HEADSTART

Harmonised European Solutions for Testing Automated Road Transport

HEADSTART's Methodology in a nutshell

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

Agenda

- ✓ Introduction
- ✓ Motivation
- ✓ HEADSTART‘s Overall Methodology

Event rules and process

- ✓ Webinar is being recorded
- ✓ Slides and recording **will be shared** and published on HEADSTART website
- ✓ Questions can be raised via www.slido.com with event code: *#HEADSTART*

  The questions are gathered and where possible raised by the webinar moderator at fixed time slots during the webinar to the presenters.
- ✓ Do not wait until the end of the presentation! If you have questions, just send them to us!

- ✓ Please, avoid using the GoToMeeting chat as your question may not arrive to us

Introduction

- ✓ Goal of this Meeting?

- ➔ **Get external expert feedback on the HEADSTART Methodology**

- ✓ Feedback will be integrated by refinement of the methodology

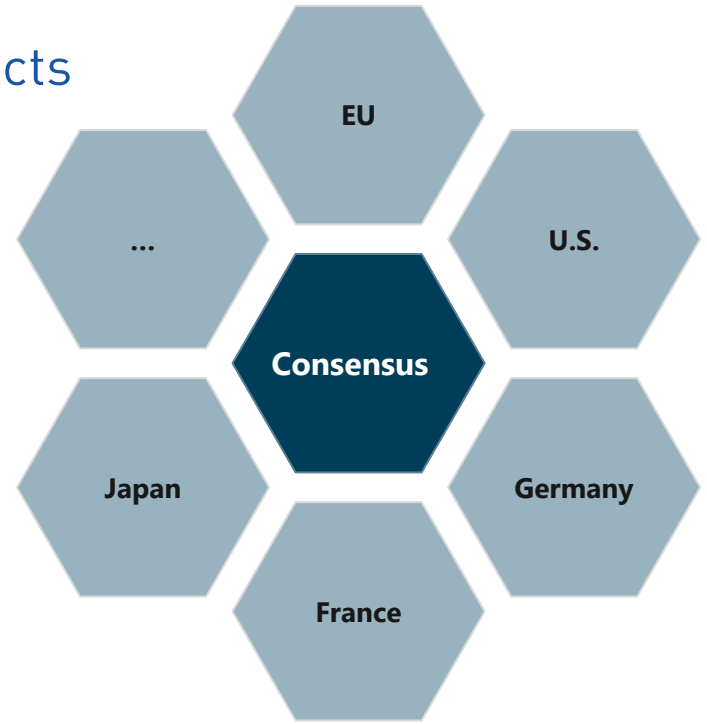
Motivation

Where does the HEADSTART Methodology come from?

Motivation

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**



Motivation

Why do we need a scenario-based safety assurance?

Motivation

Why do we need a scenario-based safety assurance?

Safety assurance by test drives?

- Sample calculations ranging **up to billions** of kilometers

➔ Not feasible

Safety assurance by expert knowledge?

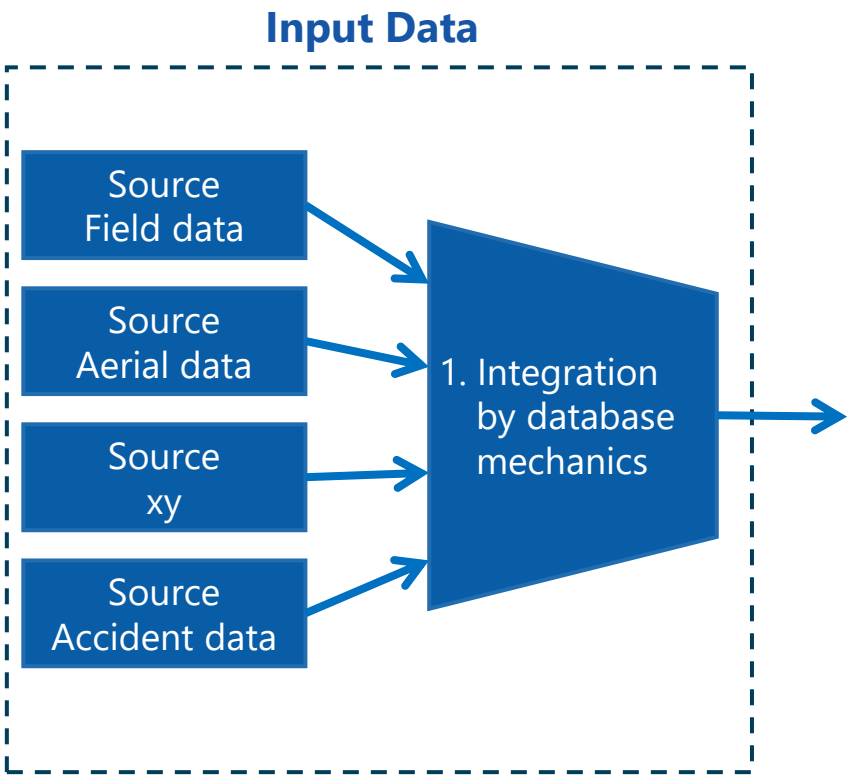
- **No evaluation methodology available** for automated driving (L3+)

➔ Not available

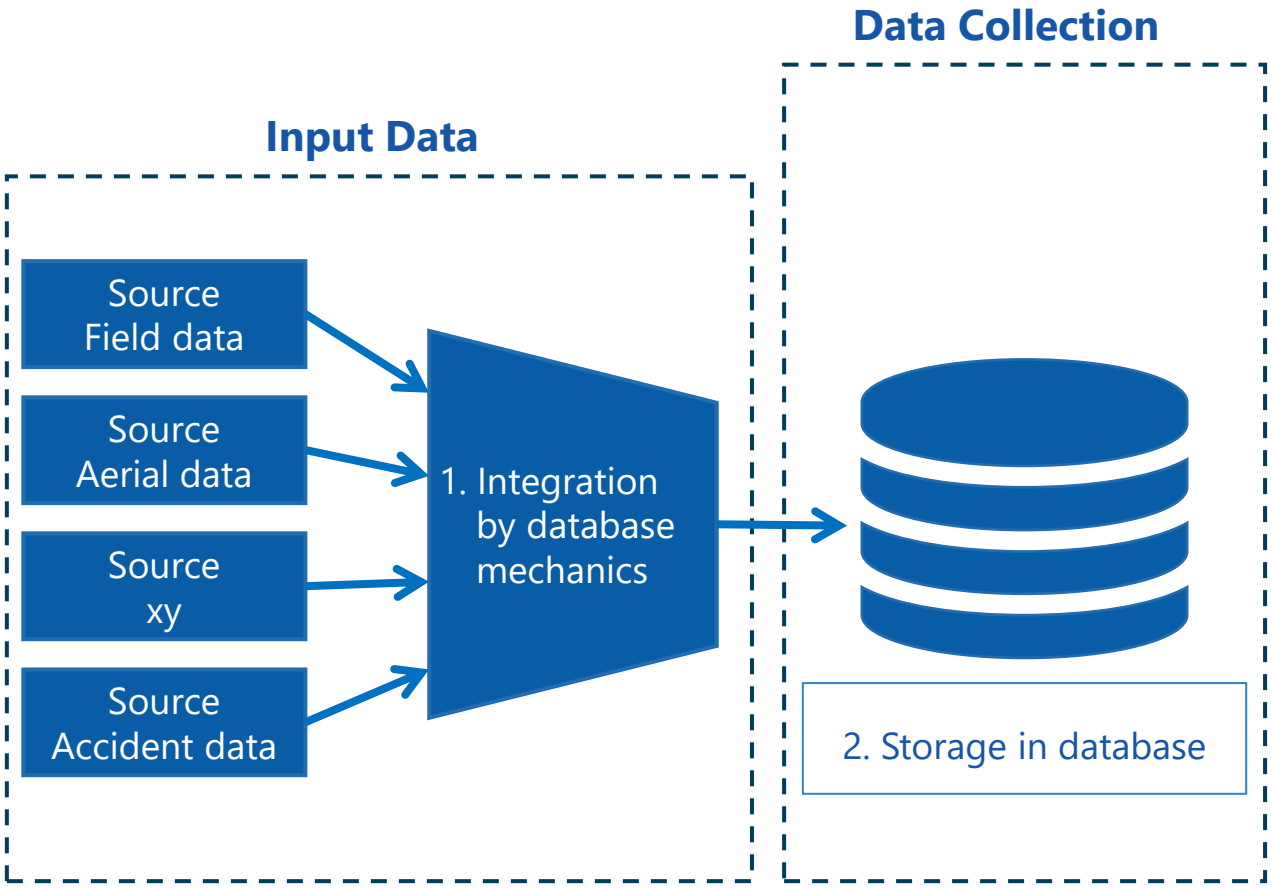
Overall Methodology

How can such a methodology look like?

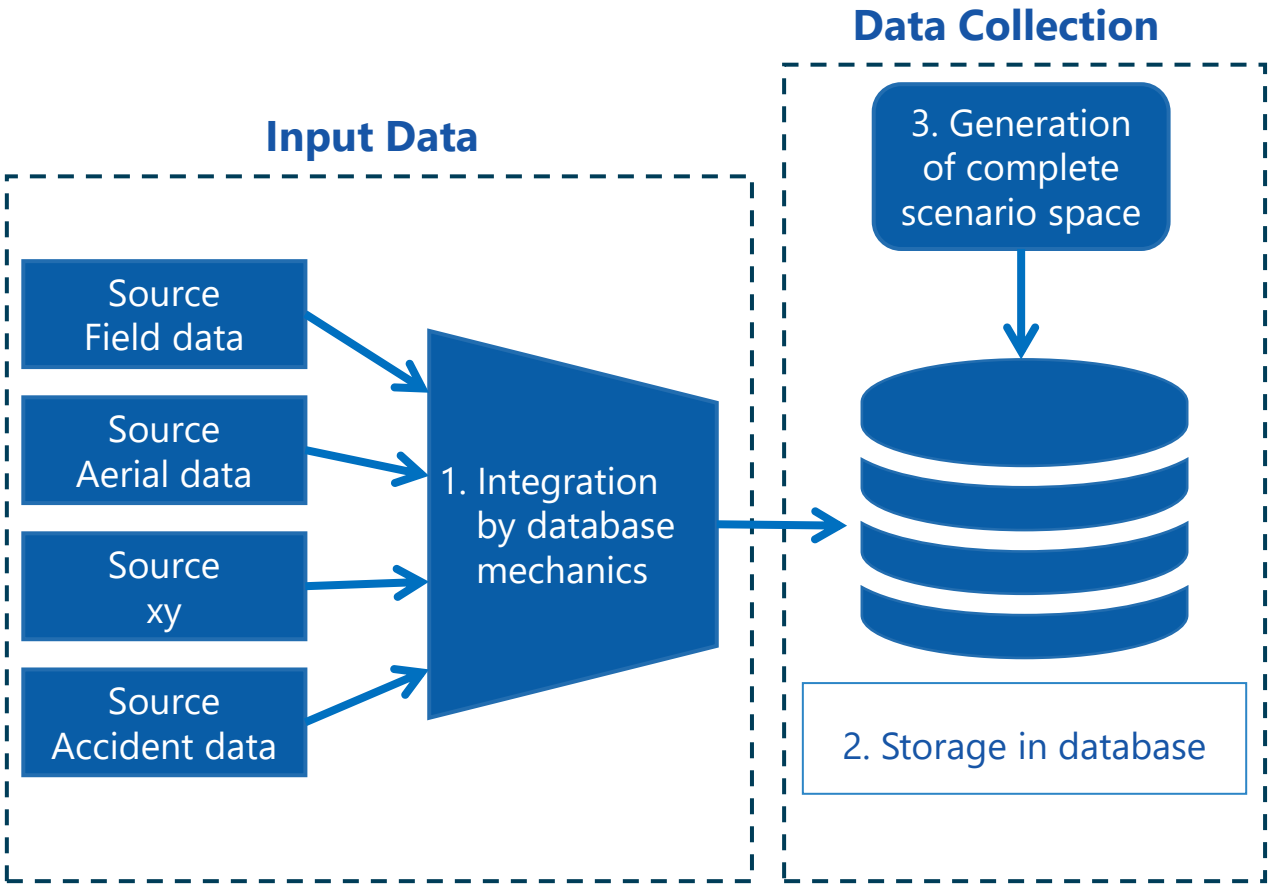
Overall Methdology



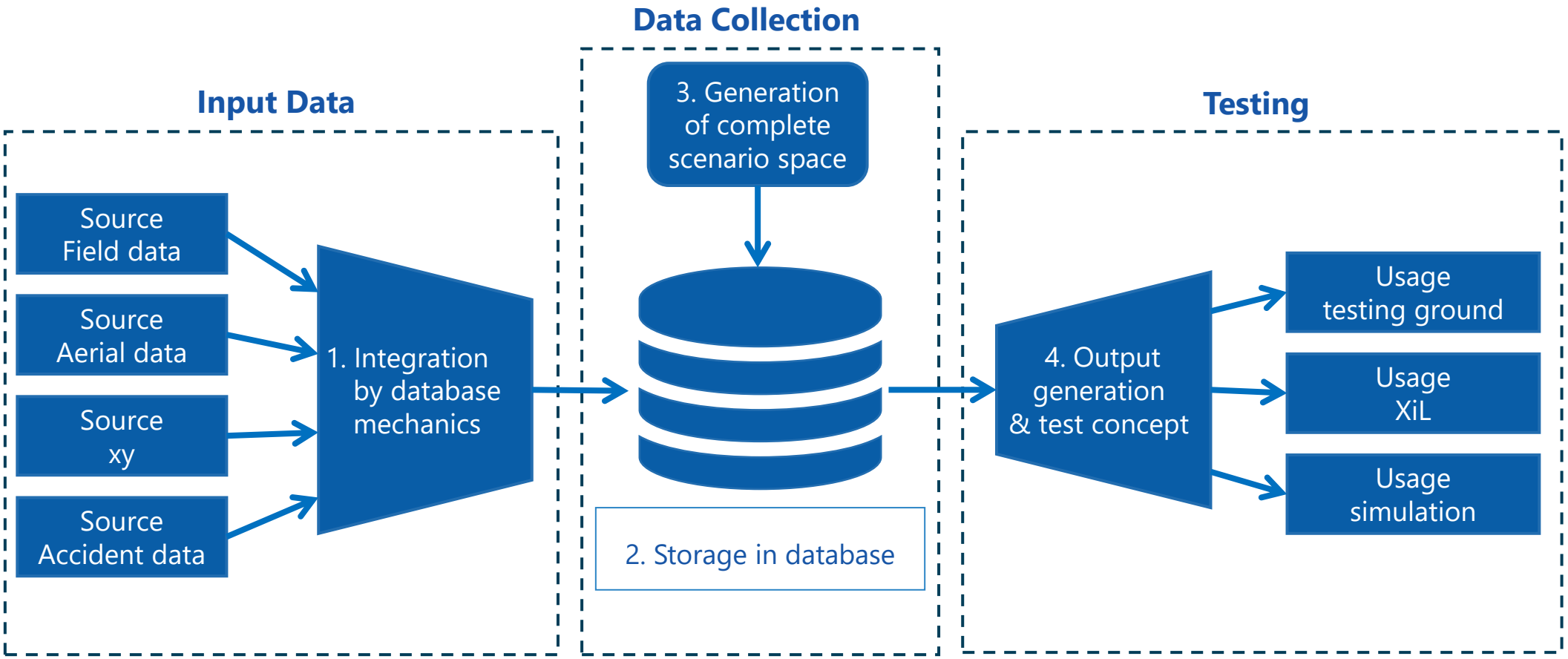
Overall Methdology



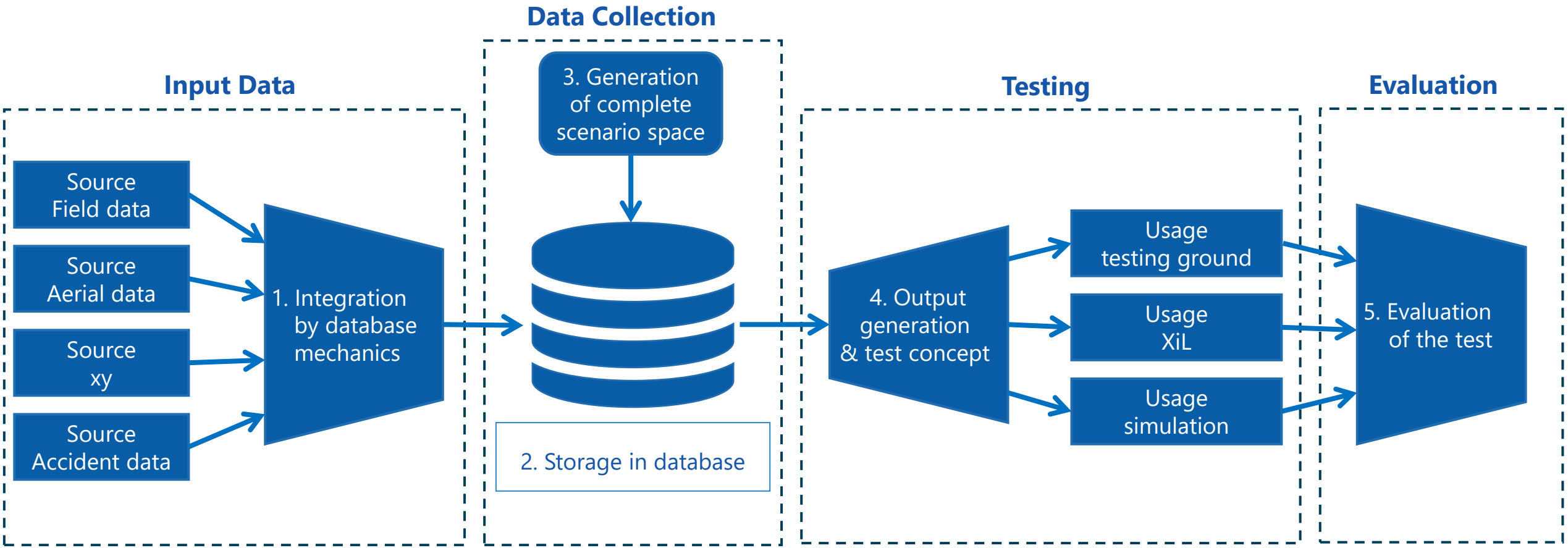
Overall Methdology

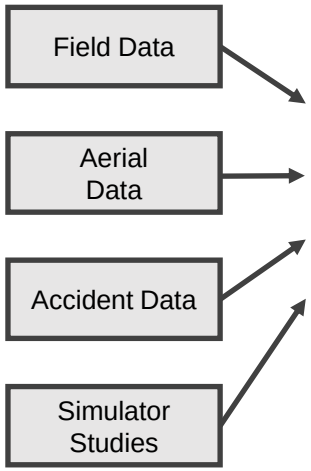


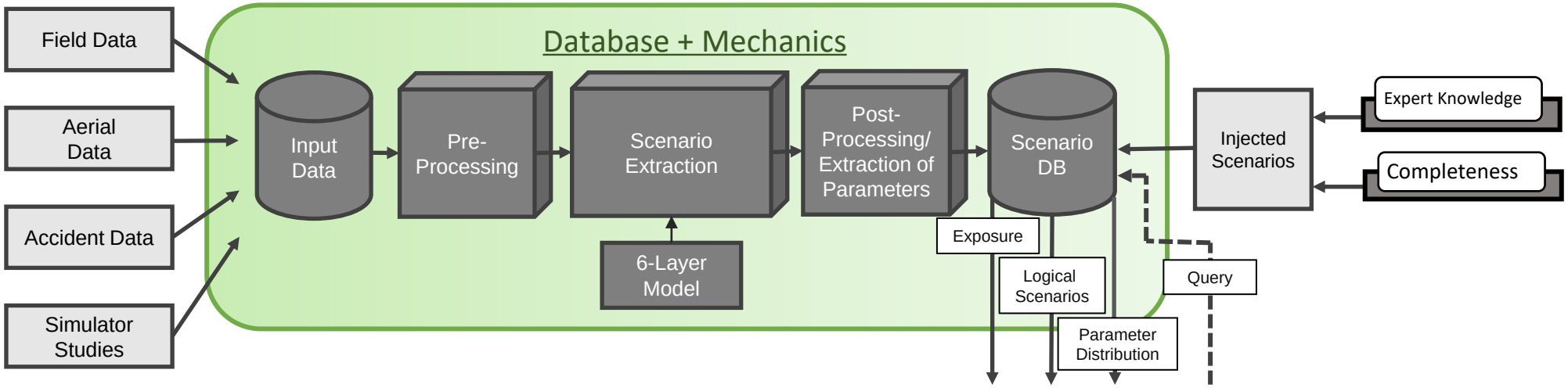
Overall Methdology

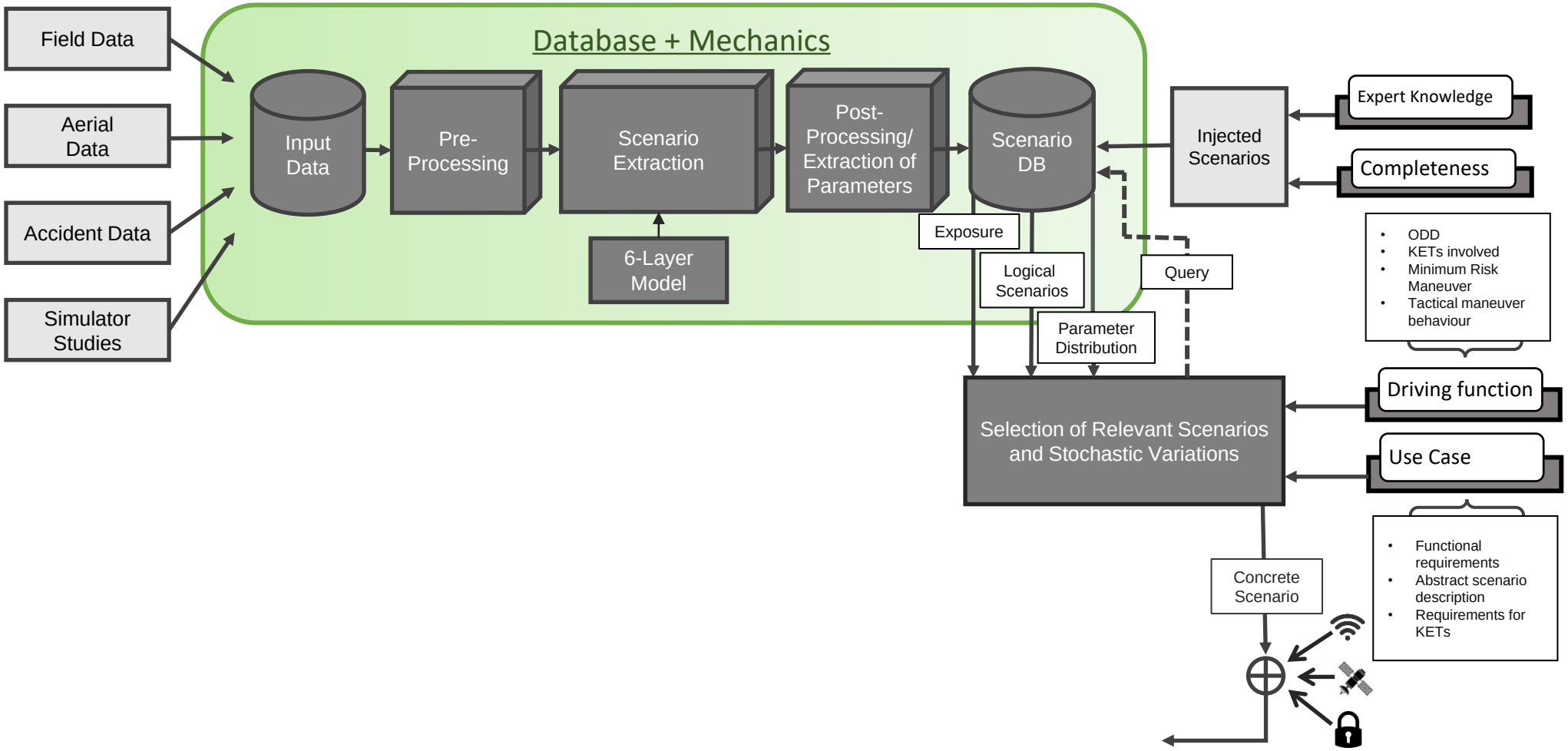


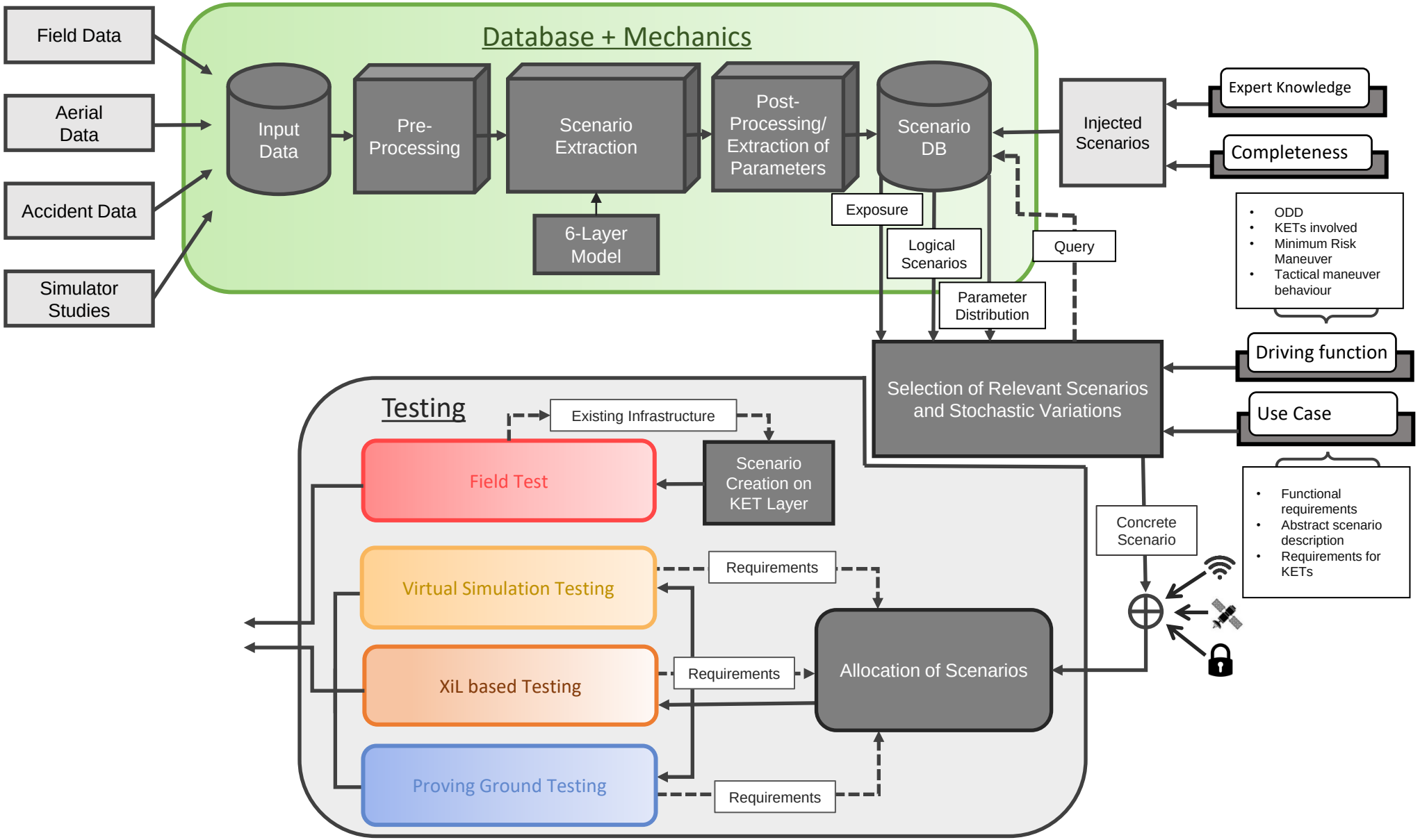
Overall Methdology

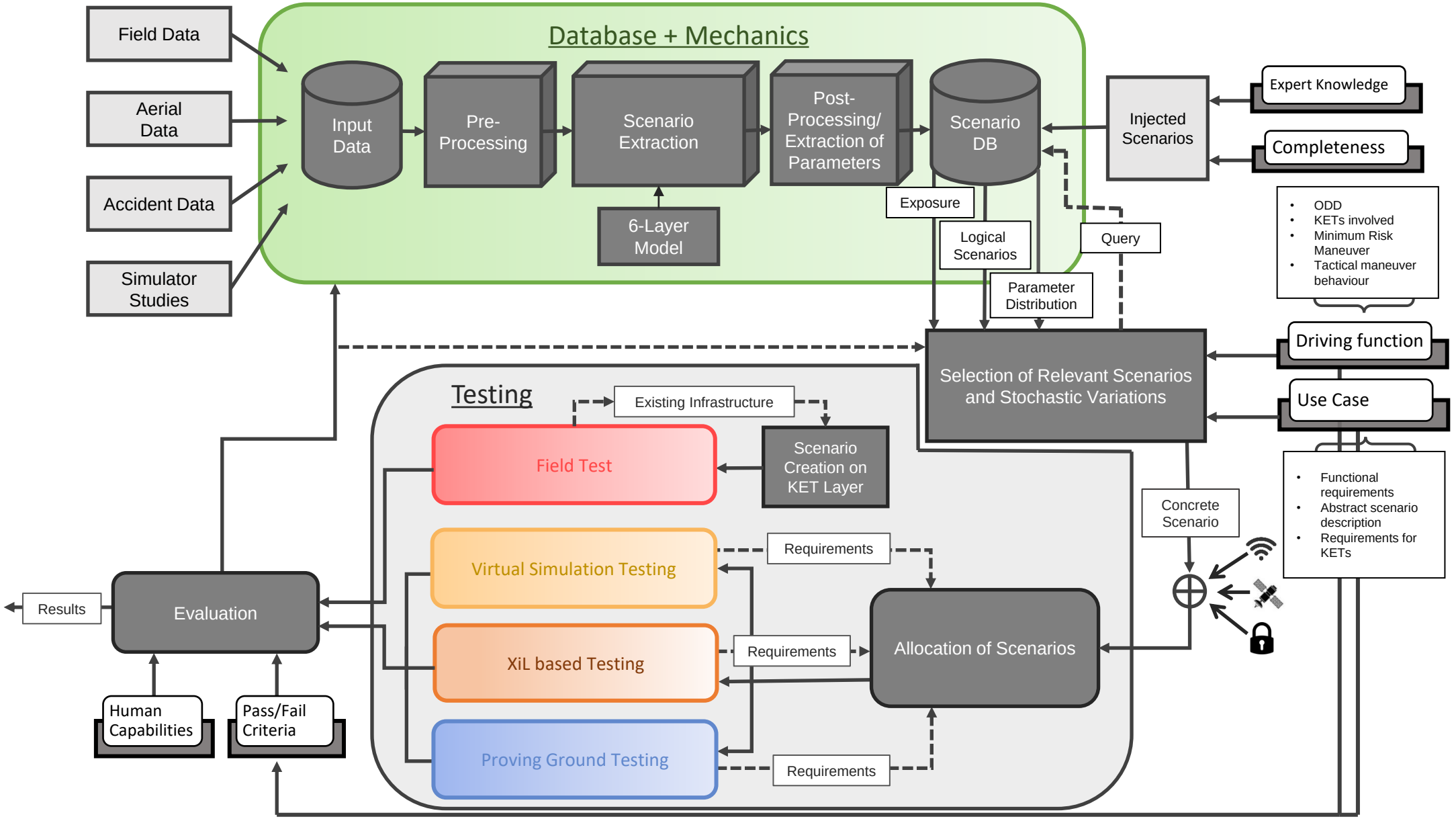


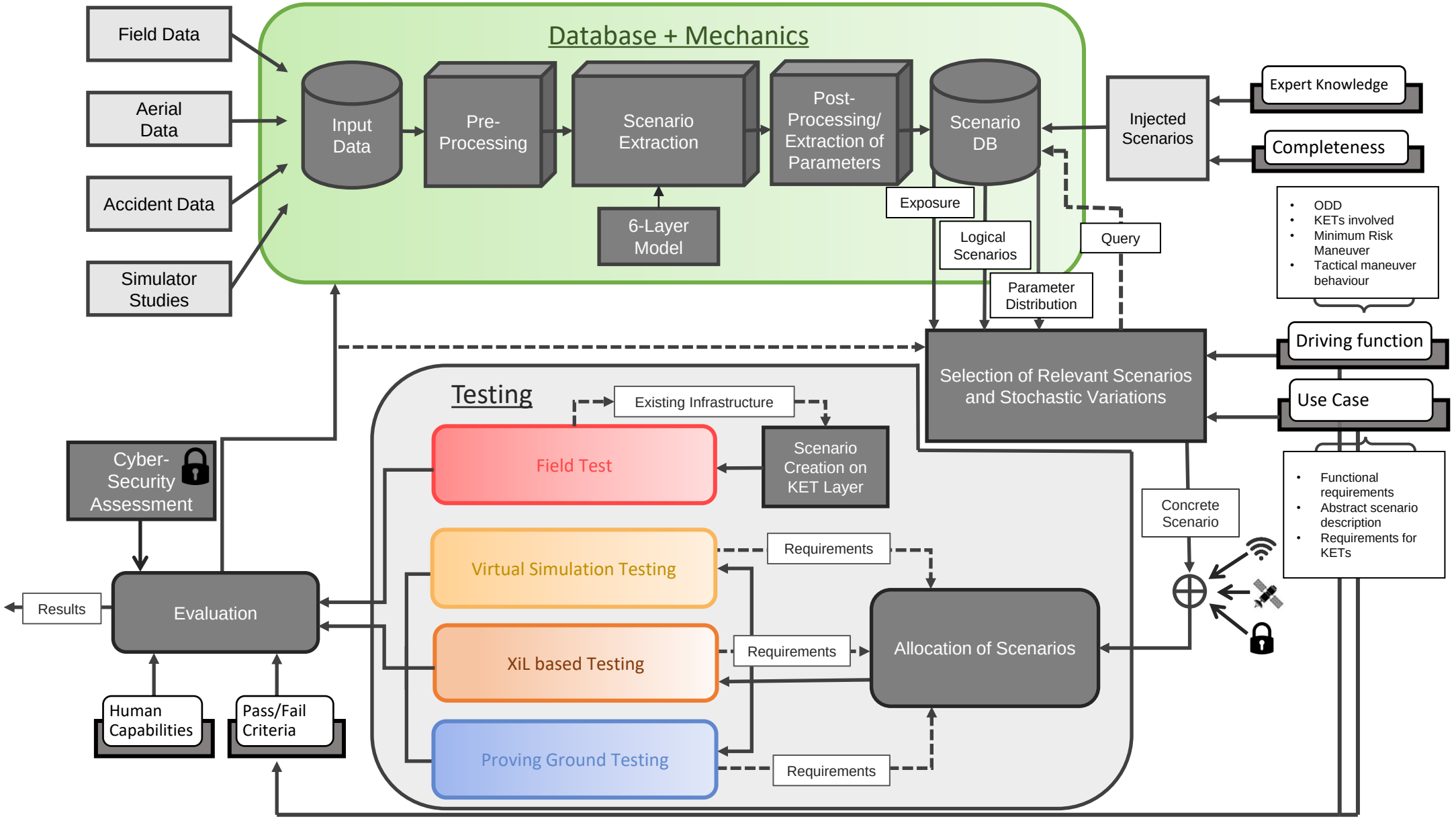

Field Data
Aerial Data
Accident Data
Simulator Studies


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

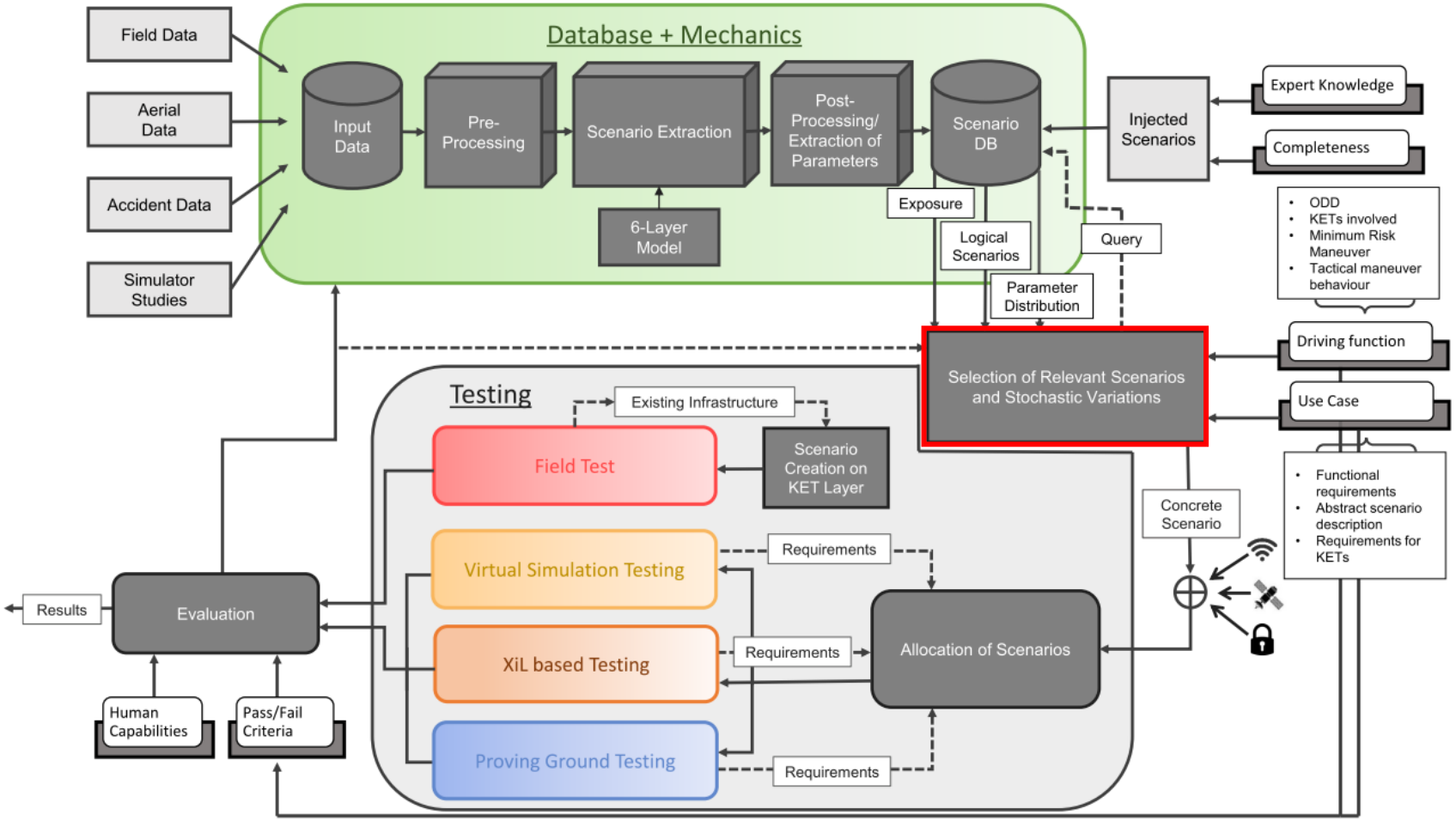

Field Data
Aerial Data
Accident Data
Simulator Studies
Database + Mechanics
Input Data
Pre-Processing
Scenario Extraction
6-Layer Model
Post-Processing/ Extraction of Parameters
Scenario DB
Exposure
Logical Scenarios
Parameter Distribution
Query
Injected Scenarios
Expert Knowledge
Completeness
ODD
KETs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


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
Cyber-Security Assessment
Evaluation
Results
Human Capabilities
Pass/Fail Criteria

Scenario Selection



Layer Model

Layer 6

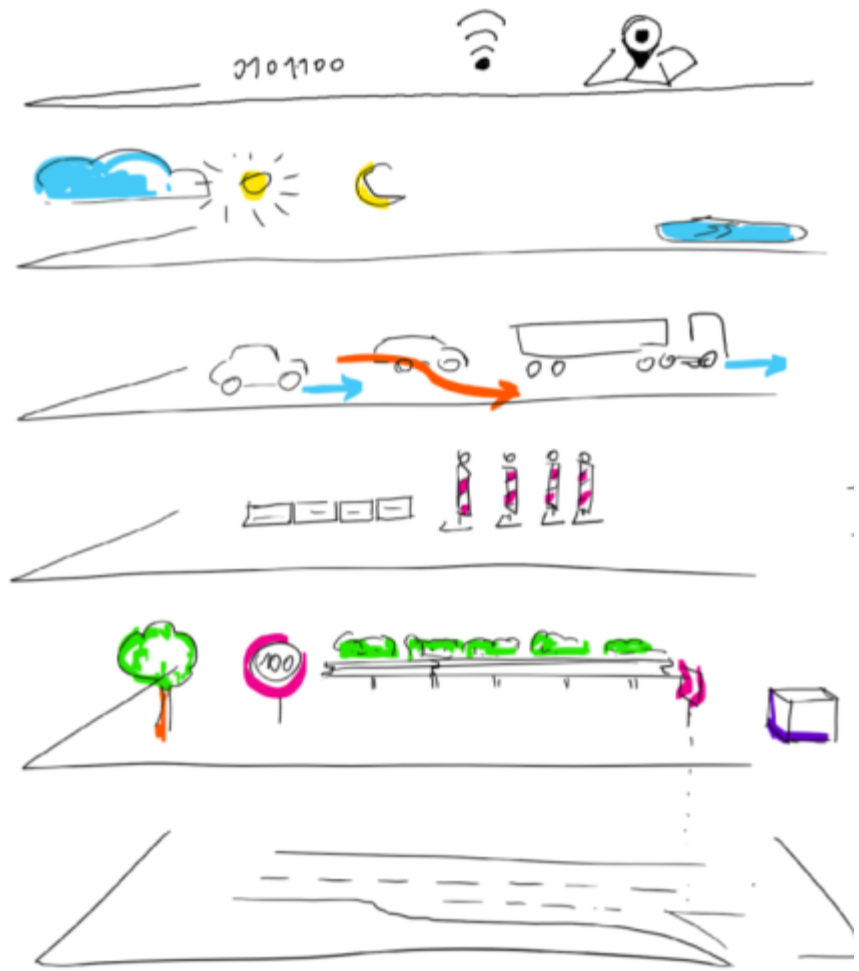
Layer 5

Layer 4

Layer 3

Layer 2

Layer 1



Digital information
e.g. V2X information on traffic signals, digital map data

Environmental conditions
e.g. Light situation, weather (rain, snow, fog)

Moving Objects
e.g. Vehicles, pedestrians, other moving objects

Temporal modifications and events
e.g. Road construction, traffic cones, fallen trees

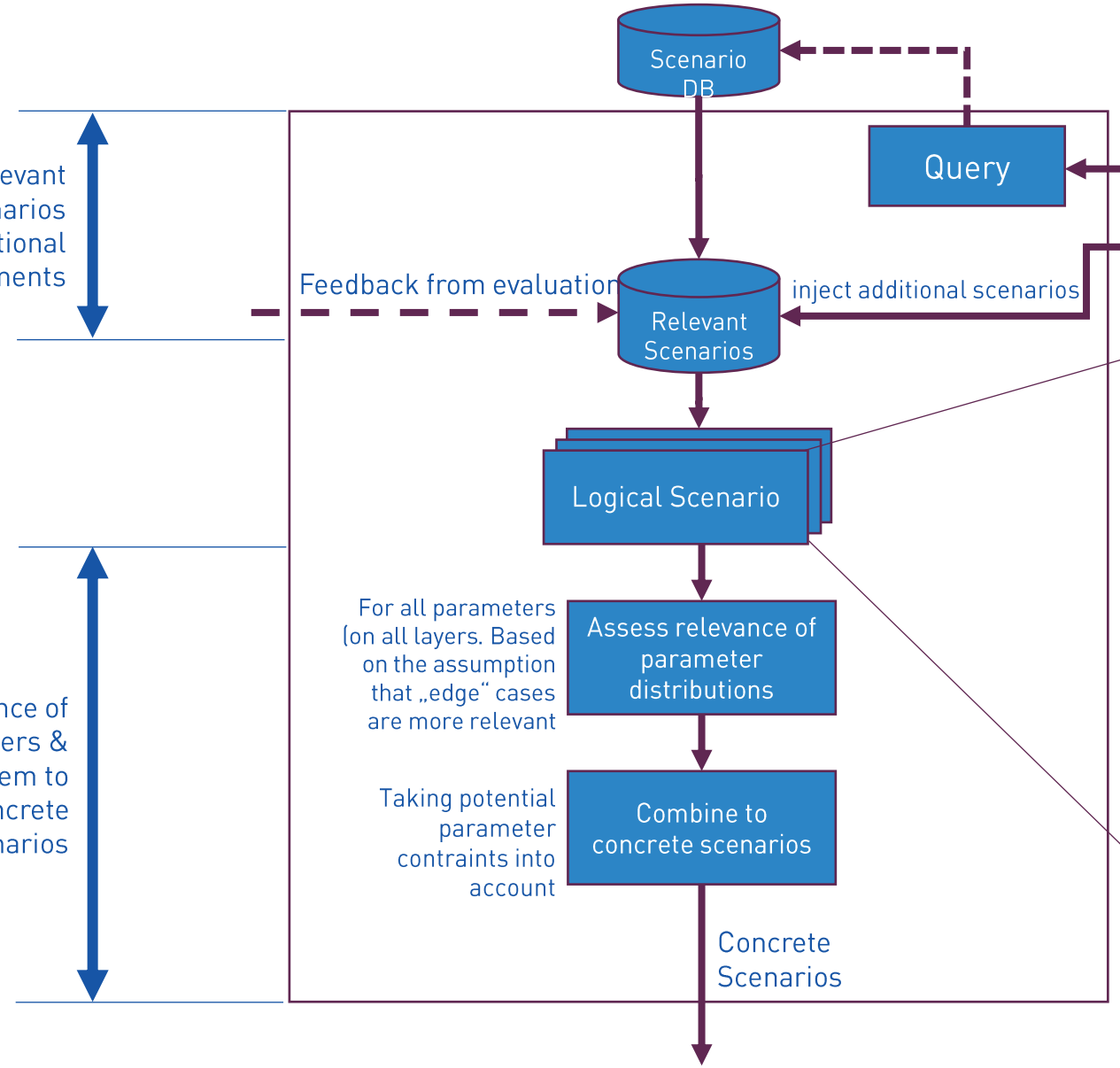
Road furniture and Rules
e.g. Traffic signs, railguards, lane rules, bot dots

Road layer
e.g. Road geometry, road unevenness, lane logic

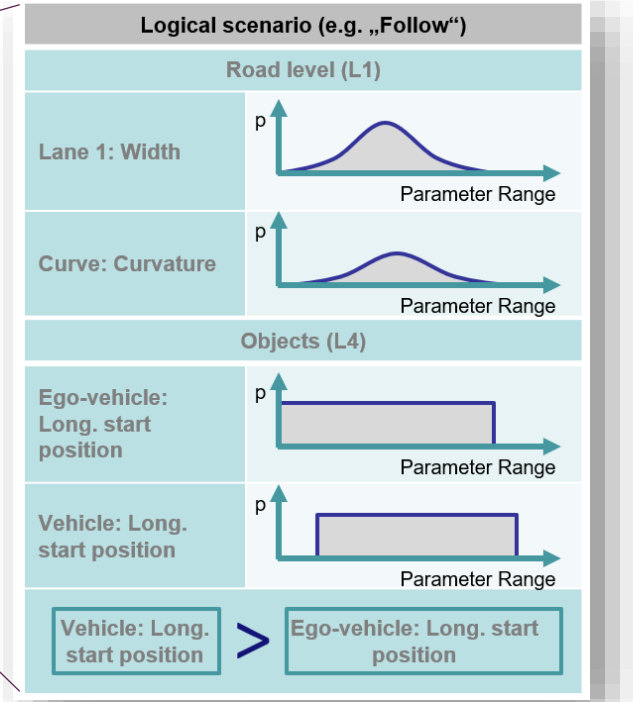
Scenario Selection

Filter all relevant logical scenarios based on functional requirements

Define relevance of parameters & combine them to form concrete scenarios

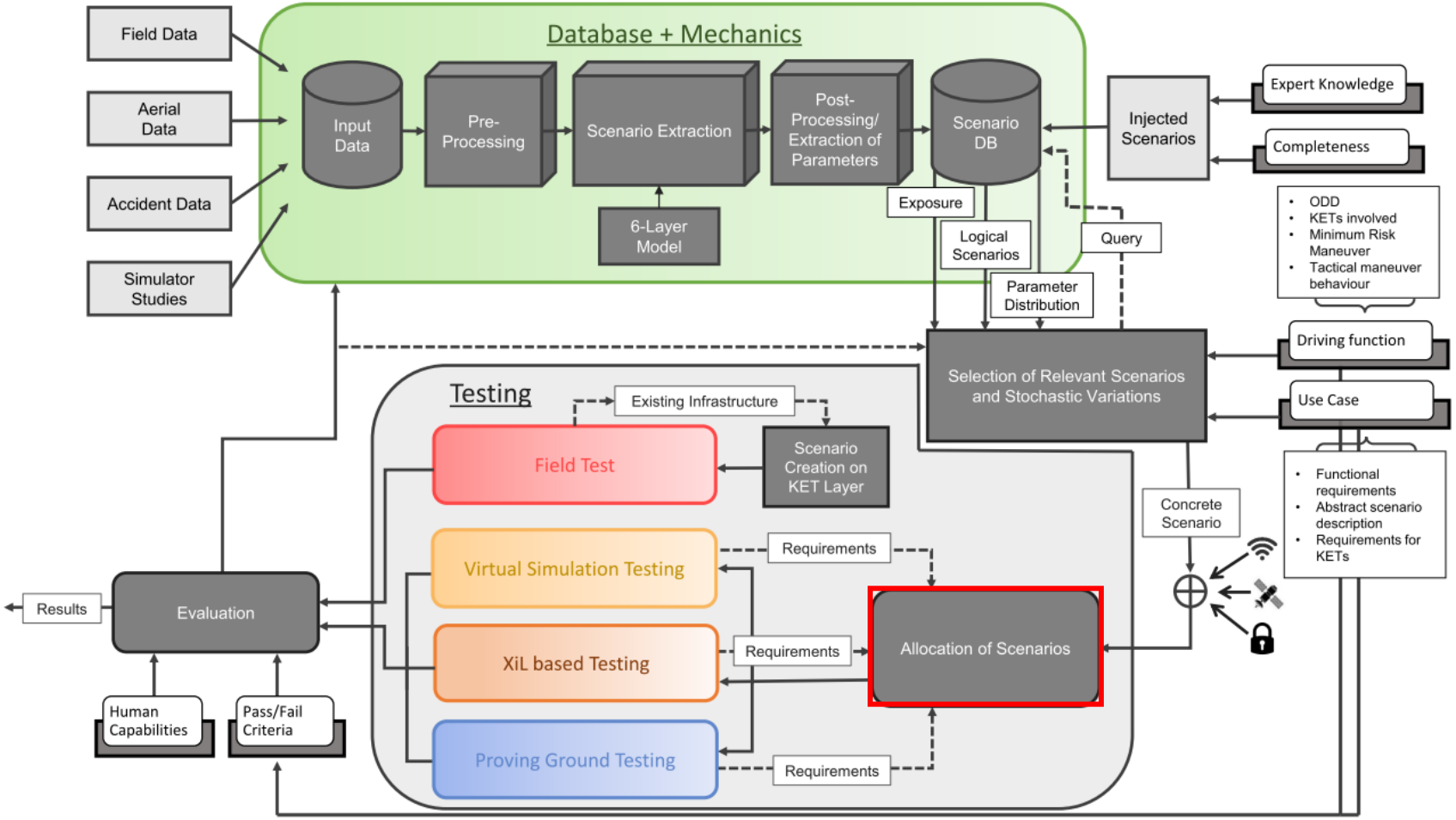


Driving function
- Functional requirements
  - Main pillars:
    - ODD
    - OEDR
    - Tactical Maneuver Behaviour



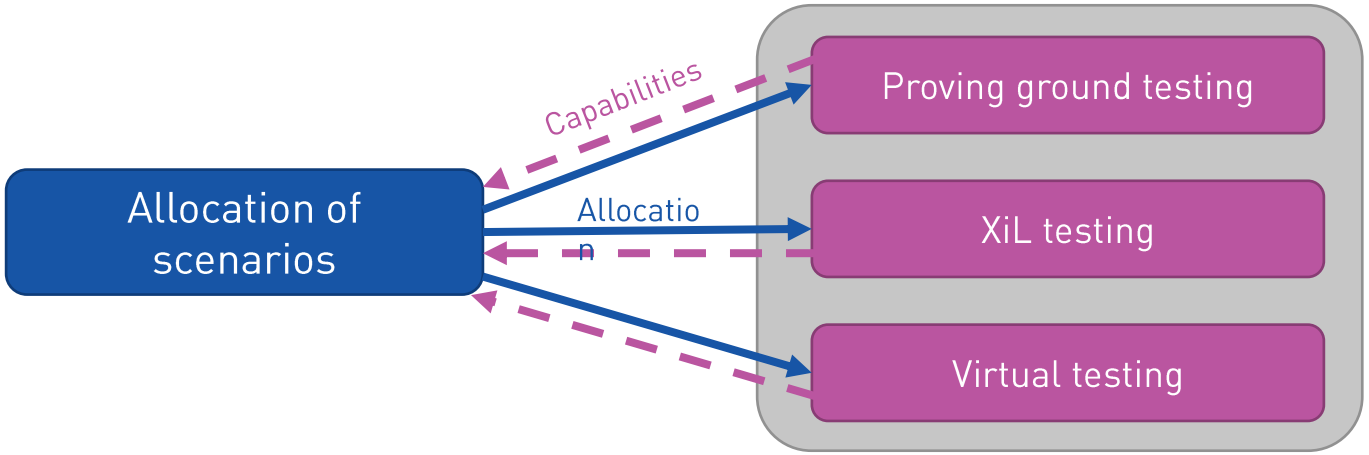
Source: Scenario for Development, Test Validation of Automated Vehicles (Menzel, Bagschik, Maurer, 2018)

Scenario Allocation



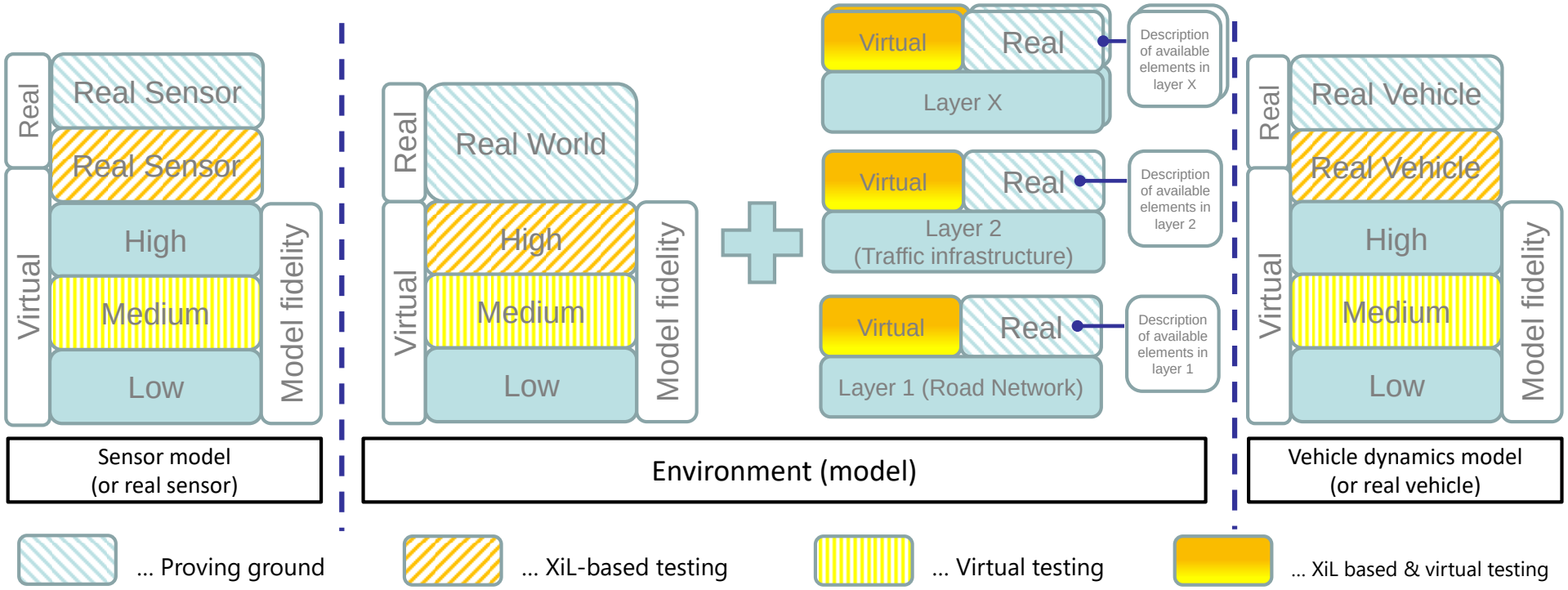
Scenario Allocation

- ✓ 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"

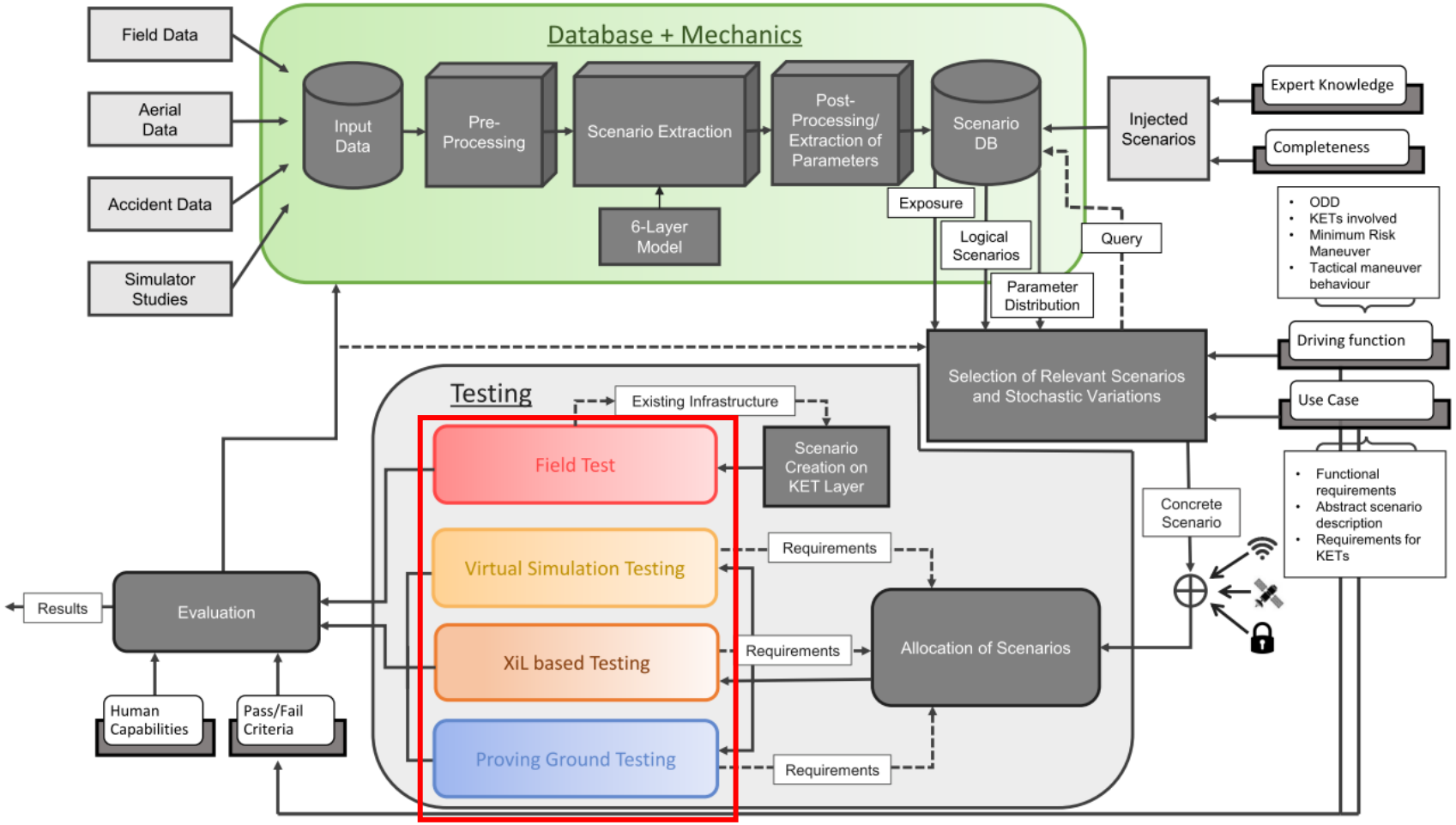


Scenario Allocation

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



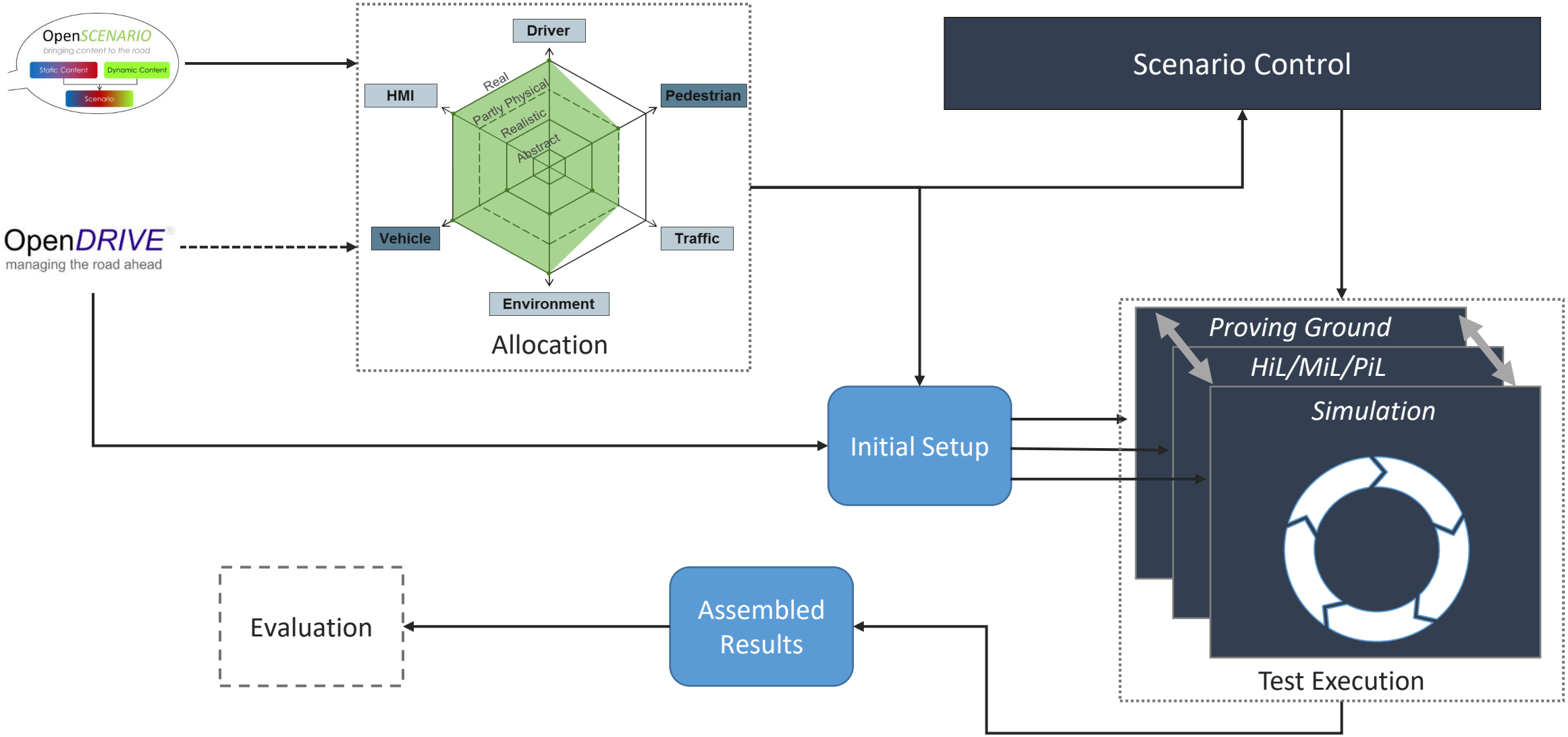
Test Execution



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

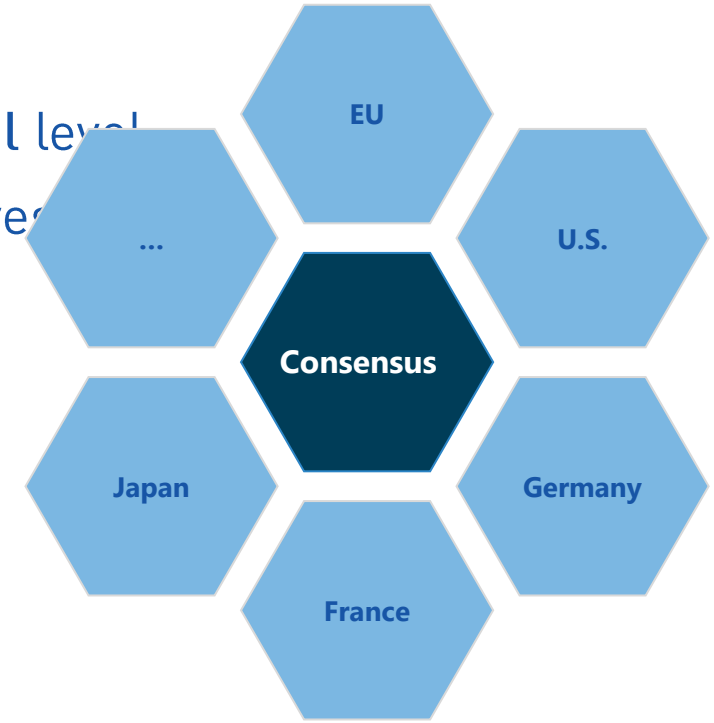


Summary

- ✓ The HEADSTART Methodology is a living process
  - Need for expert input to refine the methodology

- ✓ High effort for safety assurance on **national and international** level
- ✓ HEADSTART tries to **harmonize** different projects and initiatives

➔ International **cooperation** is key to safety assurance



Thank you!

Any questions?

Nicolas Wagener

Institute of Automotive Engineering

RWTH Aachen

Nicolas.wagener@ika.rwth-aachen.de