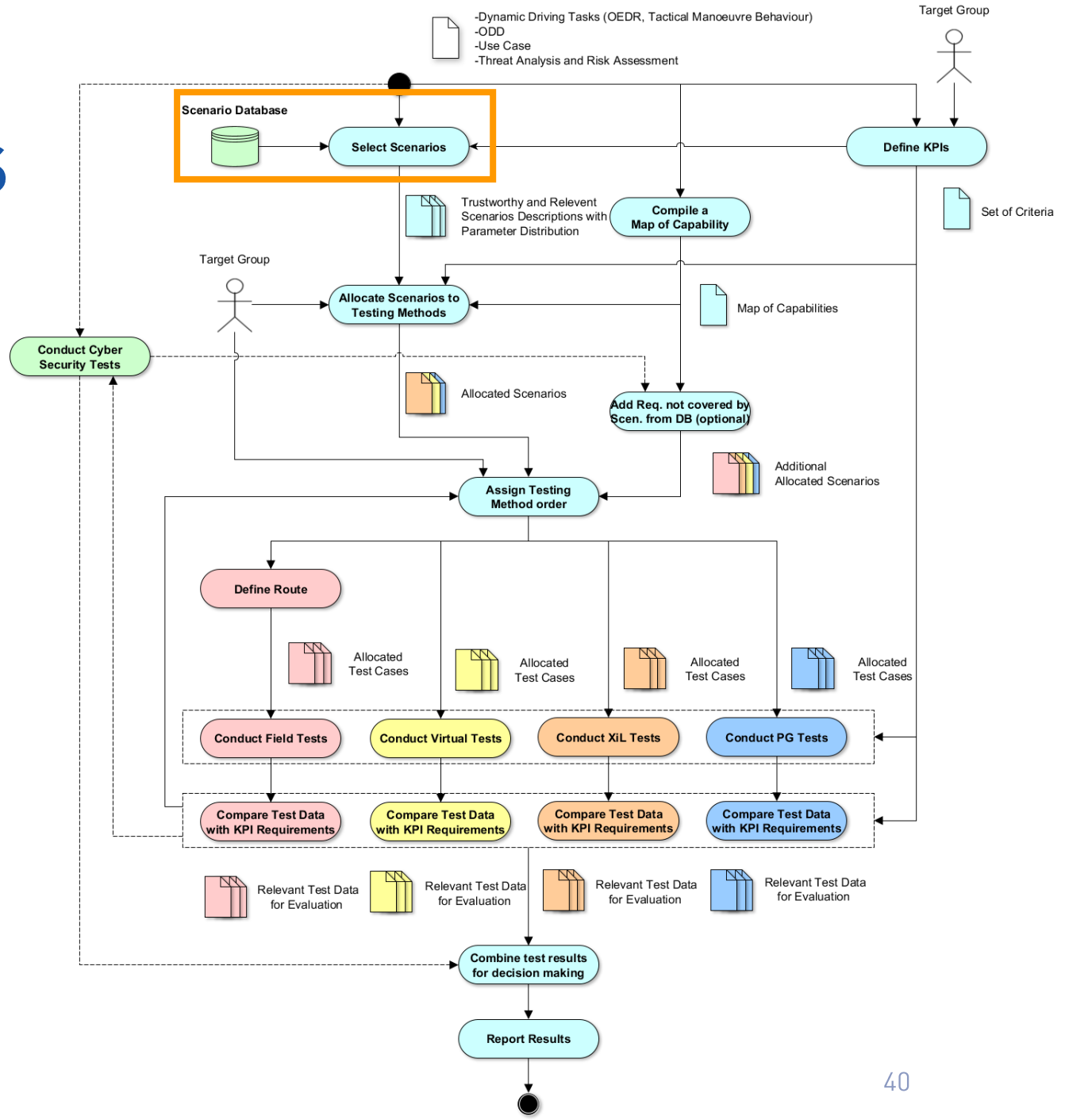
High-Level Process

- ✓ Scenario Selection
- ✓ Scenario Allocation
- ✓ Testing Method Coordination
- ✓ Field Testing
- ✓ Virtual Testing
- ✓ XiL Testing
- ✓ Proving Ground Testing
- ✓ Cyber Security
- ✓ Evaluation



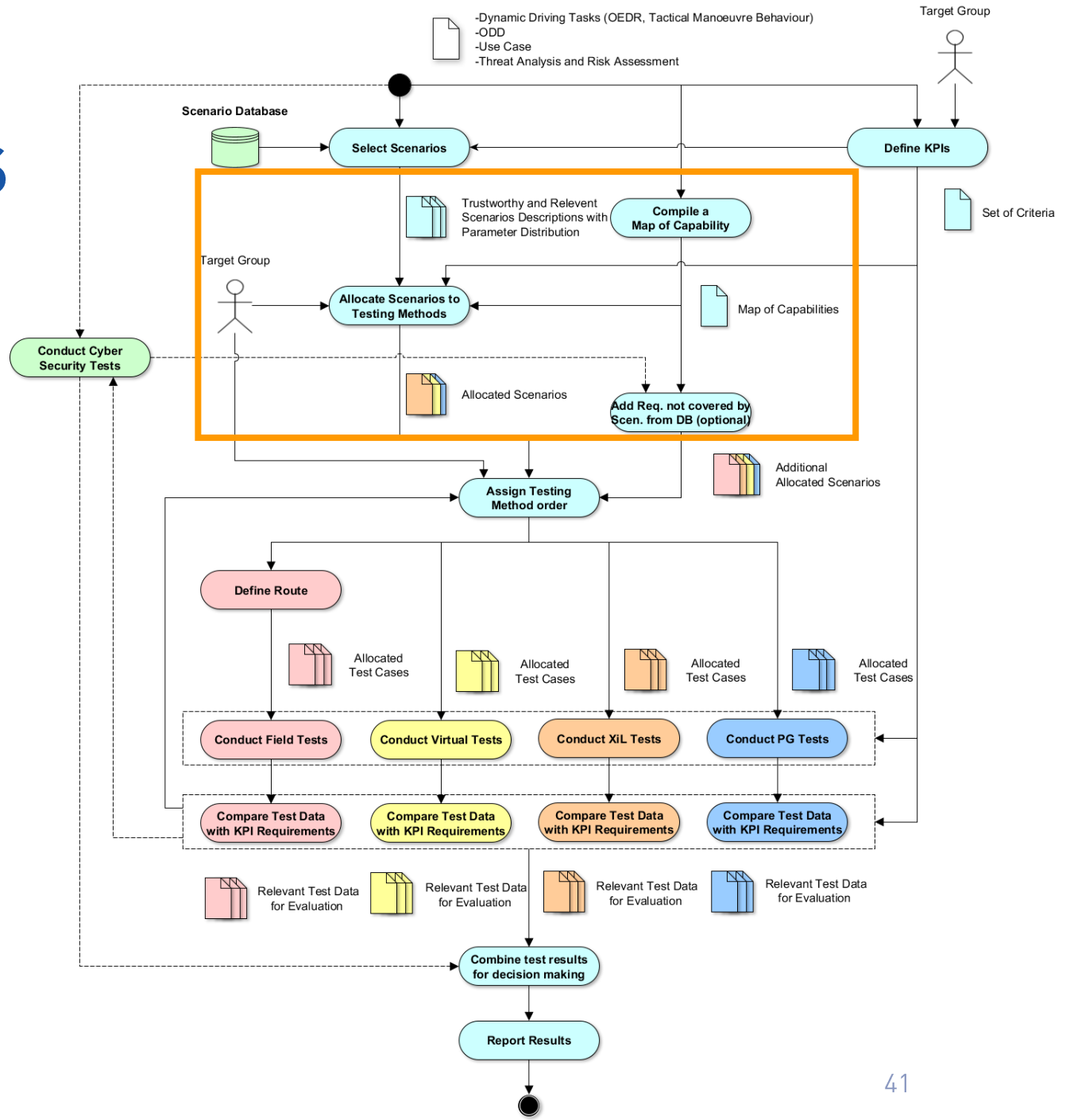
High-Level Process

- ✓ Scenario Selection
  - Extract scenarios from database
  - Include additional scenarios if ODD/functionalities are not sufficiently covered
  - Assess relevance of parameters and parameter distributions
  - Make feasibility checks



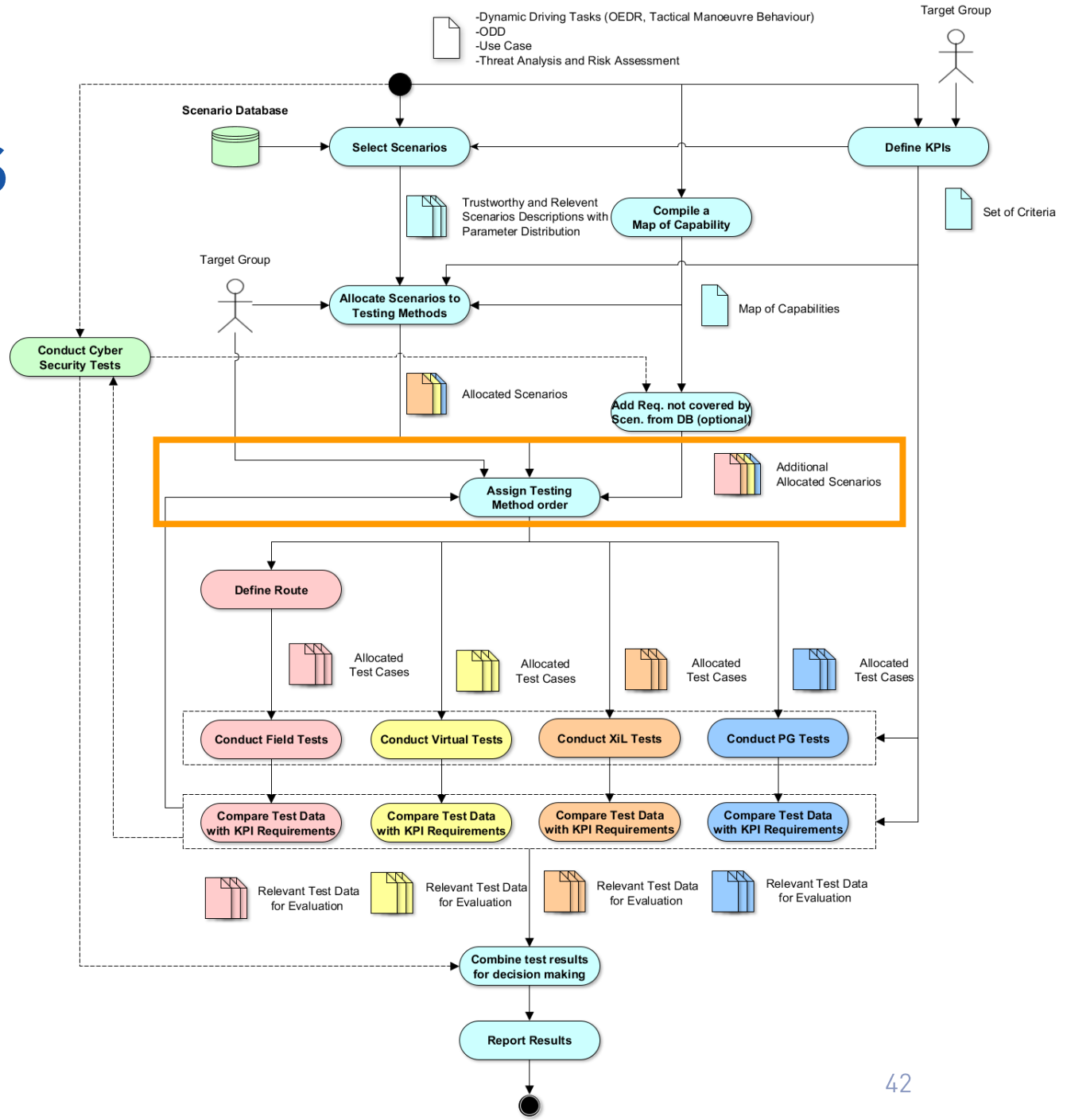
High-Level Process

- ✓ Scenario Allocation
  - Define capabilities of the testing methods
  - Compare capabilities of testing methods with requirements of scenarios
  - Allocate scenarios to testing methods
  - If additional requirements available
    - add them to available scenarios if possible
    - or create separate scenarios



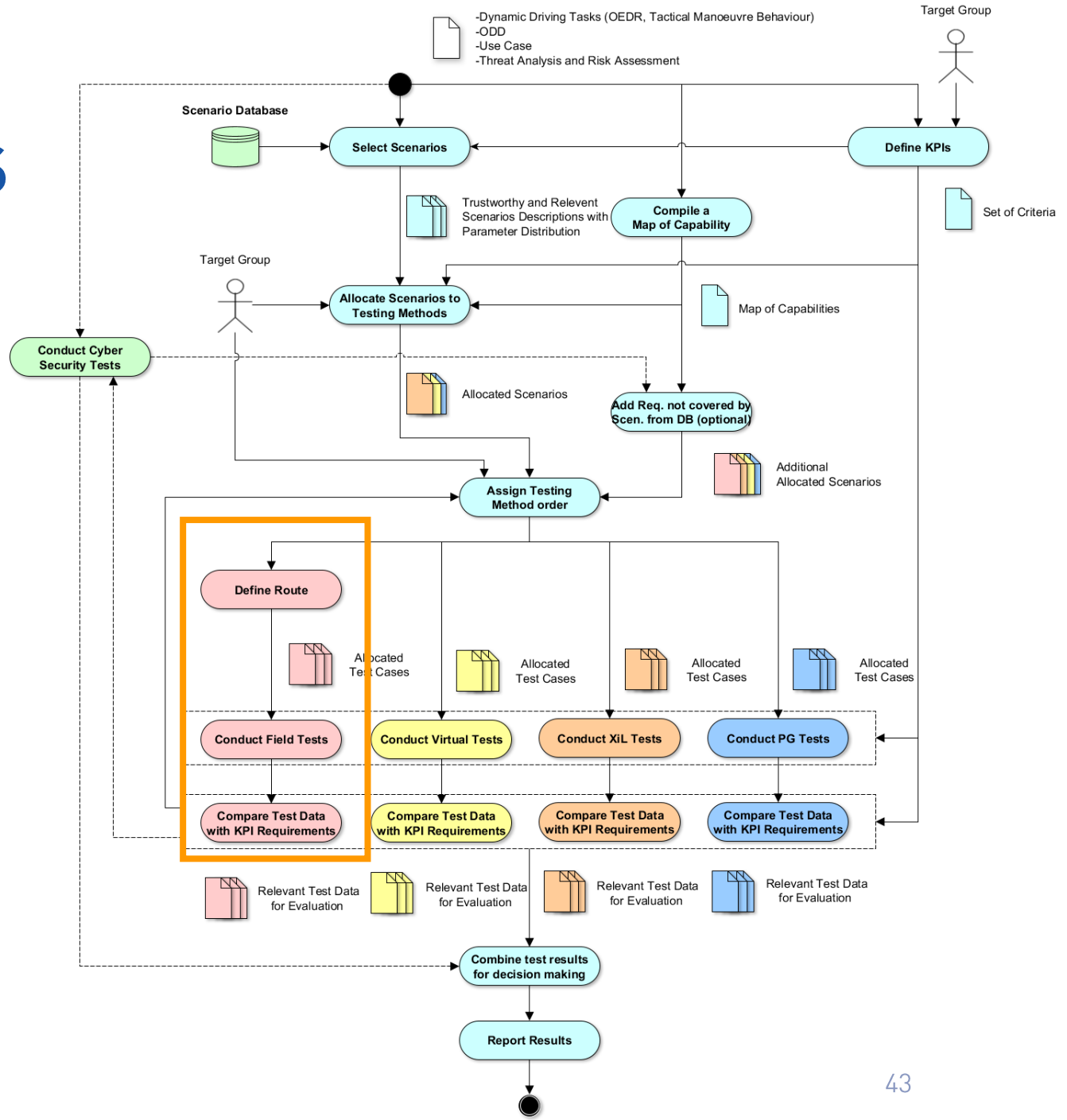
High-Level Process

- ✓ Testing Method Coordination
  - Define order in which the testing methods will be executed



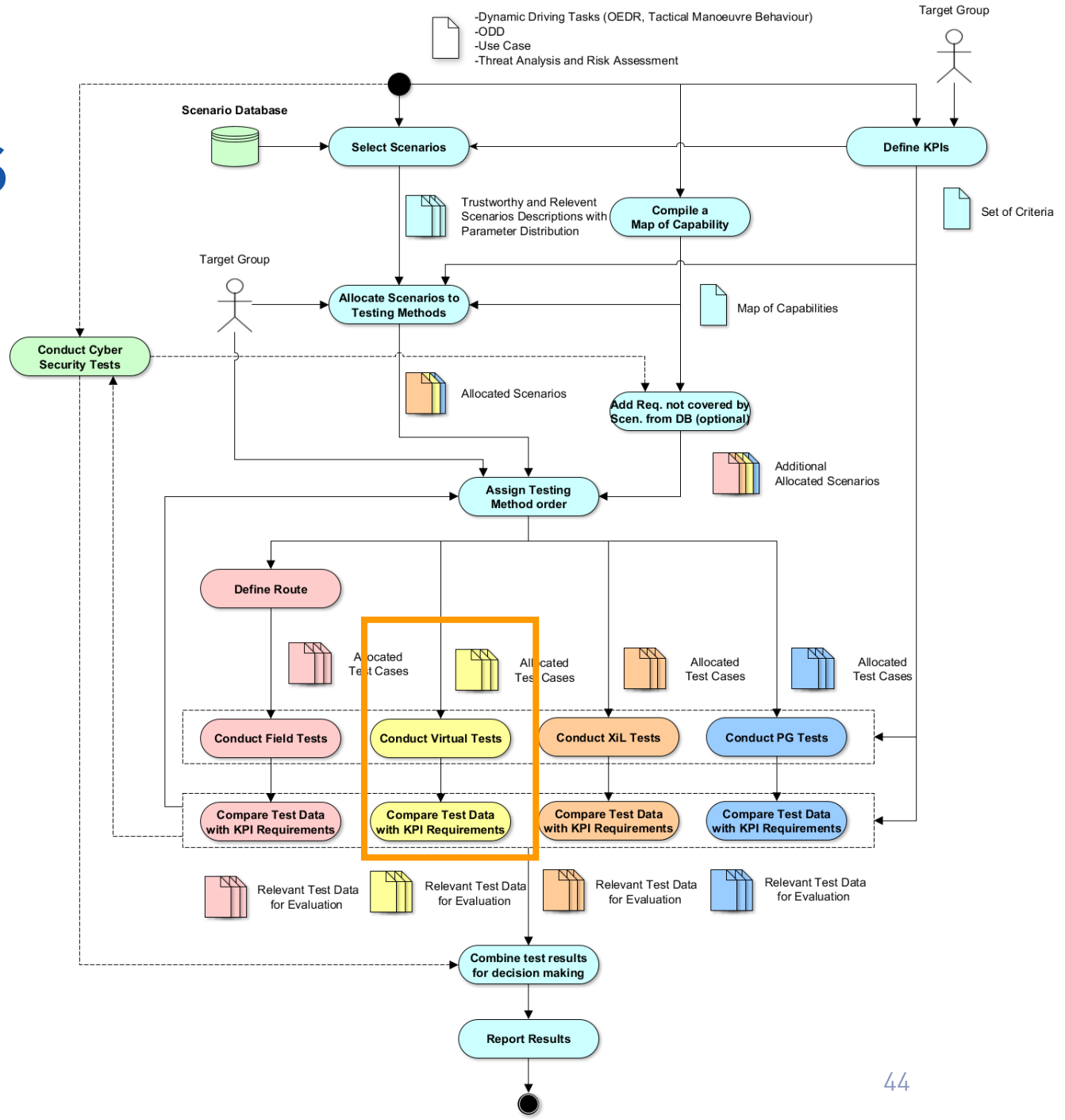
High-Level Process

- ✓ Field Testing
  - Define route
  - Prepare testing strategy, equipment and infrastructure
  - Conduct field tests
  - Compare test data with KPI requirements



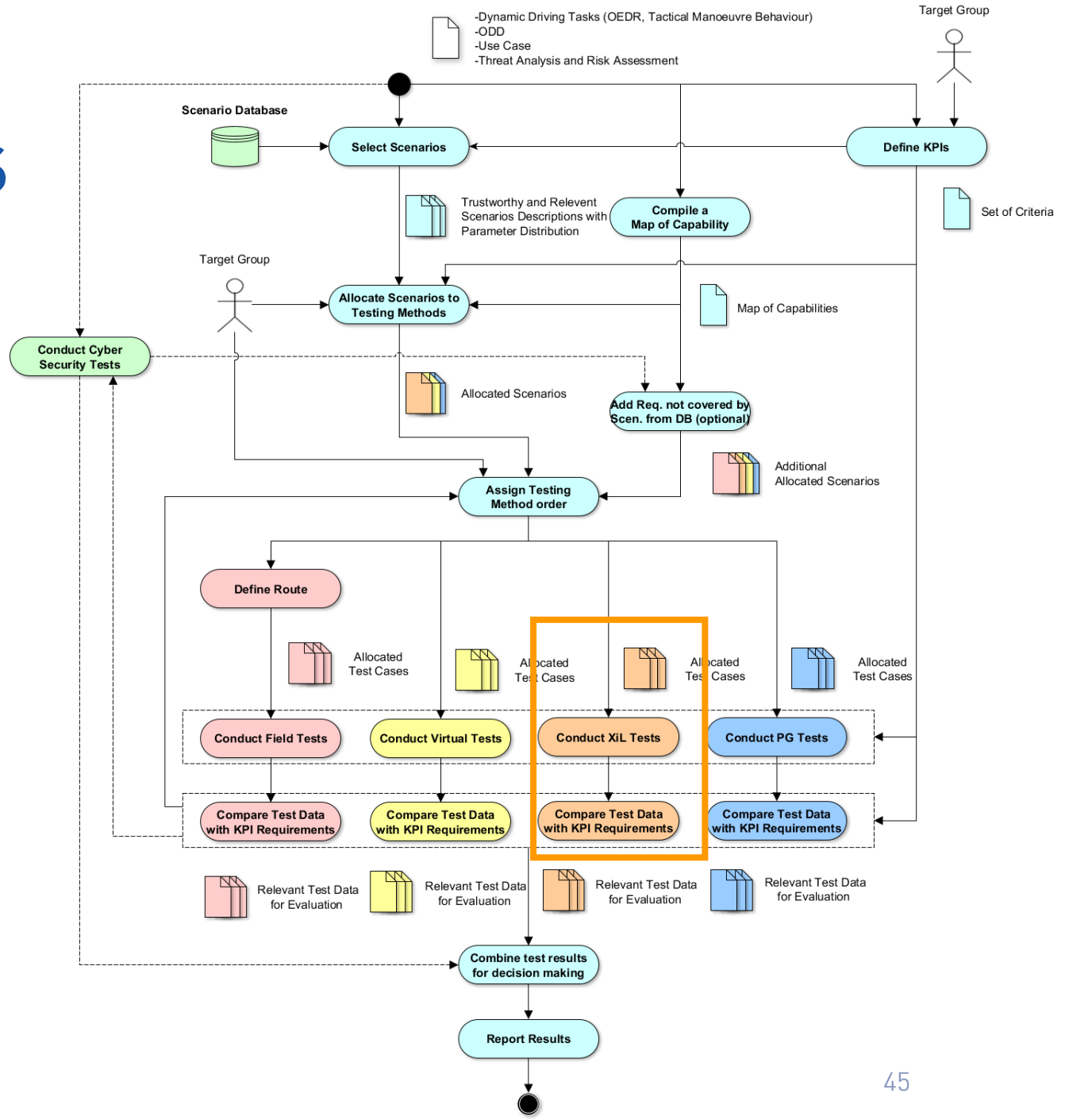
High-Level Process

- ✓Virtual Testing
  - Prepare testing strategy, simulation models and simulation environment
  - Conduct virtual tests
  - Compare test data with KPI requirements



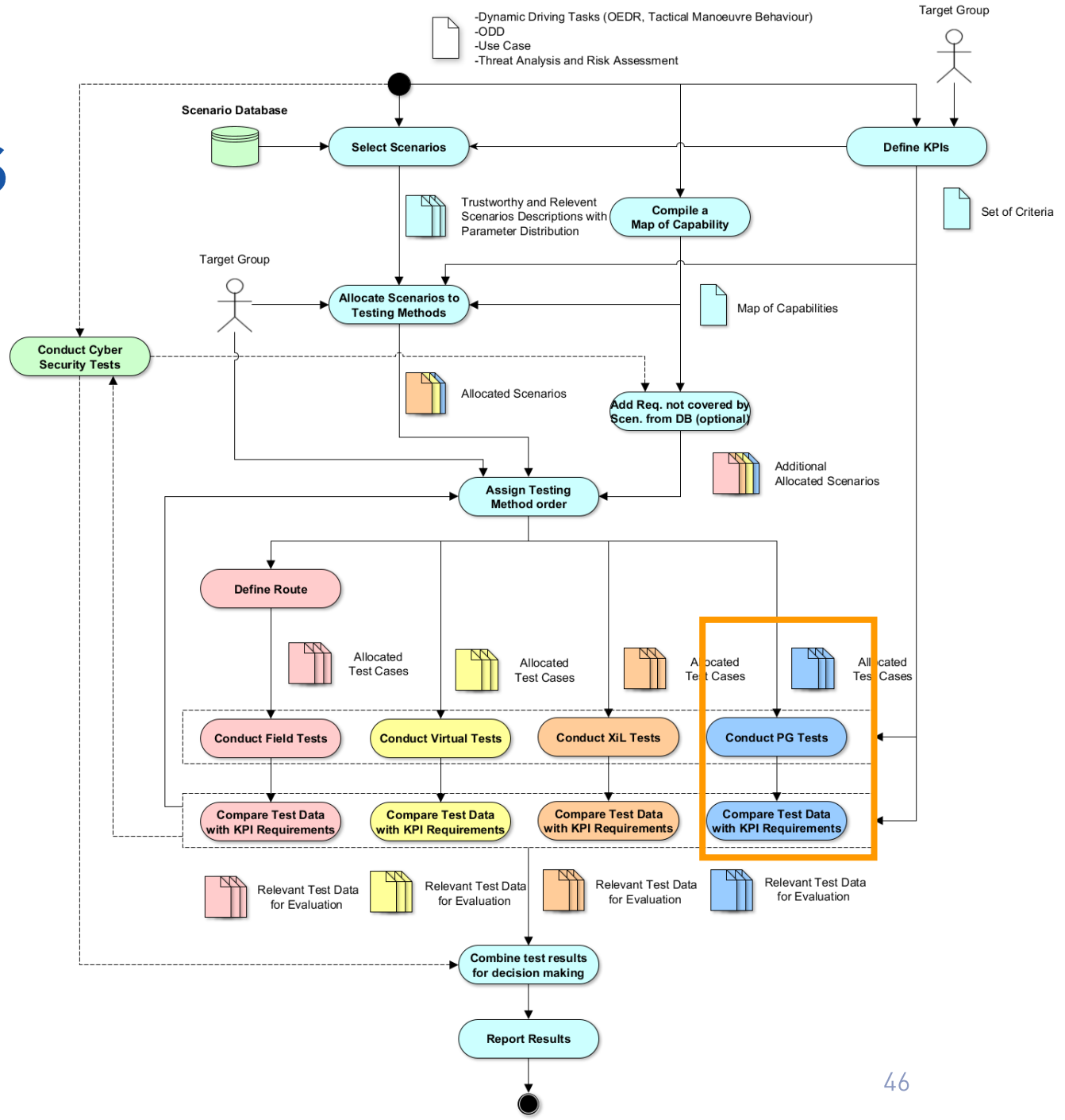
High-Level Process

- ✓XiL Testing
  - Prepare testing strategy, simulation models, simulation environment and XiL infrastructure
  - Conduct XiL tests
  - Compare test data with KPI requirements



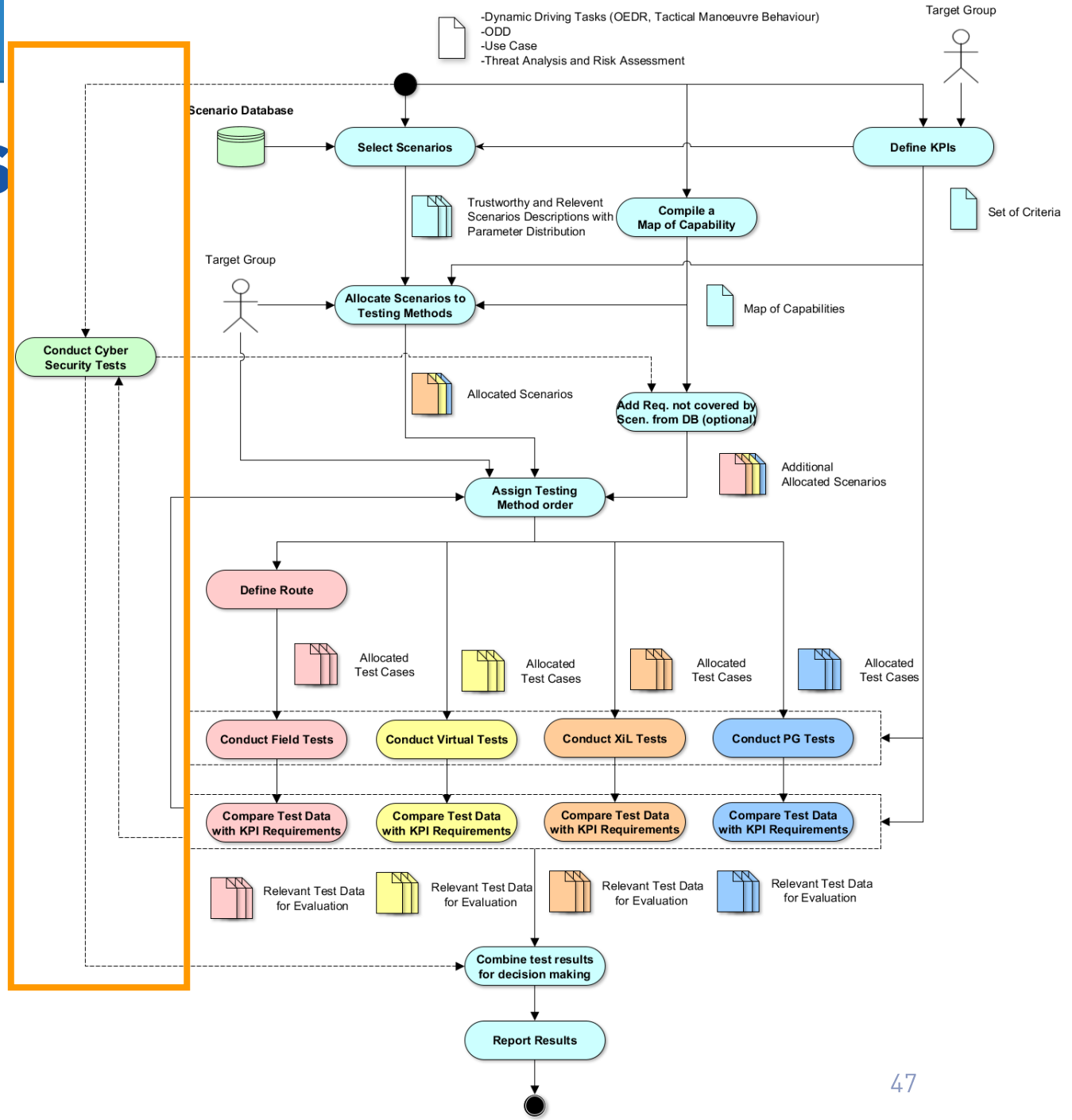
High-Level Process

- ✓ Proving Ground Testing
  - Prepare testing strategy, equipment and infrastructure
  - Conduct proving ground tests
  - Compare test data with KPI requirements



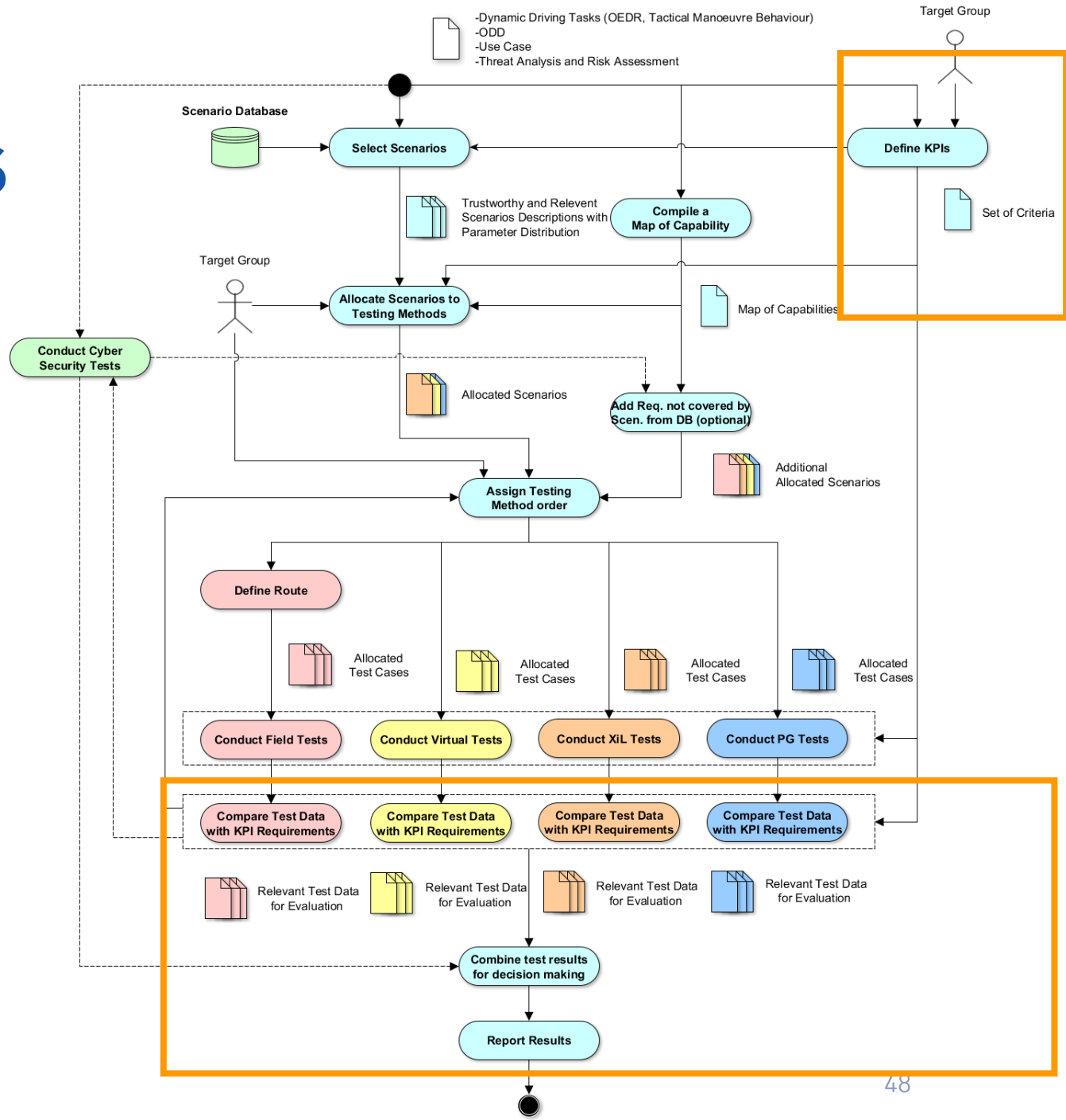
High-Level Process

- ✓ Cyber Security
  - Optional side branch
  - Based on common criteria
  - Linked to the scenario allocation phase for additional requirements that can be allocated to testing methods



High-Level Process

- ✓ Evaluation
  - Define key performance indicators (KPIs)
  - Define KPI verification
  - Compare test data with KPI requirements (for each testing method)
  - Combine test results for evaluation



Thank you!

Any questions?

Dipl.-Ing. Bernhard Hillbrand
Senior Researcher Department E/E & Software
Bernhard.Hillbrand@v2c2.at

virtual vehicle