TATA ELXSI

Development and Validation of ADAS/AD Features Using MATLAB Solutions

MATLAB EXPO

Tata Elxsi Overview

ENGINEERING SERVICES COMPANY
that helps develop and sustain differentiated products and solutions through innovation and by focused technology management.

Focus on Product Engineering & Design since inception

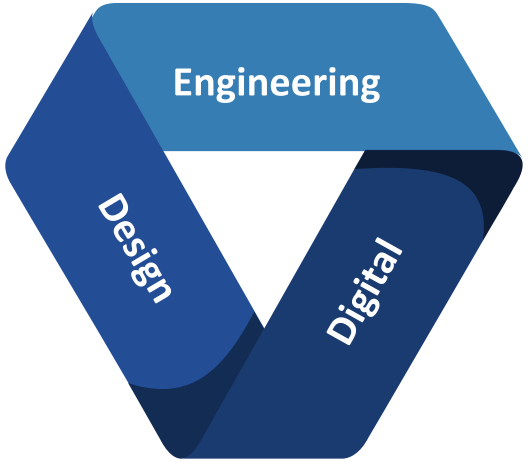
32+ Years in Business

12,000+ Engineers and Designers

33 Cities Worldwide

35.3% YoY Growth FY'22

CORE SERVICES



Transportation

PASSENGER & COMMERCIAL

- Passenger Experience
- Connected & Autonomous
- Shared & Electric

OFF HIGHWAY

- Product Design & UI
- System Software & Hardware
- Connected & Autonomous

RAIL

- Industrial
- Service design
- Rolling Stock and systems

Media & Communication

BROADCAST & MEDIA

- OTT Streaming
- RDK, Android TV, CPE
- QoE, QoS, Customer Experience

COMMUNICATIONS

- 5G, SDWAN
- Network Transformation
- Digital Transformation

Established 1989

Global HQ Bangalore

Healthcare

MEDICAL DEVICES

- Product Design
- Systems Engineering
- Regulatory Compliance

PHARMACEUTICALS

- Safety
- Packaging & Labelling
- Pharmacovigilance

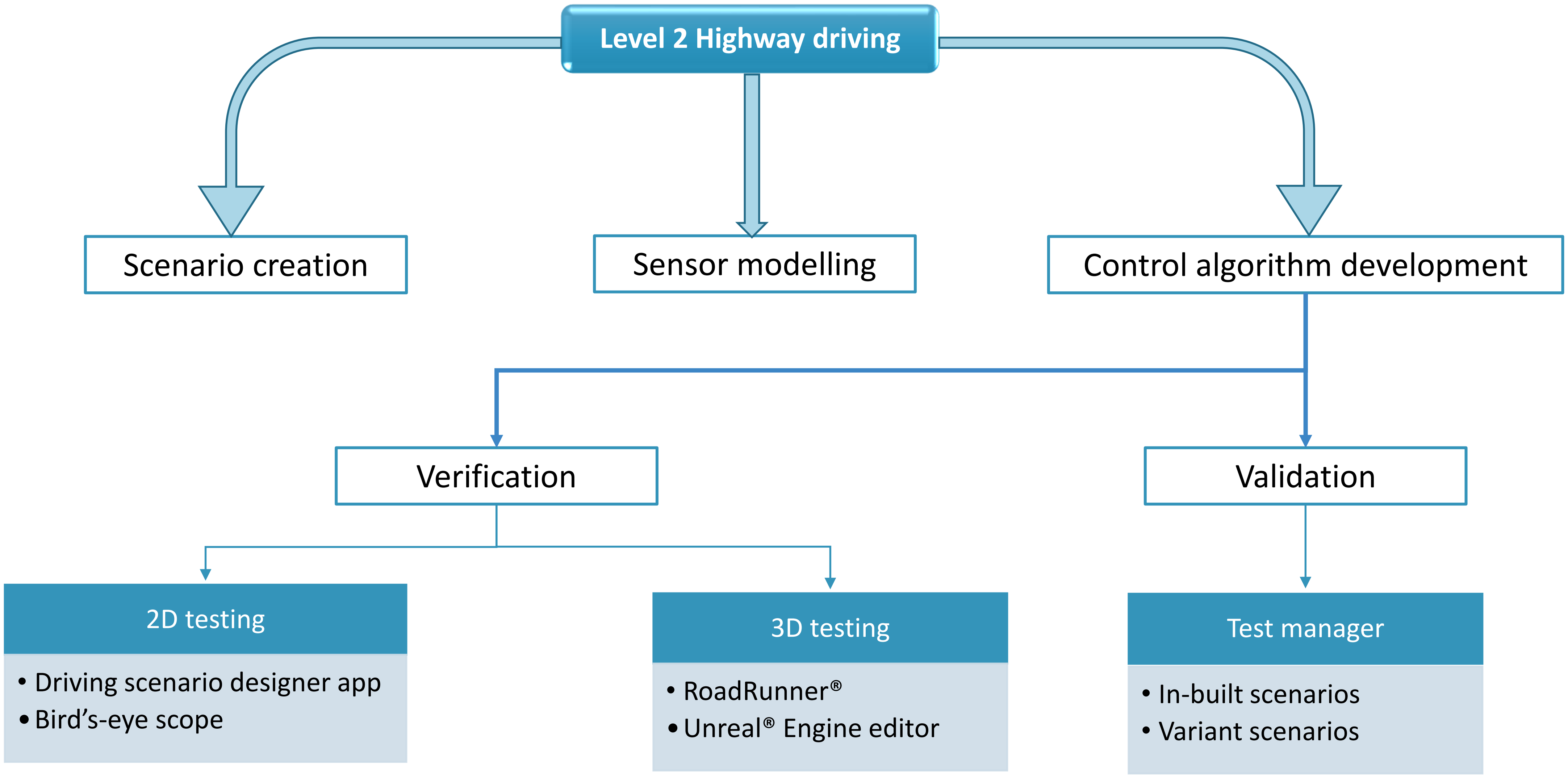
Agenda

- Introduction
- Control algorithm development
- Sensor modelling
- Virtual validation (MIL & HIL)
- ISO SOTIF validation

Introduction

- Autonomous driving (AD) and advanced driver assistance systems (ADAS) will see widespread adoption
- Design, development, and validation of complex AD ADAS algorithms are critical: Vehicle occupants' safety
- Model based design using MathWorks solutions can ease the process
- The left shifting using virtual validation: early bugs, cost efficient, early time to market
- MathWorks solutions for design, development, simulation, and virtual validation: Systematic, efficient, intuitive
- **CHALLENGES**:
  - Co-simulation of multiple tools
  - Non- user friendly nature of simulation tools
  - Design to development to validation is complex when did from scratch

Overview


Level 2 Highway driving
Scenario creation
Sensor modelling
Control algorithm development
Verification
Validation
2D testing
• Driving scenario designer app
• Bird's-eye scope
3D testing
• RoadRunner®
• Unreal® Engine editor
Test manager
• In-built scenarios
• Variant scenarios

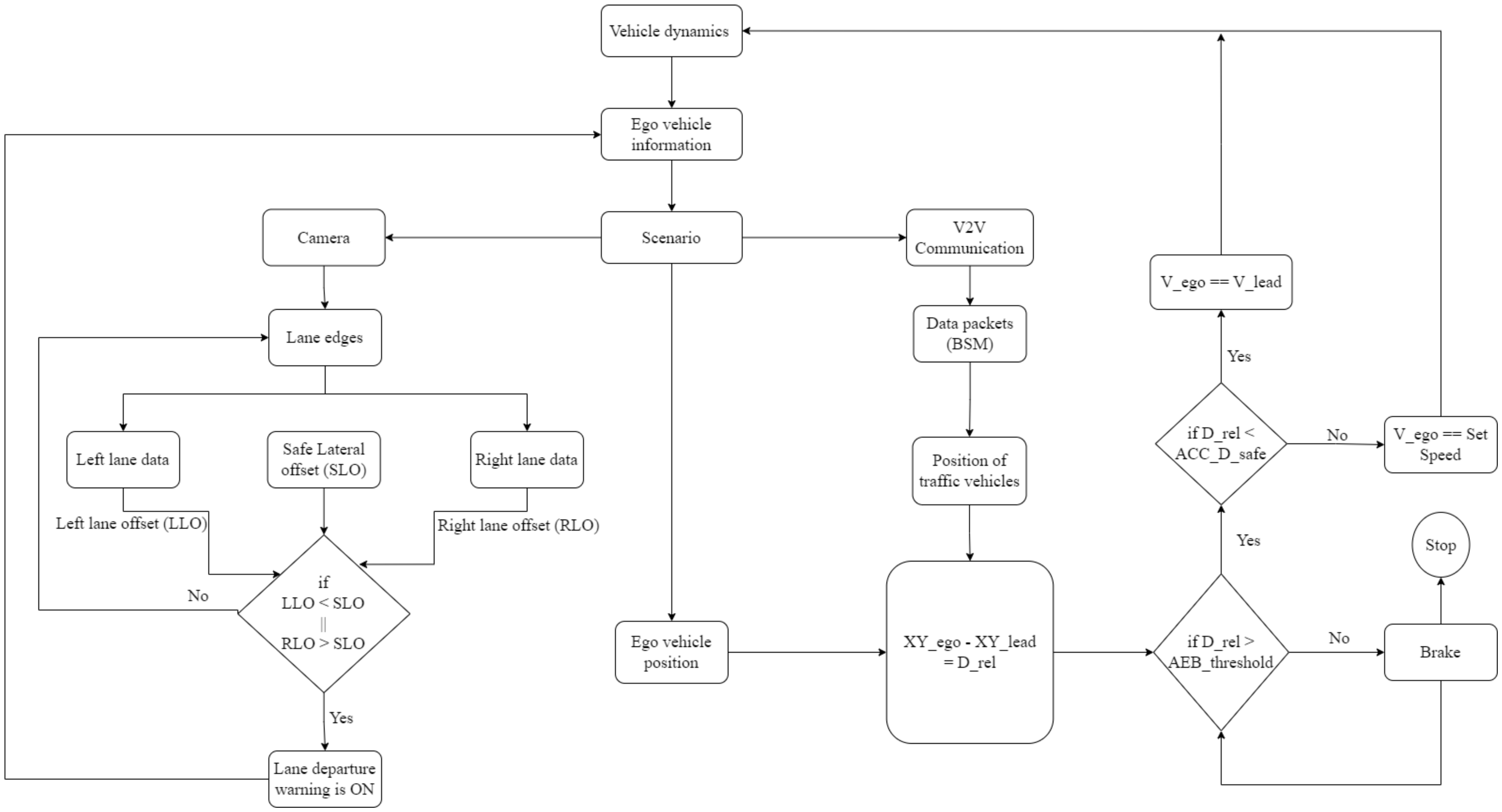
Technical overview

- The scope is to develop a level 2 highway driving control algorithm (LDW, ACC, AEB)
- Vehicle dynamics, sensor modelling, scenario creation, environment modelling, closed-loop integration and validation are to be carried out
- Control algorithm is developed by Tata Elxsi by utilising the Simulink blocks
- A pseudo logic for the control algorithm is designed and frozen first
- It is then implemented using MathWorks® solutions such as RoadRunner® and Simulink
- Control algorithm is then verified using the Simulink test manager

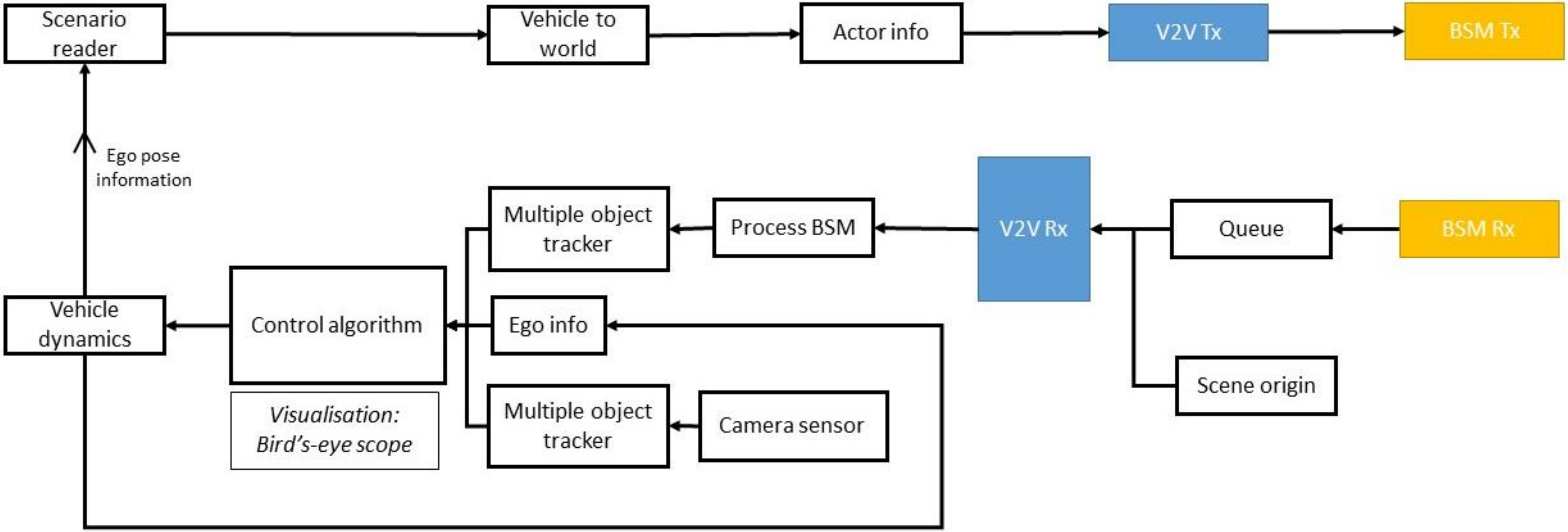
Control logic

V2V: Vehicle-to-vehicle communication
BSM: Basic safety message
D_rel: Relative distance
ACC_D_safe: Safe distance for ACC

V_lead: Lead vehicle velocity
V_ego: Ego velocity
XY_ego: Ego vehicle position
XY_lead: Lead vehicle position

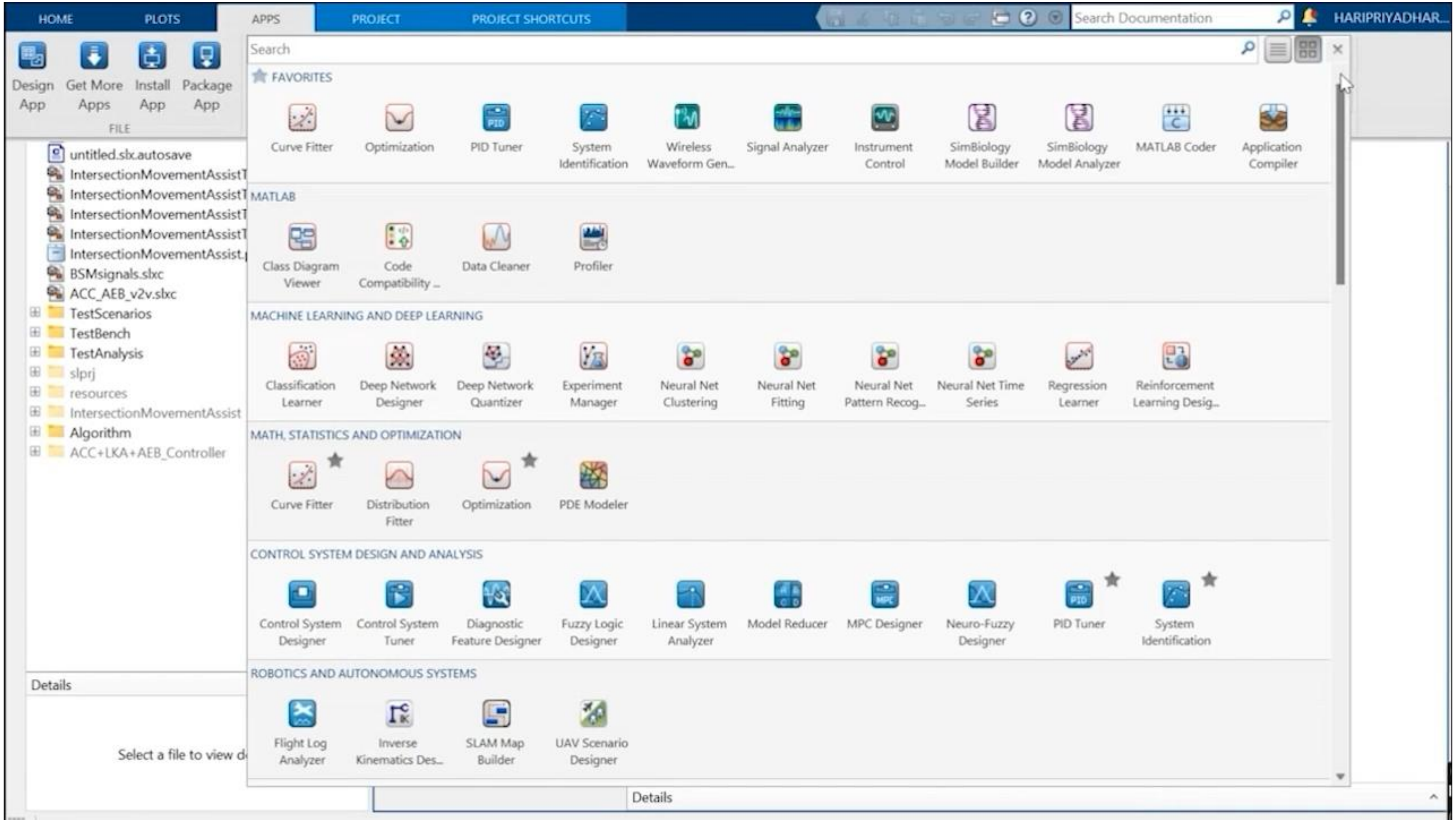


Model structure

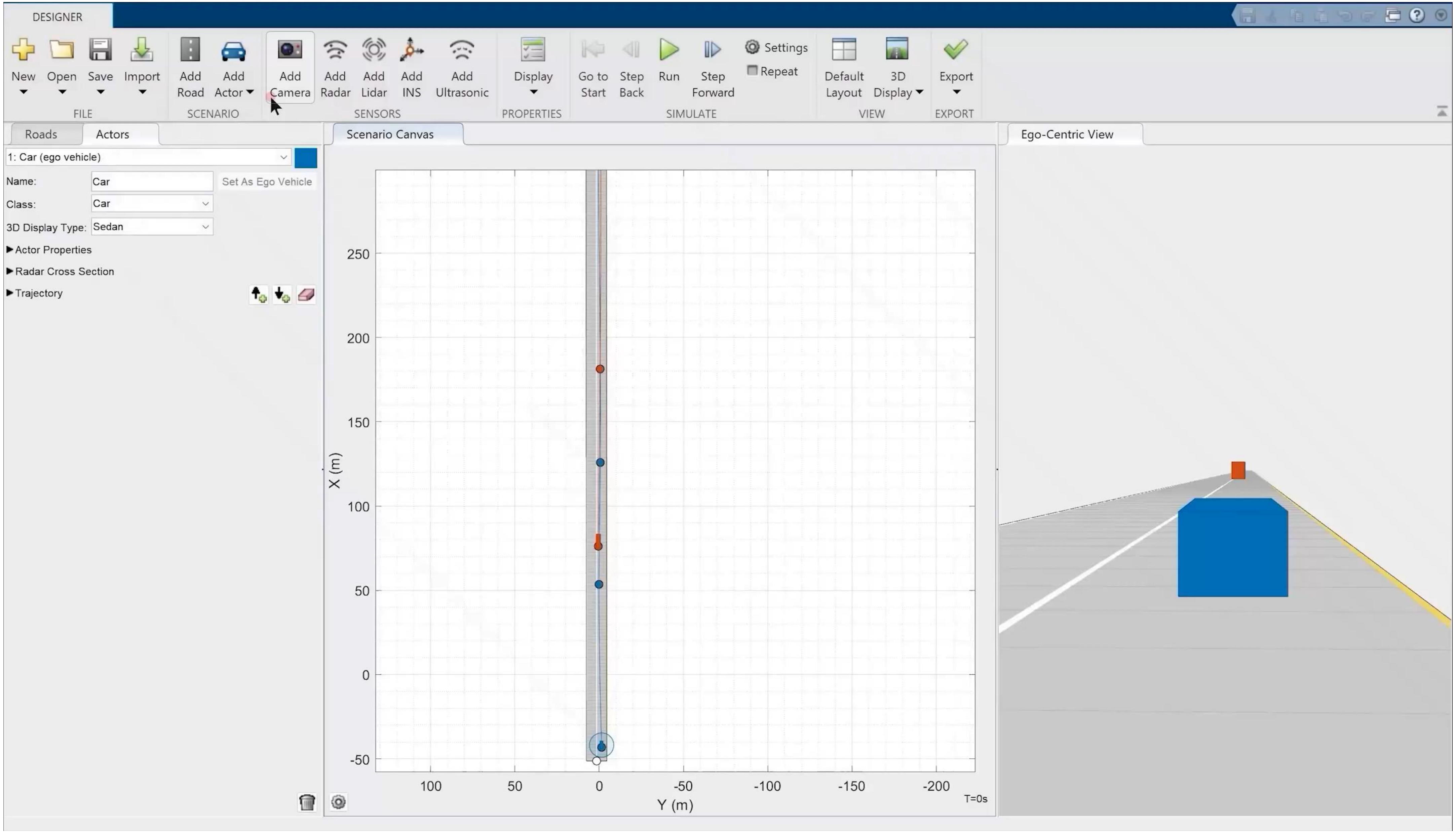


Scenario creation

Using Driving scenario designer app to add vehicles and trajectories for them, on a created road network

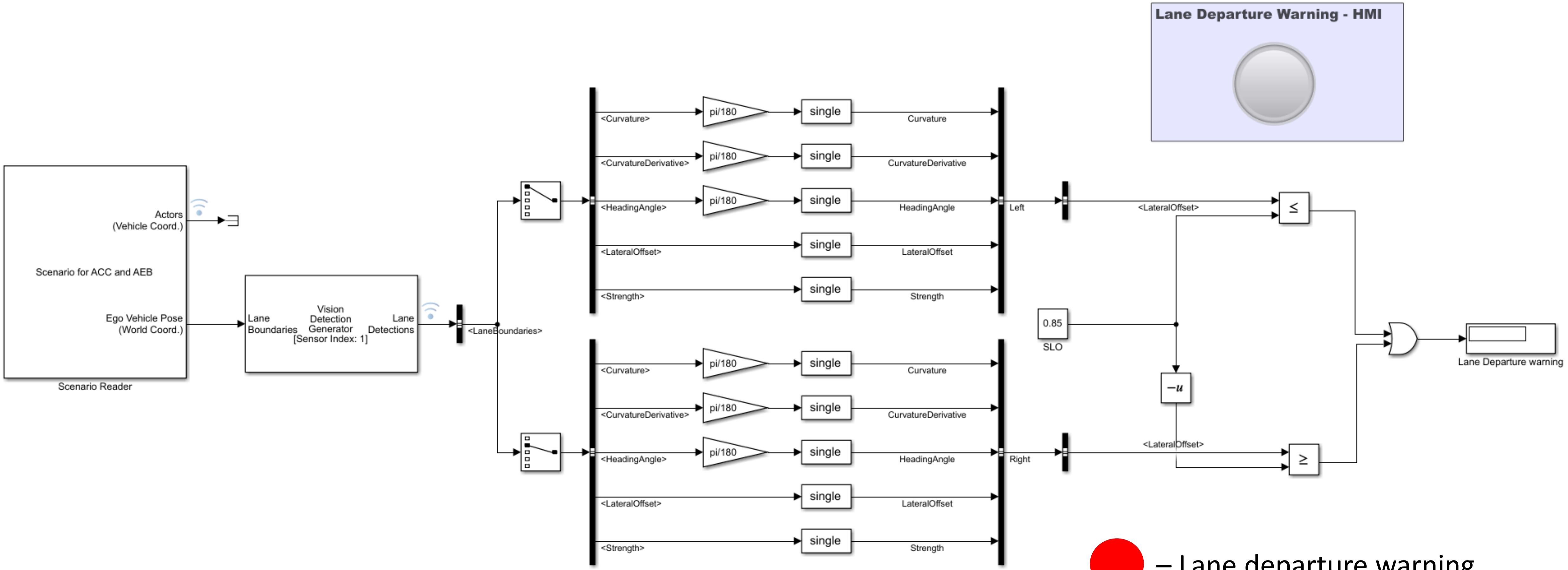


Camera sensor modelling and LDW control algorithm development



Camera sensor modelling and LDW control algorithm development

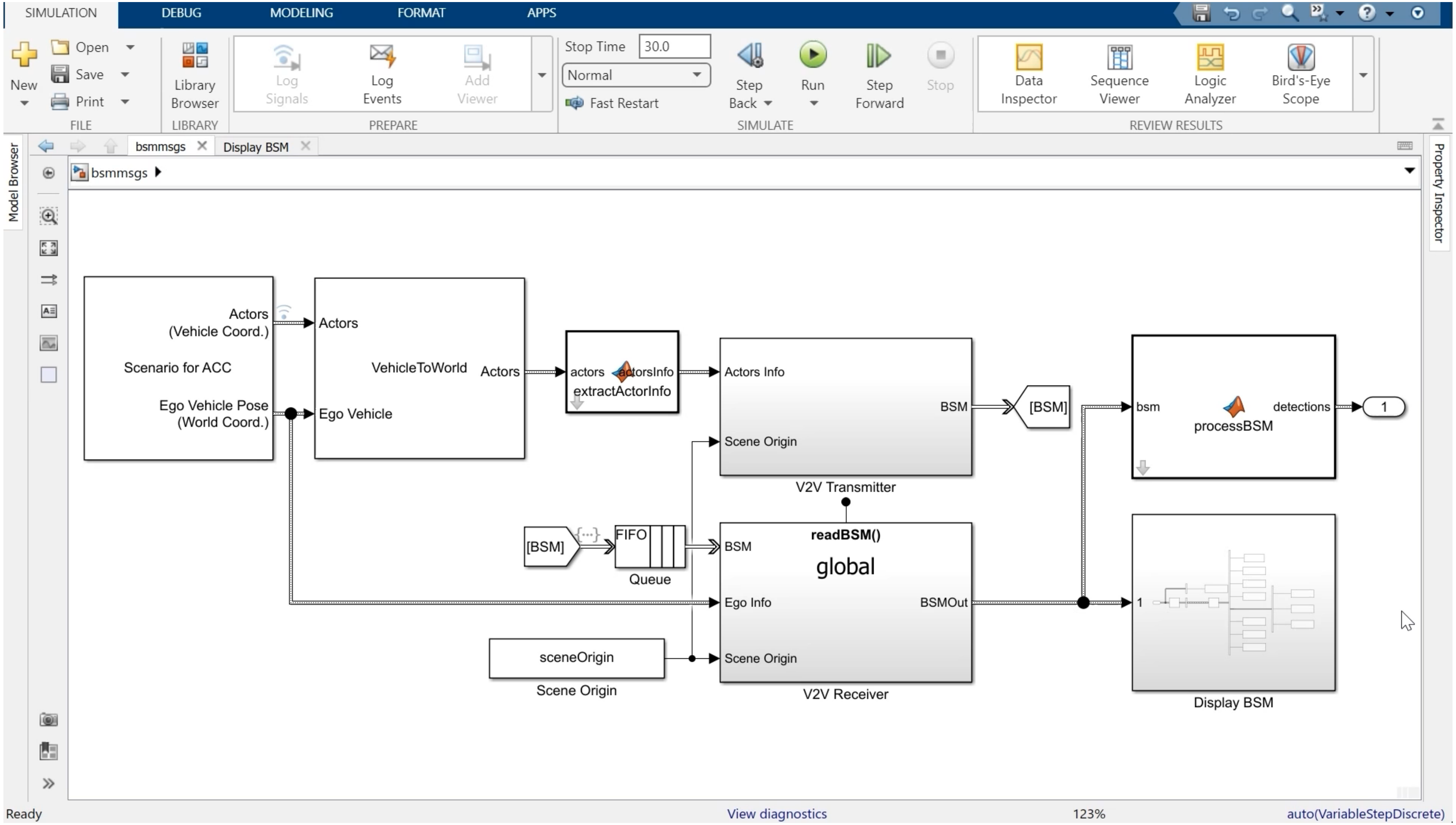
- The model detects the lane boundaries and objects by utilizing a camera sensor and aids in the LDW functionality.



– Lane departure warning

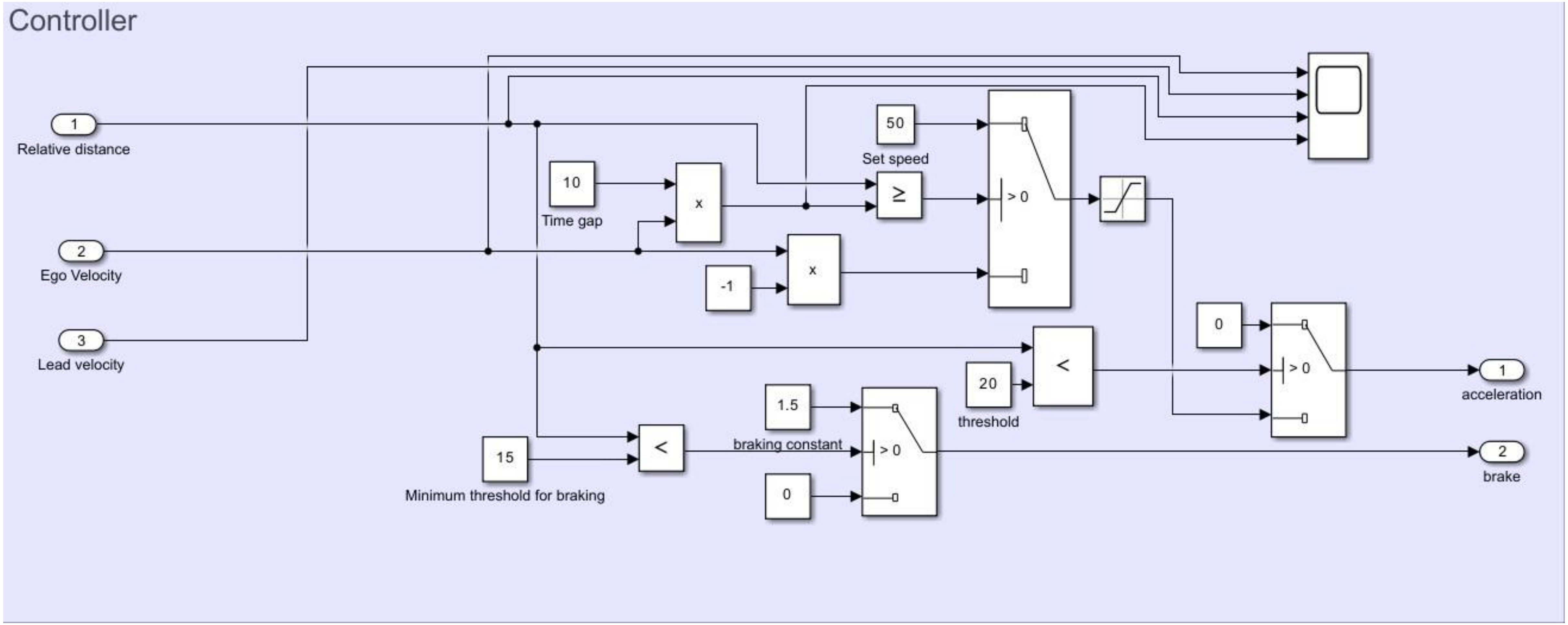
– No departure detected

V2V modelling

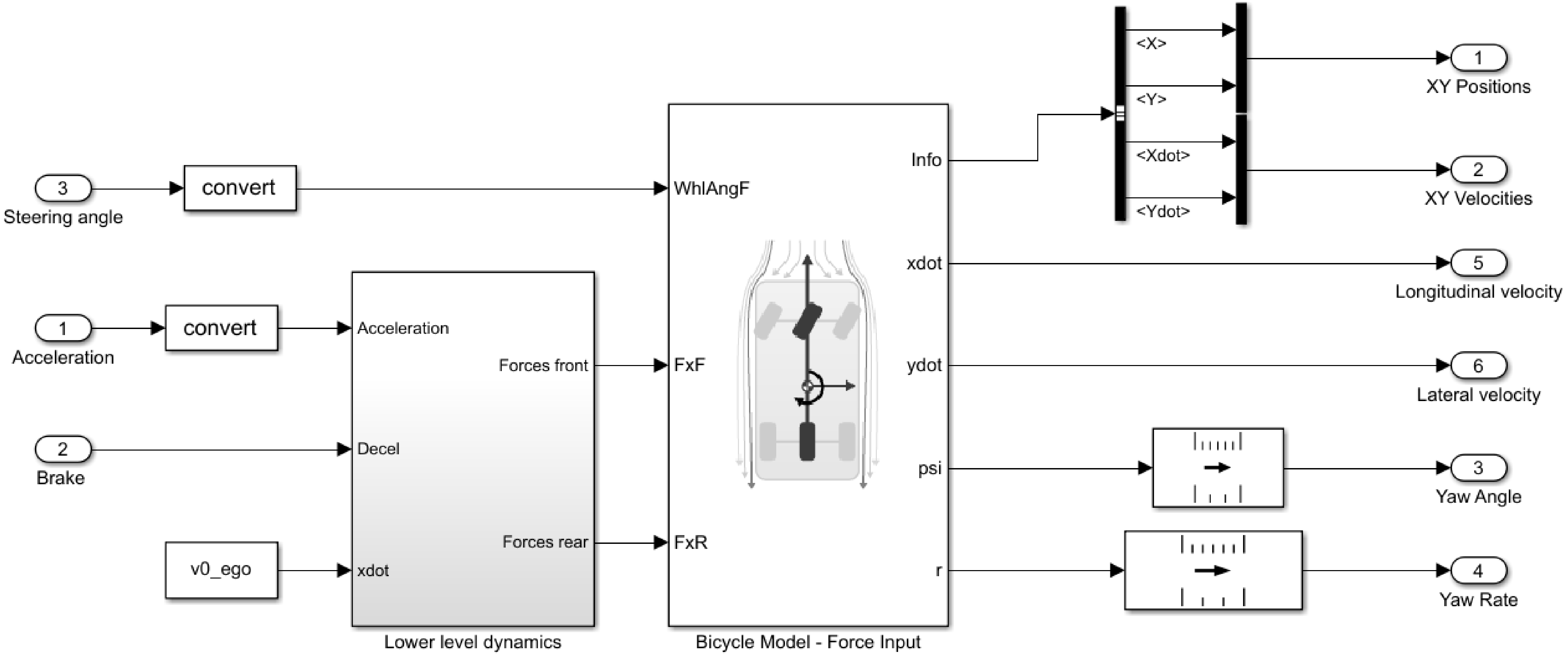


Control algorithm development for AEB & ACC

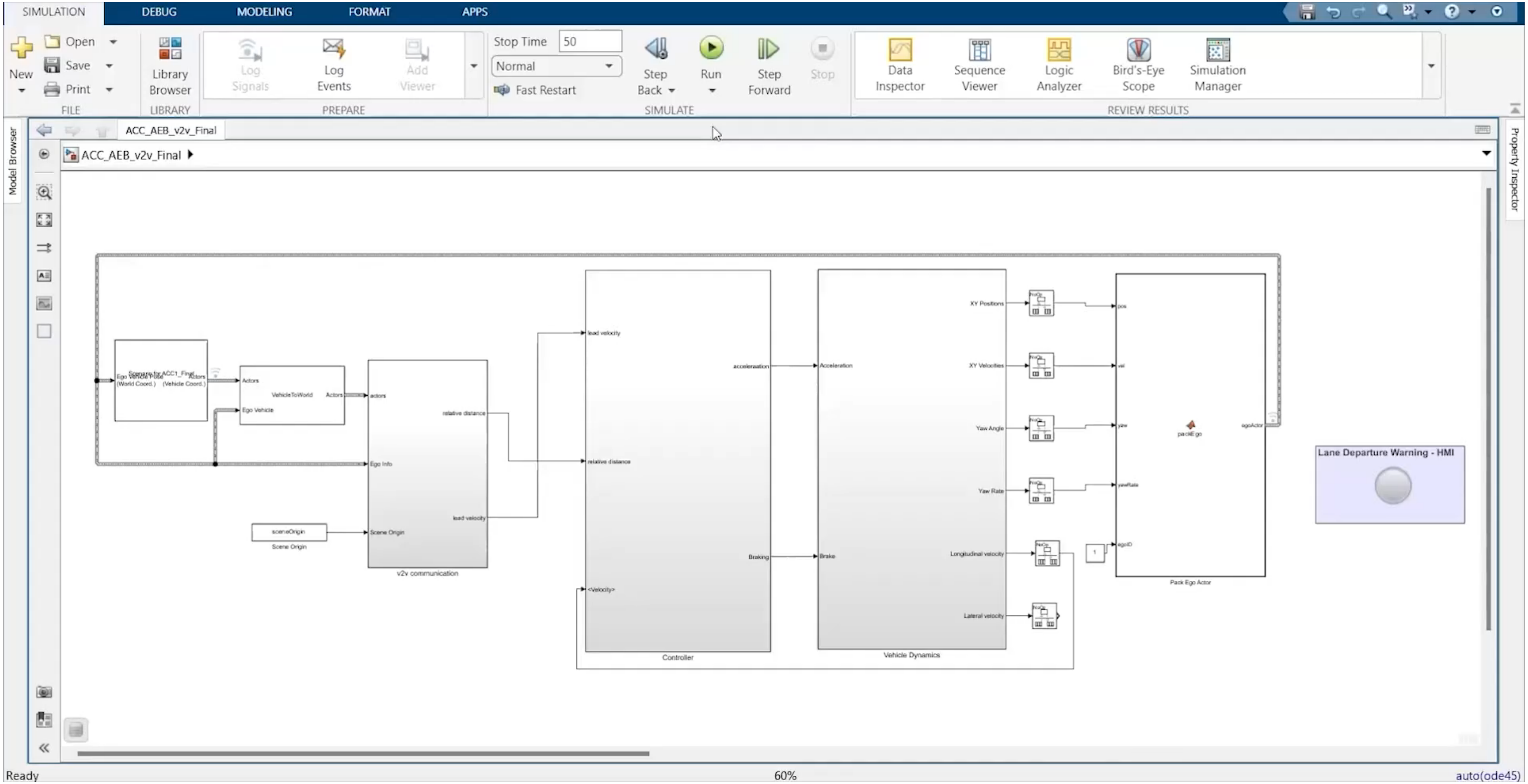
ACC and AEB control algorithm makes use of the BSM message from V2V communication



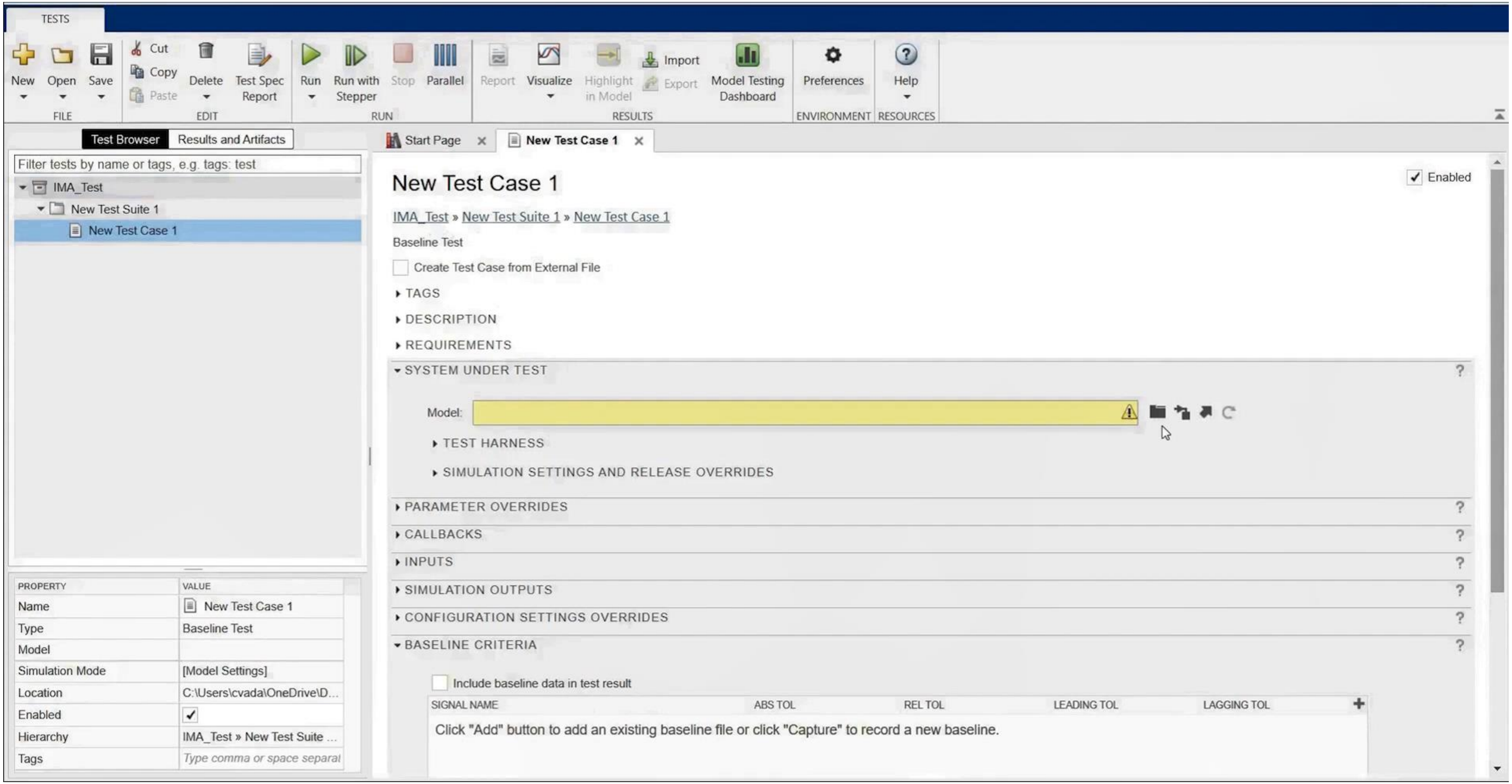
Vehicle dynamics modelling



Closed loop integration

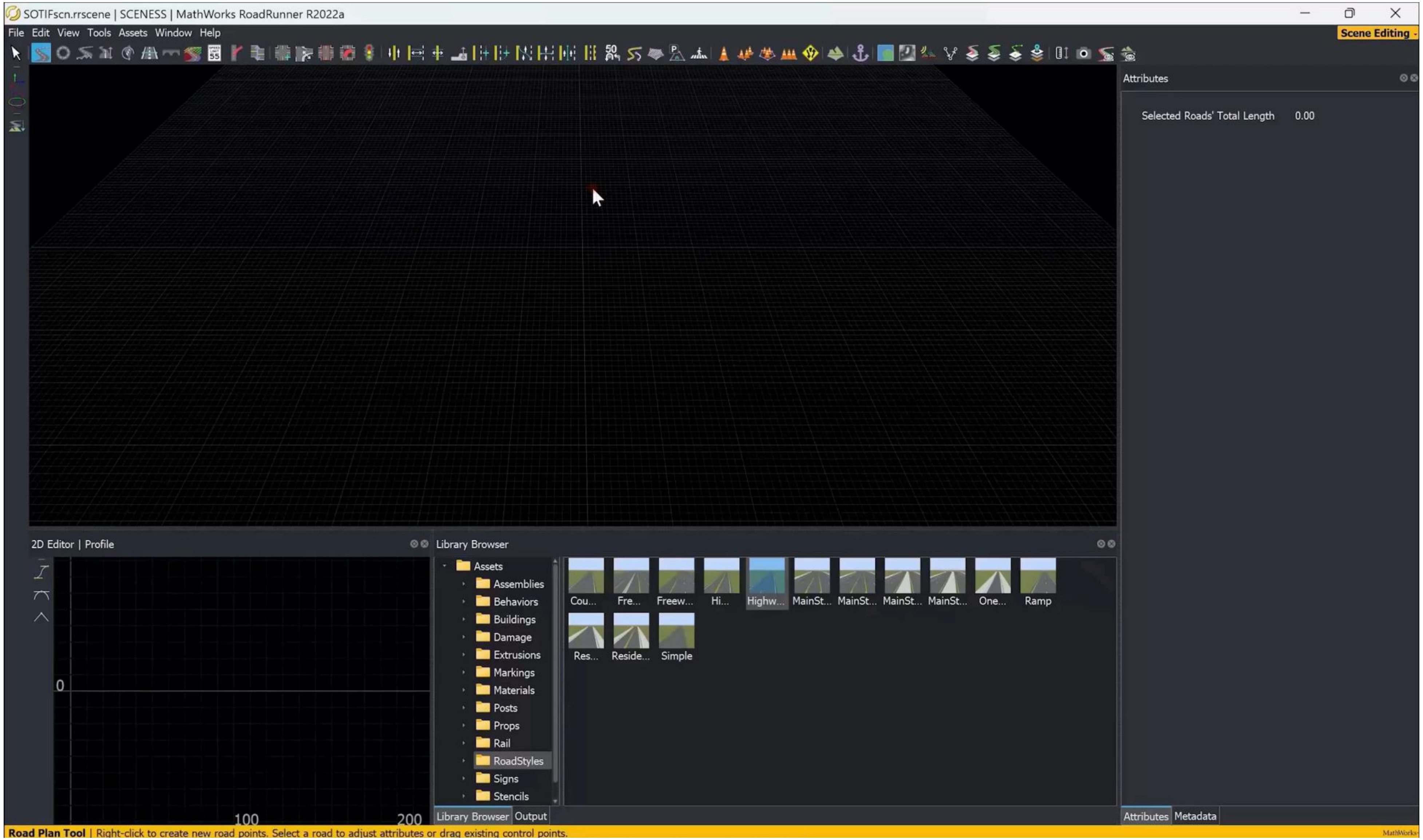


Validation of AEB & ACC



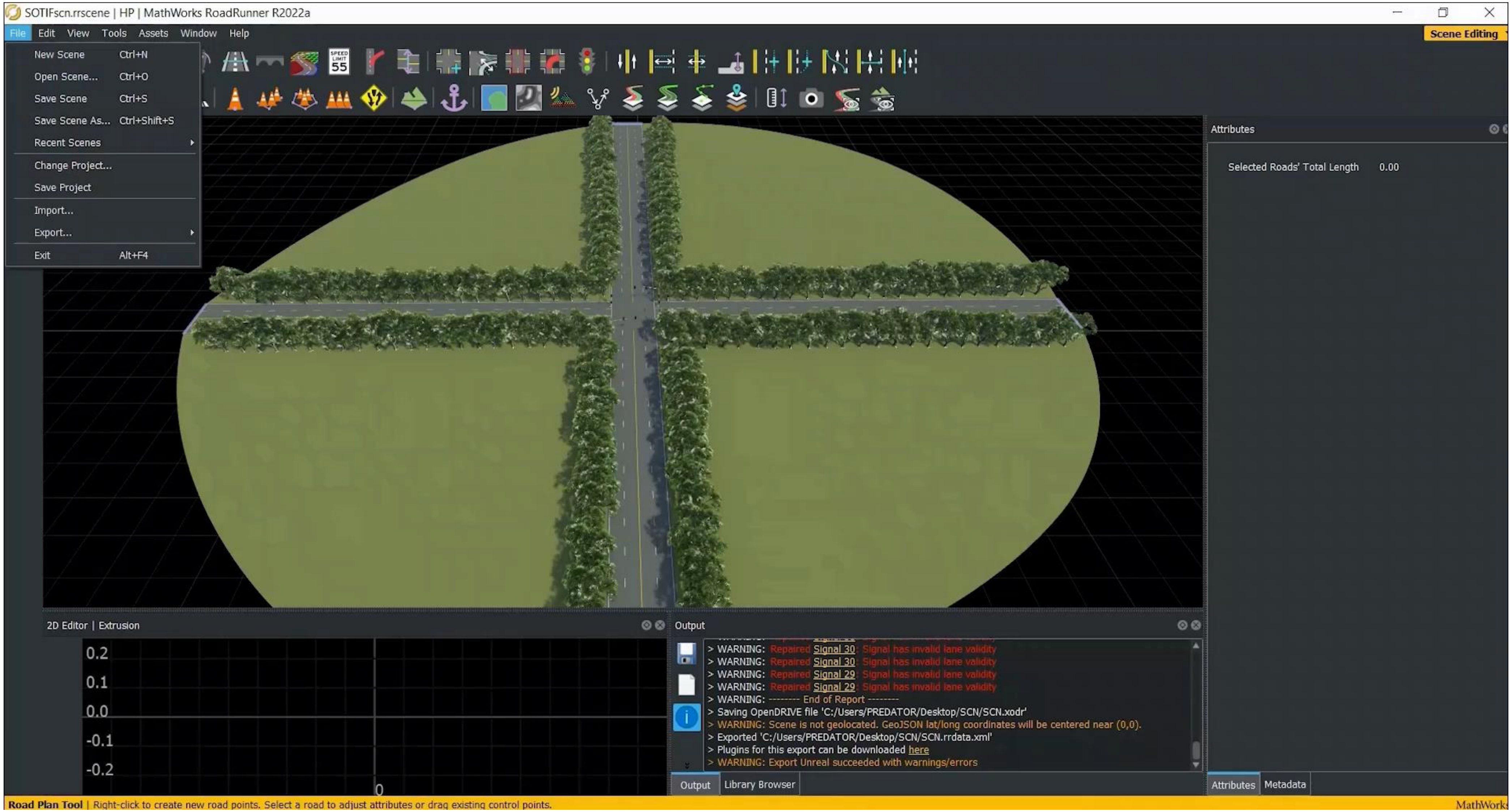
Environment modelling

- Scene and scenario creation using RoadRunner®

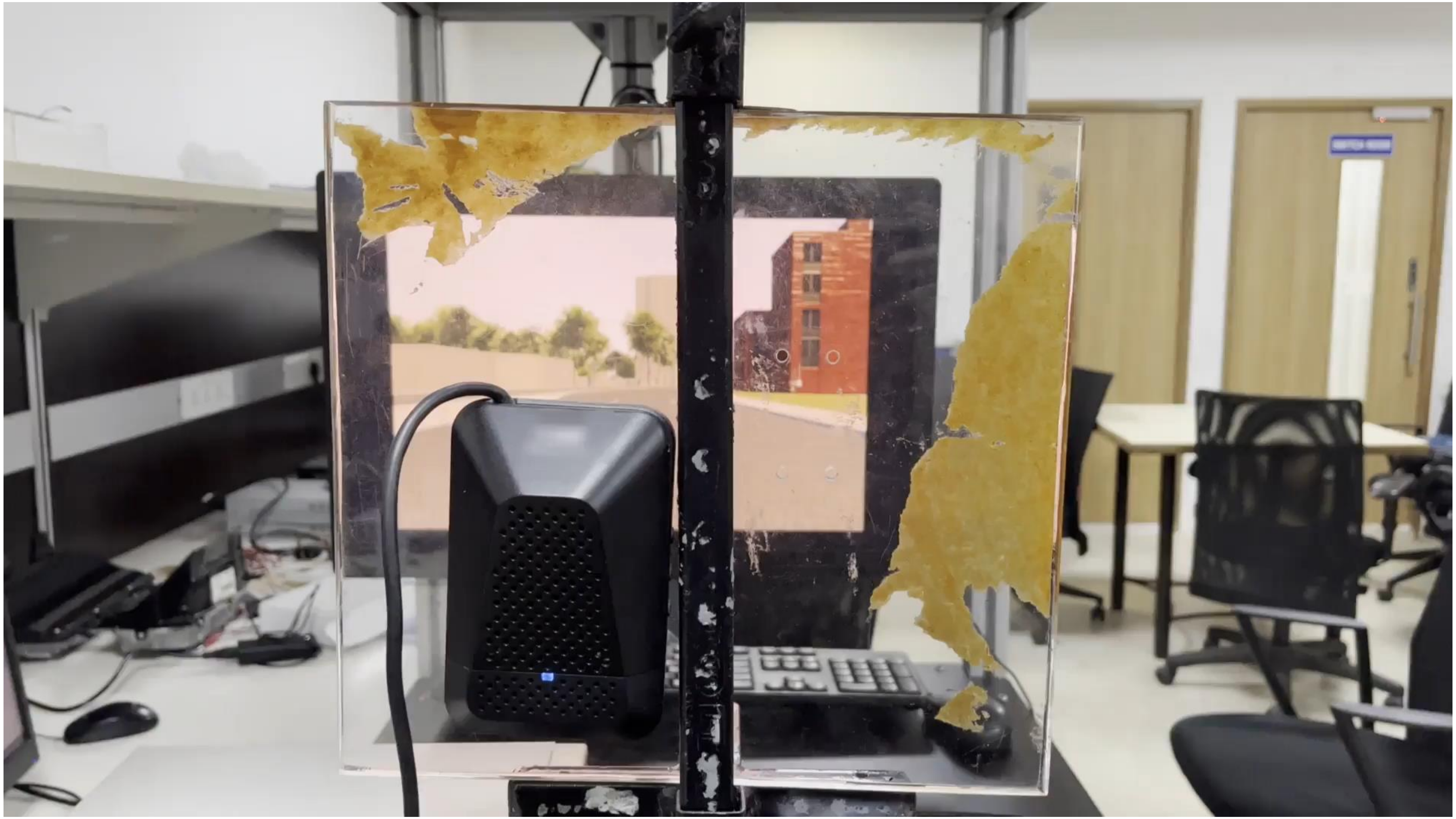


Interoperability of Matlab with 3D simulation tools

- Creation and implementation of simulation using Driving scenario designer app, Simulink and Unreal Engine



Validation using automotive camera ECU



ISO SOTIF

Step No.	Elements of flow chart	AEB
5	Functional and system specification	Function utilises radar to calculate TTC. Comparing TTC with the stopping time for FCW, PB and FB, AEB is activated accordingly
6	Hazard identification and risk evaluation	Traffic situation: Driving on urban road Potential hazard: Unwanted breaking leads to rear-end collision
	Risk of harm acceptable?	No. Hazard is not under the control of the driver. Hazard controlling depends on driver of the following vehicle. (S>0 and C>0)
7	Identification and evaluation of triggering events	Objects maybe present on road which can give rise to radar echo leading to interpretation as an obstacle.
	Identified triggering events acceptable?	No. Severity of rear-end collision should be reduced (E>0)
8	Functional modification to reduce SOTIF risk	Improve object detection by adding camera.
5	Functional and system specification	Function utilises radar to calculate TTC. Comparing TTC with the stopping time for FCW, PB and FB, AEB is activated accordingly. *Additional specification: Camera added for better object detection*
6	Hazard identification and risk evaluation	Traffic situation: Driving on urban road Potential hazard: Unwanted breaking leads to rear-end collision
	Risk of harm acceptable?	Yes. The controllability and severity levels are analysed and found to be at an acceptable risk level. (S0 and C0)
7	Identification and evaluation of triggering events	Objects maybe present on road which can give rise to radar echo leading to interpretation as an obstacle.
	Identified triggering events acceptable?	Yes. Exposure level identified is close to target value of E0.
9	Definition of verification and validation strategy	Definition of test cases for evaluating the AEB function in known and unknown unsafe scenarios based on Clause 9, Table 4.

ISO SOTIF

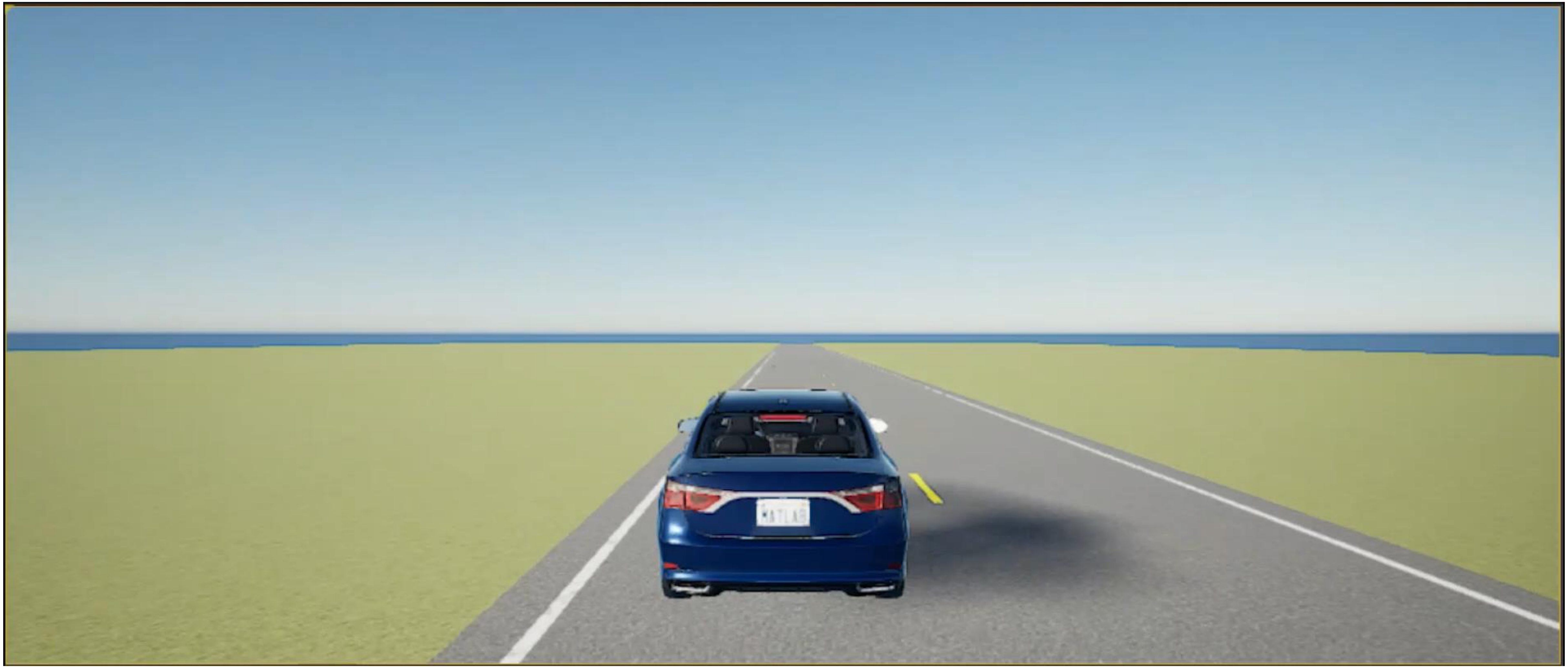
Step No.	Elements of flow chart	AEB
10	Validation of SOTIF	Known and relevant scenarios (object on road and sudden oncoming of vehicle from another track in front of EV) are covered and system behaves as expected
	Known scenarios are sufficiently covered? System and components behave as expected?	All known relevant scenarios are covered and system behaves as expected leading to acceptable residual risk in Area 2
11	Validation of SOTIF	Long term vehicle level testing on selected scenarios can be carried out. Endurance run for AEB functionality that is relevant to target market can be taken for validation.
	System and components do not cause unreasonable risk in real-life scenarios?	Complies with GAMAB priniciple. Acceptable residual risk in Area 3
12	Methodology and criteria for SOTIF realease	Verification and validation target values obtained as per demonstartions shown.
	Acceptable residual risk?	Yes

ISO SOTIF

- Functional specification of AEB

ISO SOTIF

- Potential hazard identified

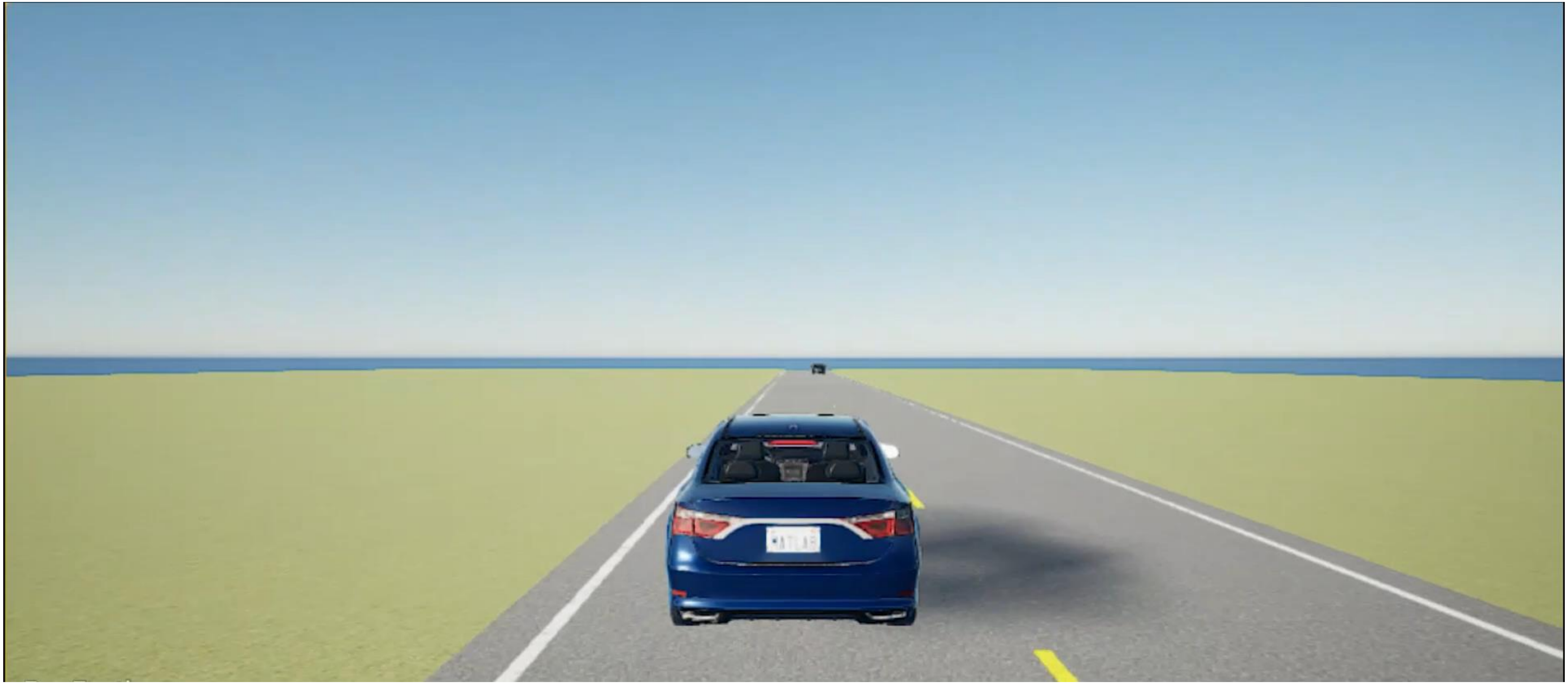


ISO SOTIF

- Functional modification made – camera added

ISO SOTIF

- Verification and validation of AEB



Conclusion and Future works

- To develop level 2 highway driving algorithm – Scenario developed, sensor modelled, and control algorithm developed
- All 3 are integrated together and tested using 2 methods
  - 2D testing
  - 3D testing
- Validation is done using test manager using various scenarios and corresponding reports with needed graphs are obtained
- Validation using automotive camera ECU implemented
- For TE – Validating and improving the autonomous driving experience
- For future works
  - Extending this to a real-time closed-loop HIL validation environment
  - Performing real recorded videos to virtual scenario conversion automatically

Advantages of MathWorks solutions

- User-friendly platform: With the convenient and clear-cut interface along with thorough documentation helps users to easily work with MATLAB for various applications
- Toolboxes: Numerous application specific toolboxes are provided by MATLAB which aids users in executing their applications efficiently
- Simulink: Control models can be easily developed using function-specific Simulink blocks
- Effortless integration with other software tools such as RoadRunner and Unreal® Engine
- Support: Technical support & online forums for rectifying errors
- Reference examples: Ready availability of reference examples for easy reference

THANK YOU

TATA ELXSI

FIND OUT MORE

www.tataelxsi.com