Oprogramowanie
Naukowo-Techniczne
sp. z o.o.

Kraków, 19.10.2023 r.

RoadRunner Introduction

3D Scenes and Scenarios for ADAS Design and Verification

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Application Engineer ONT

SEMS'23

MathWorks
Authorized Reseller

Agenda

1. Introduction
2. RoadRuner Product Family
3. ADAS Simulation Example

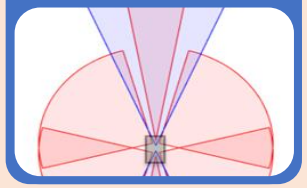
Introduction

Automated Driving Applications Developement

Virtual Worlds

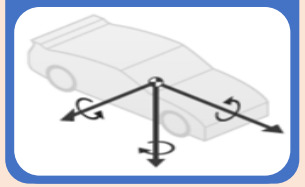
Scenes

Sensors



Scenarios

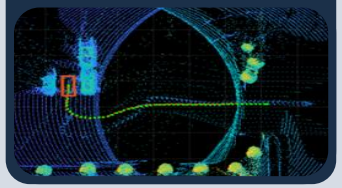
Dynamics



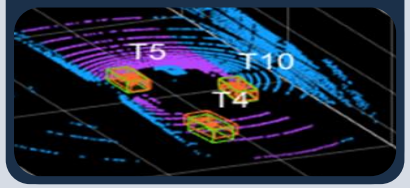
Algorithms

Detection

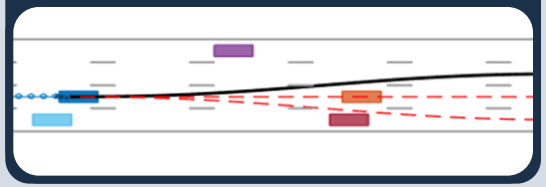
Localization



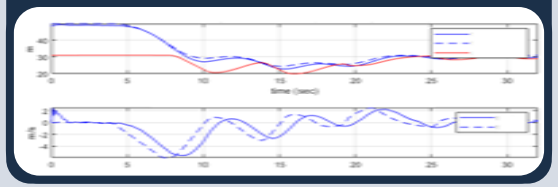
Tracking



Planning



Decision & Controls



Software

Code Generation

C/C++
GPU HDL

Architectures

AUTOSAR
ROS DDS

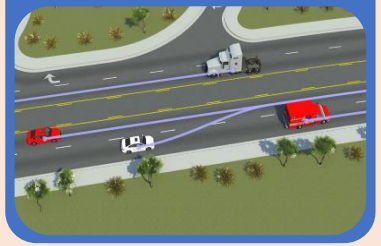
RoadRunner	MATLAB & Simulink	Polyspace
product family	product family	product family

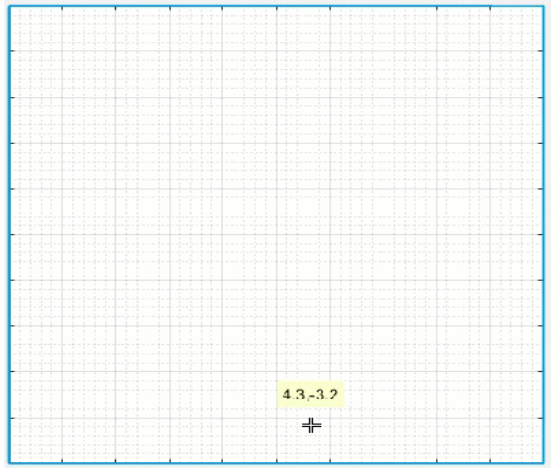
Complex Scenes and Scenarios for Today's Needs

Virtual Worlds

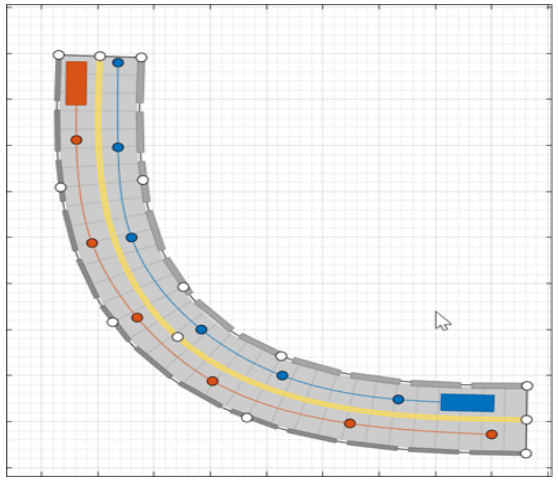
Scenes

Scenarios

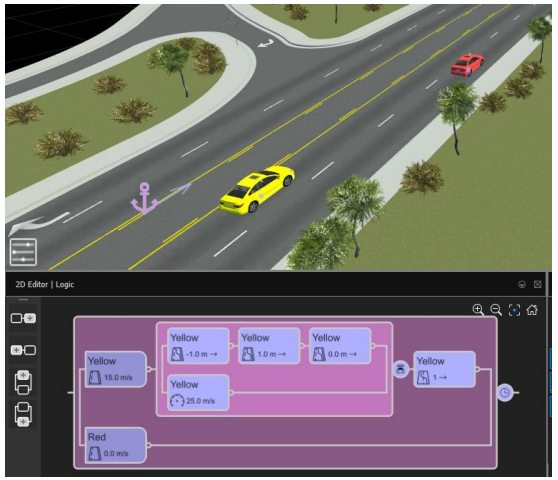




OR



OR



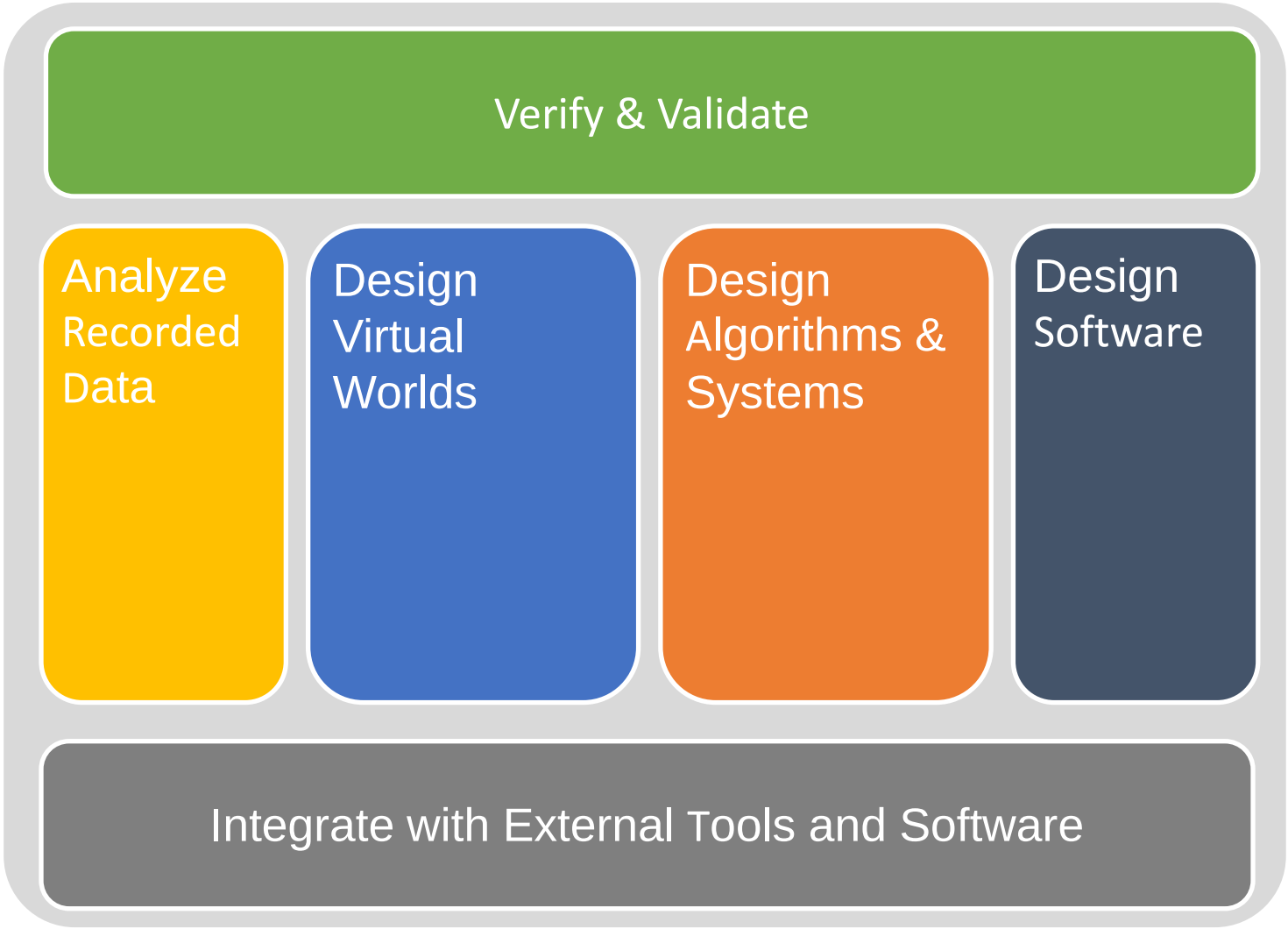
Complexity and realism

Accurate Road Models

Real Photo – Shanghai, China

RoadRunner

Continuous investment in virtual simulation for design & verification

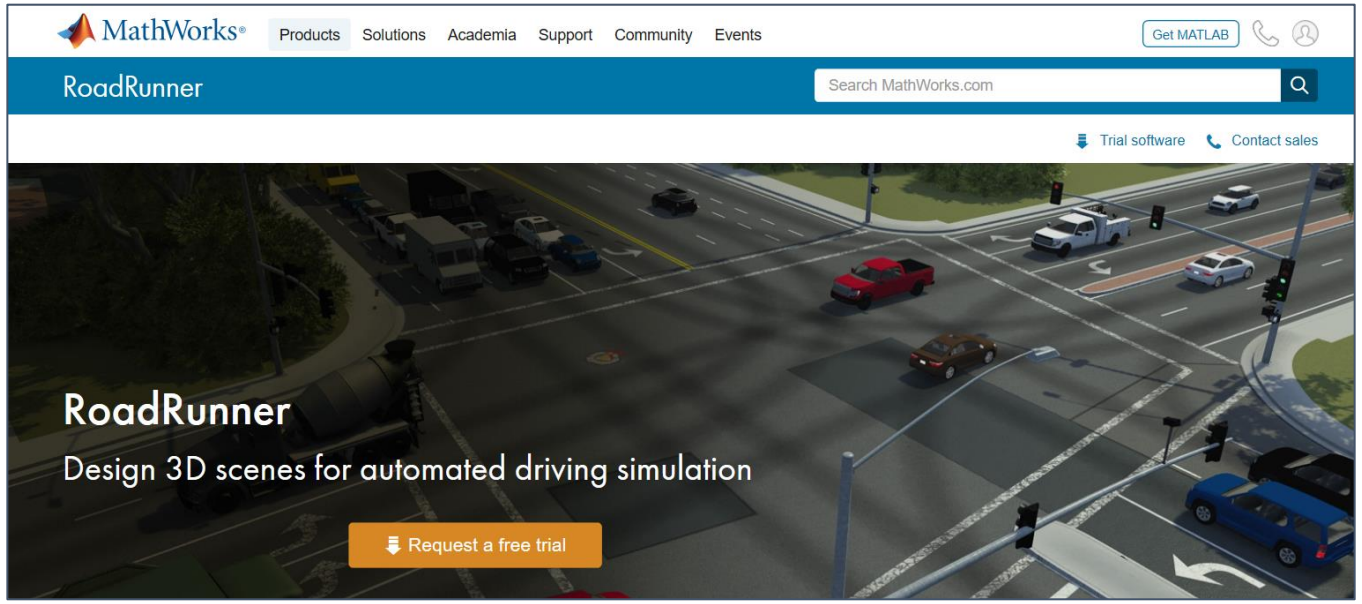


- Representative scenes and scenarios to maximize simulation value
- Increased automation of building scenes and scenarios for recorded data
- Interactive tools to design new and refine automatically built world
- Tool interoperability to work with multiple driving simulation environments

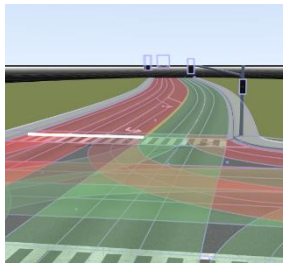
RoadRunner Product Family

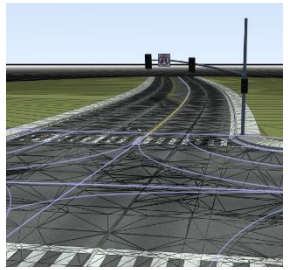
RoadRunner Video Presentation

Use of RoadRunner Environment

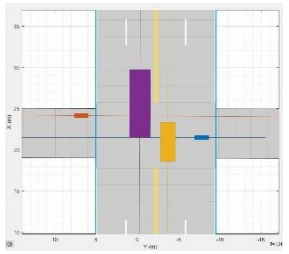


External Simulators





MATLAB & Simulink



RoadRunner Product Family

Here HD Live Maps
TomTom HD Maps
Others

OpenDRIVE (1.4 - 1.7)
OpenStreetMap
OpenCRG
Zenrin SD Maps

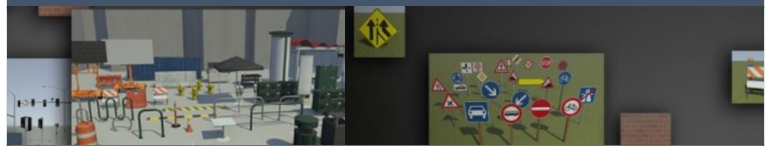
Geographic Information System (GIS) Files

Custom Assets

RoadRunner Scene Builder

RoadRunner

RoadRunner Asset Library

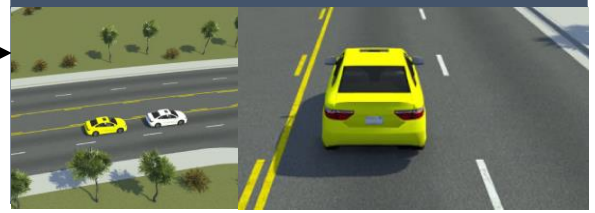


OpenDRIVE

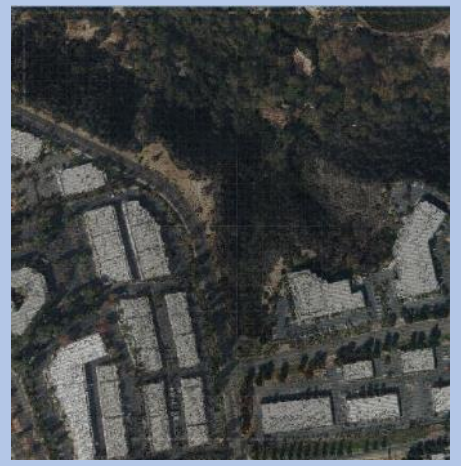
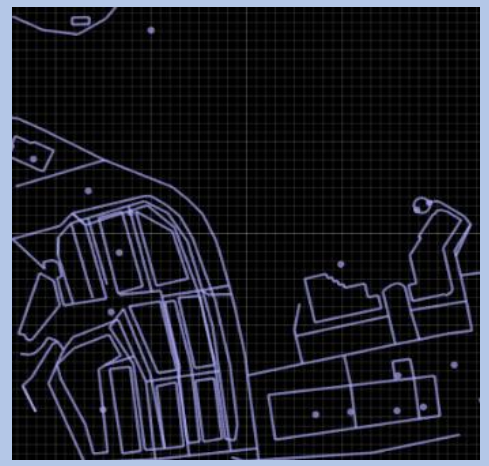
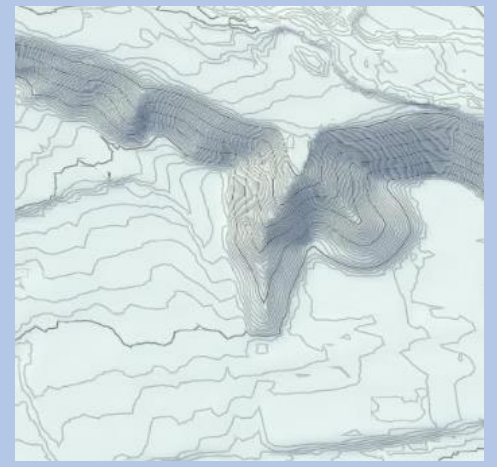
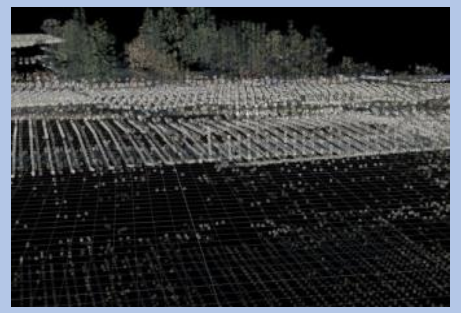
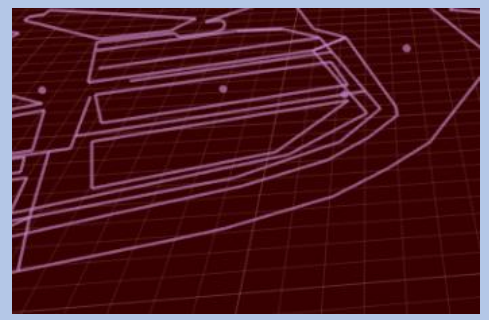
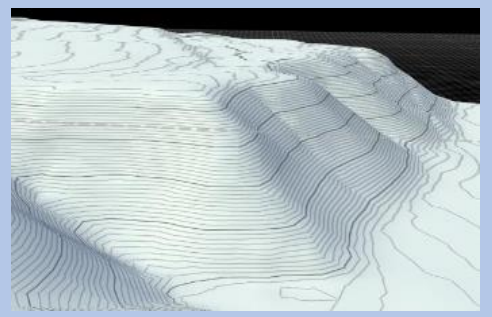
3D Scene Geometry
AutoCad, FBX, STL, gITF

Third Party Simulators
- CARLA
- Unreal Engine®
- rFpro
- NVIDIA DRIVE Sim®

RoadRunner Scenario

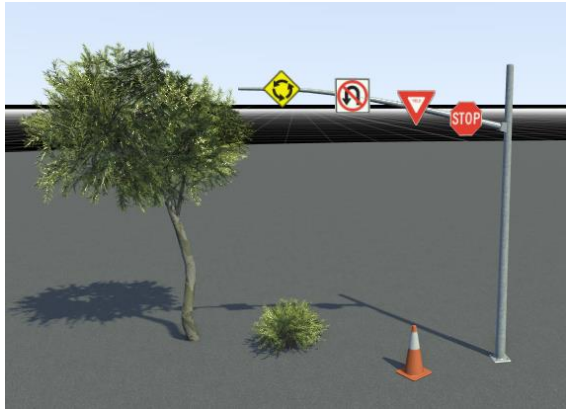


GIS File Interpretation

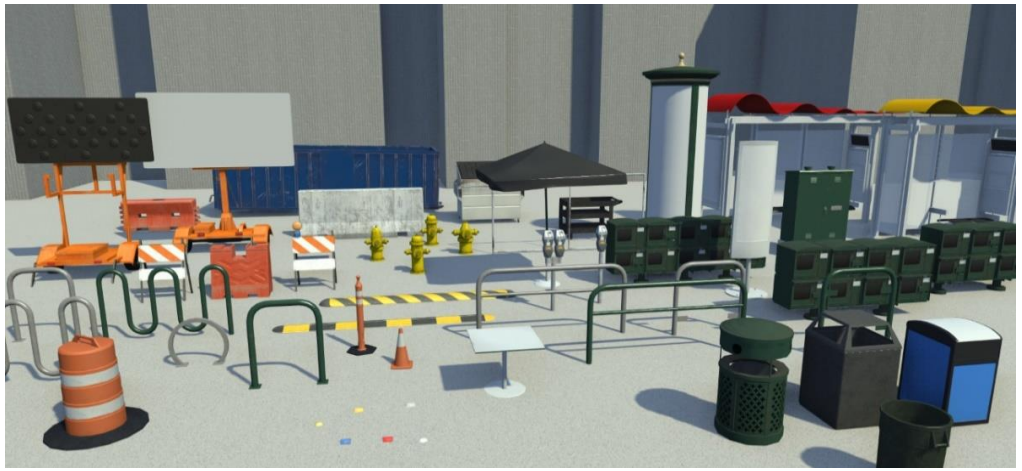
Point Cloud	Aerial Imagery	Vector Data	Elevation Data
			
			

RoadRunner Asset Library

- Road signs
- Traffic signals
- Road surface markings and textures
- Buildings
- Guardrails and urban items
- Trees

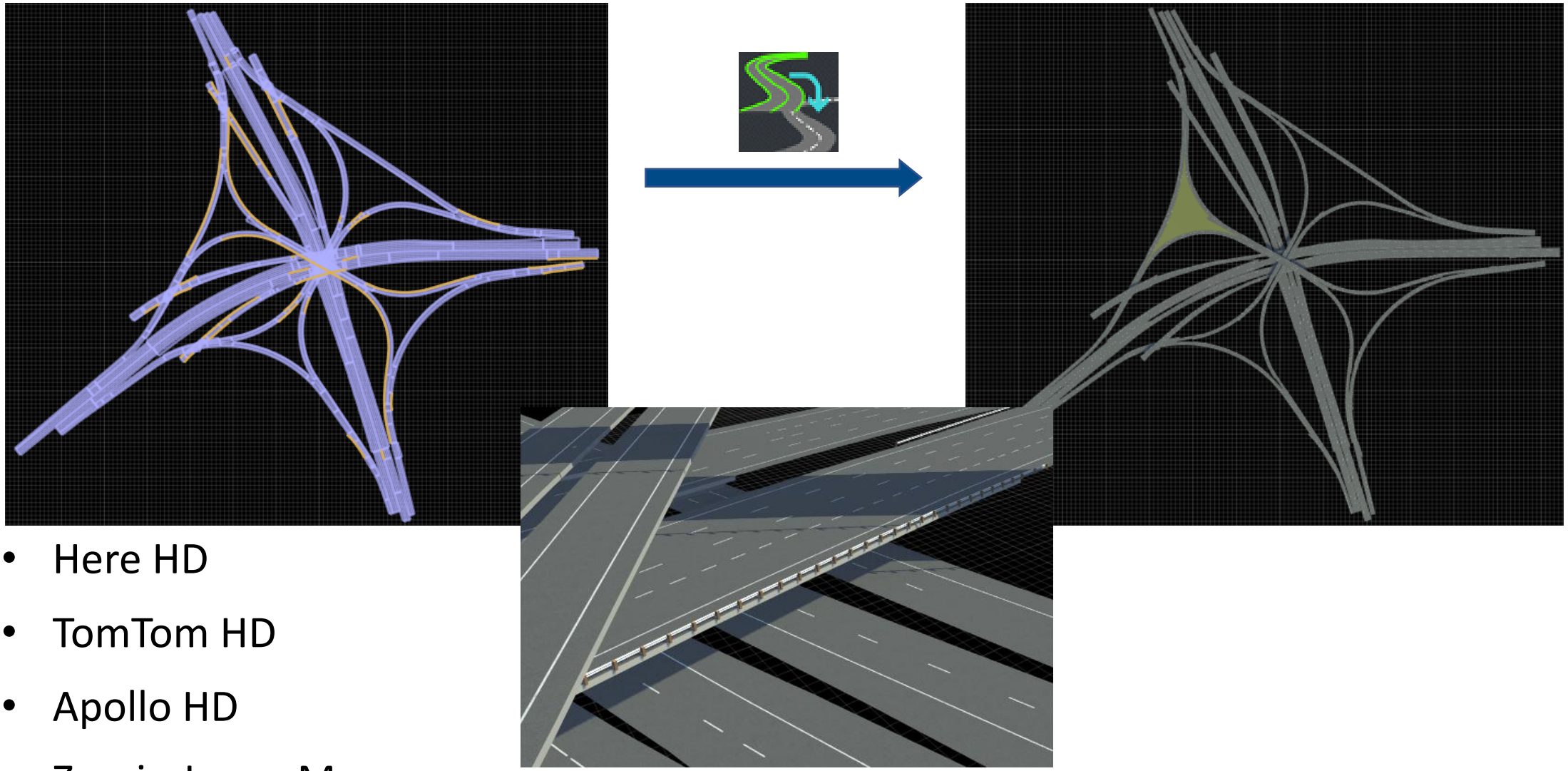


Basic models



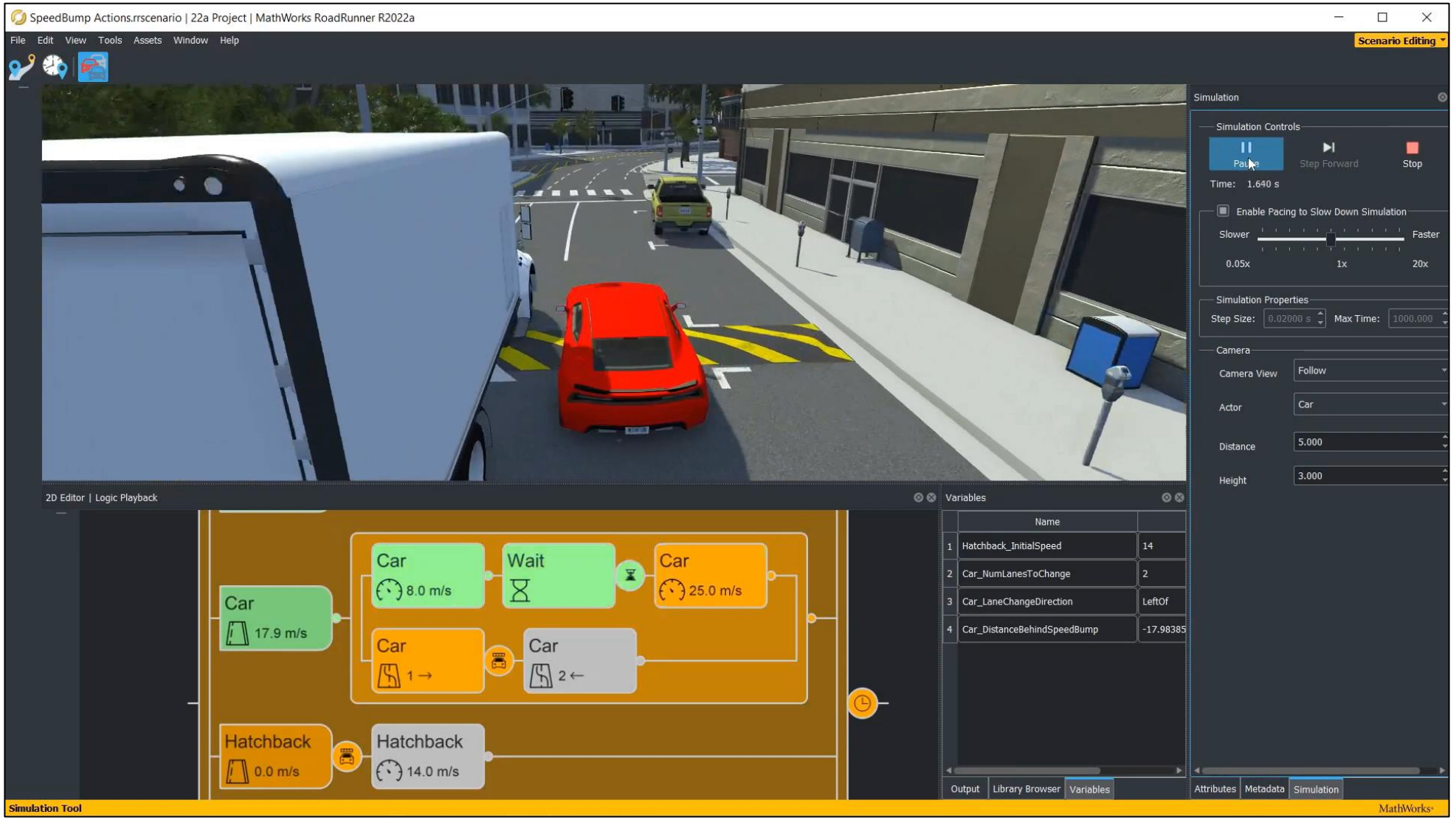
Asset Library Models

RoadRunner Scene Builder Tool



- Here HD
- TomTom HD
- Apollo HD
- Zenrin Japan Map

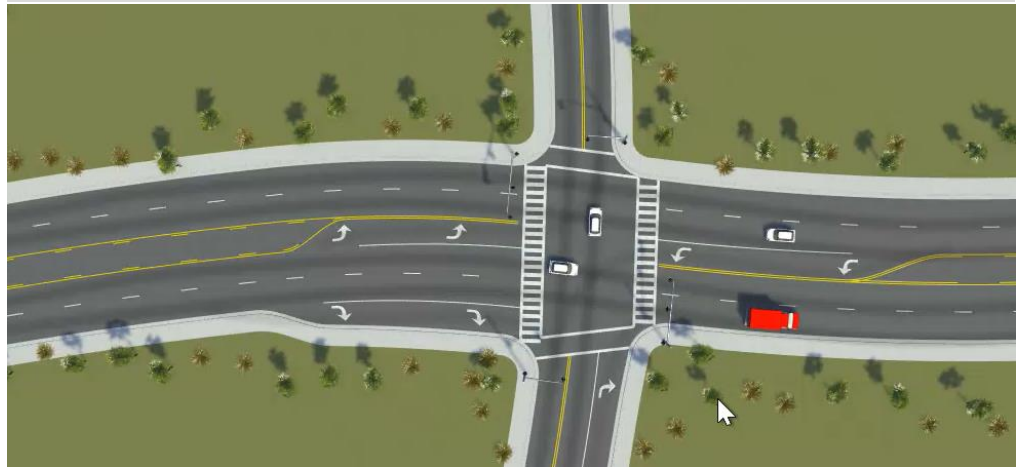
RoadRunner Scenario



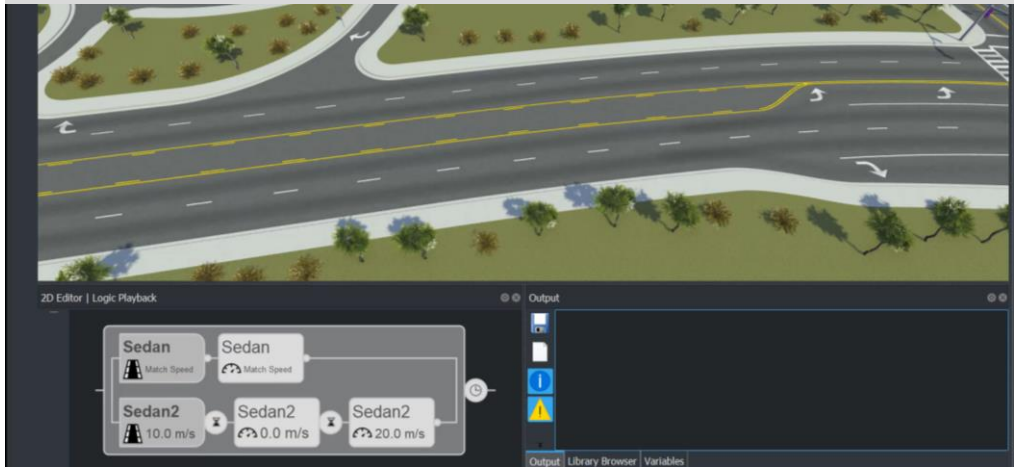
R2022a

Scenario Logic and Paths

Follow lanes when no path is specified

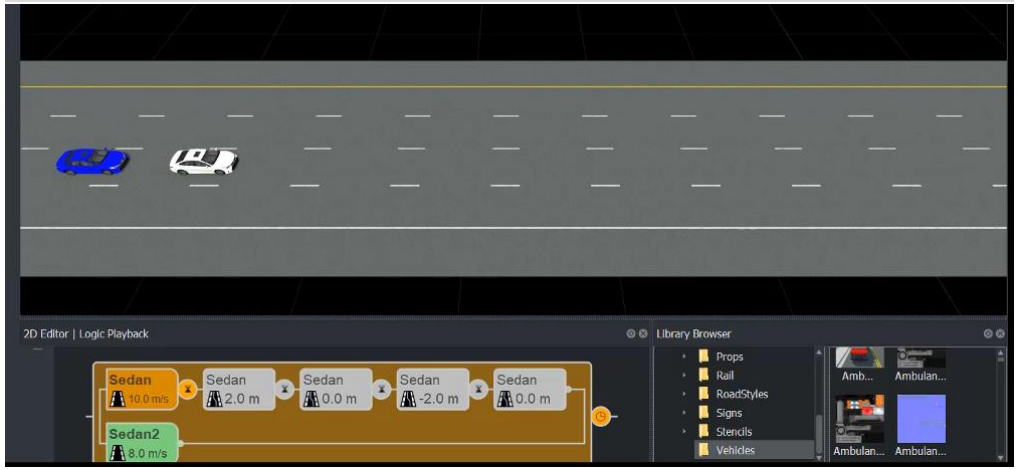


Speed actions



Lane change actions

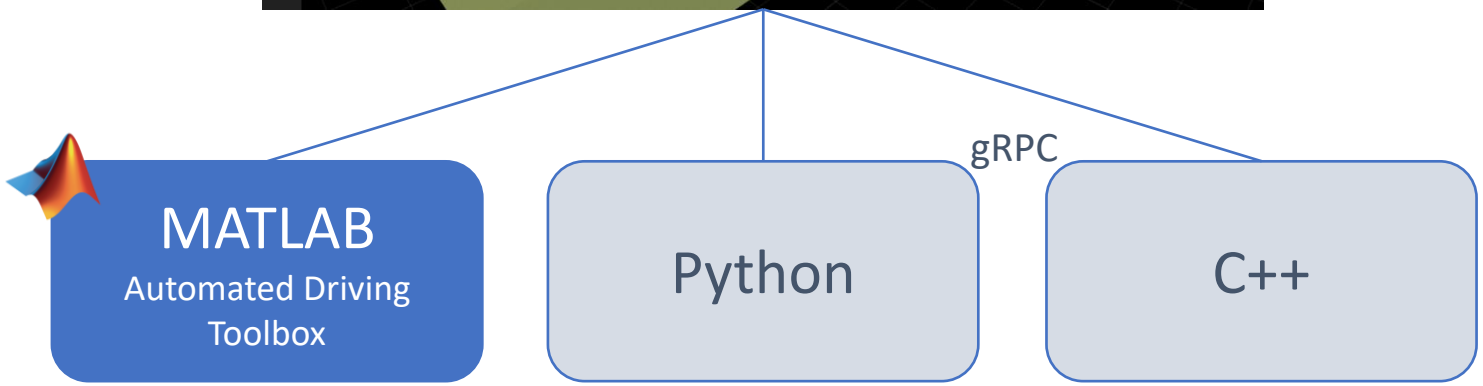
Lateral offset actions



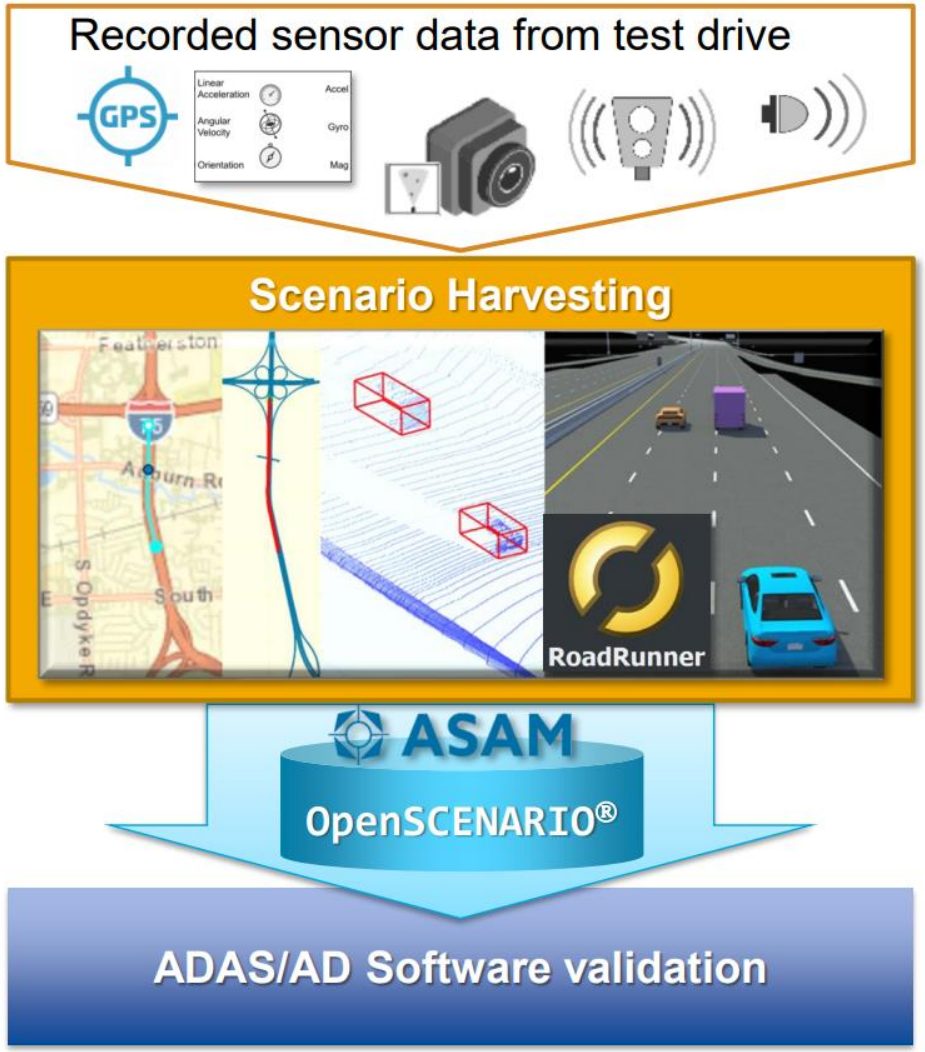
Programmatic Scene and Scenario Management

RoadRuner API

- Starting/Closing RoadRunner
- Change scenario variables
- Running scenario simulations
- Data acquisition such as trajectory and speed
- Export to ASAM formats
- Save/Create/Open
- Plot



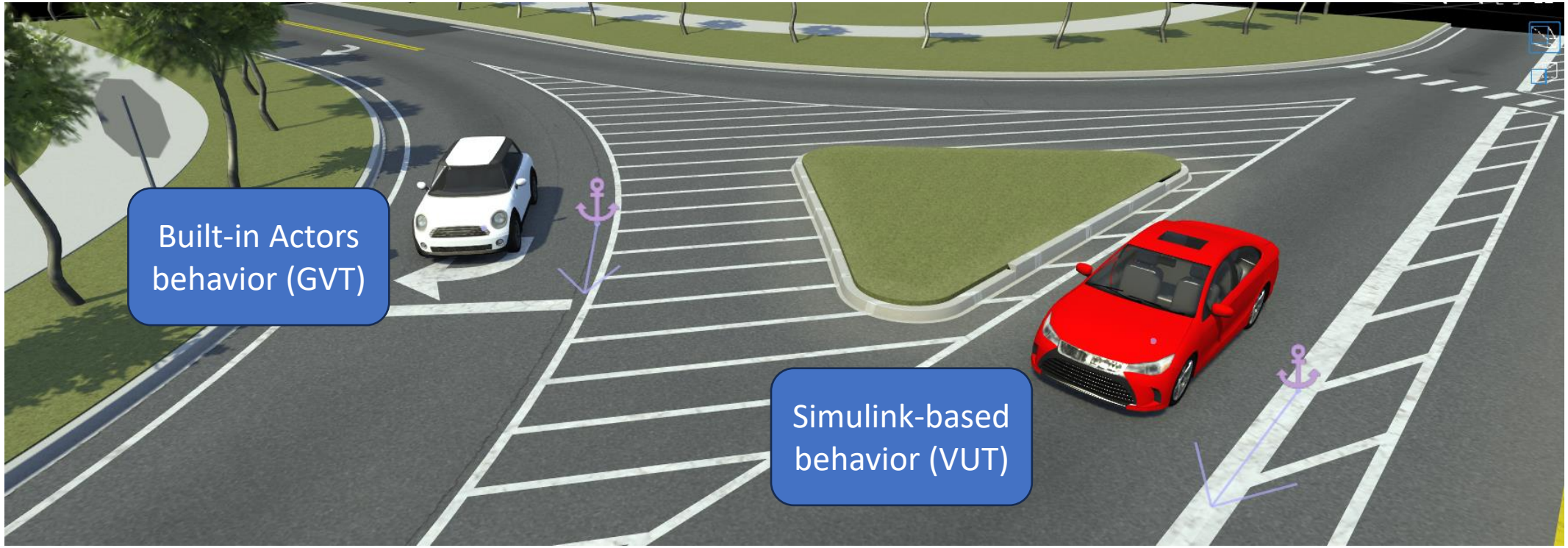
Digital Twin of real-world scenarios



ADAS Simulation Example

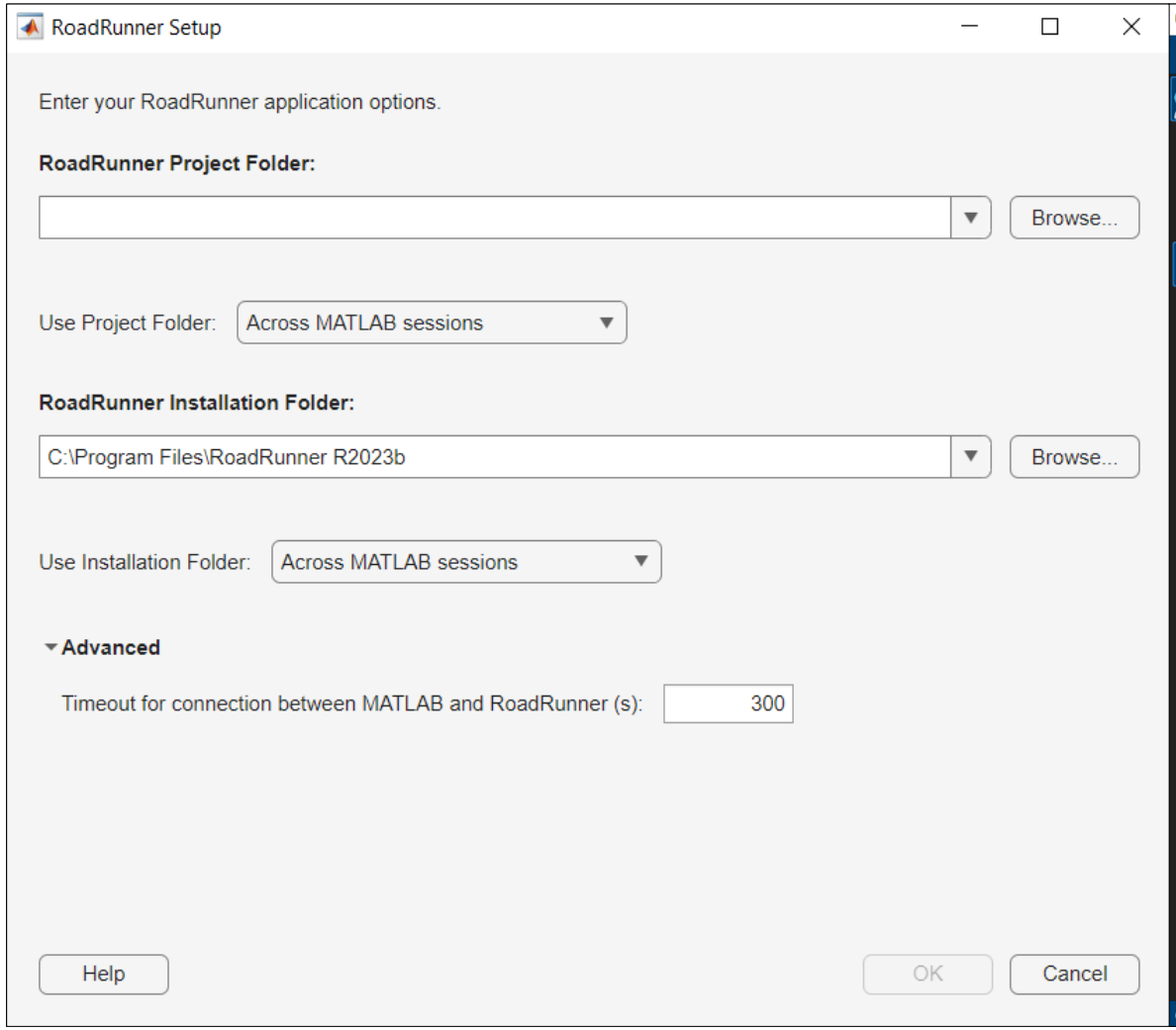
Connection Between MATLAB and RoadRunner

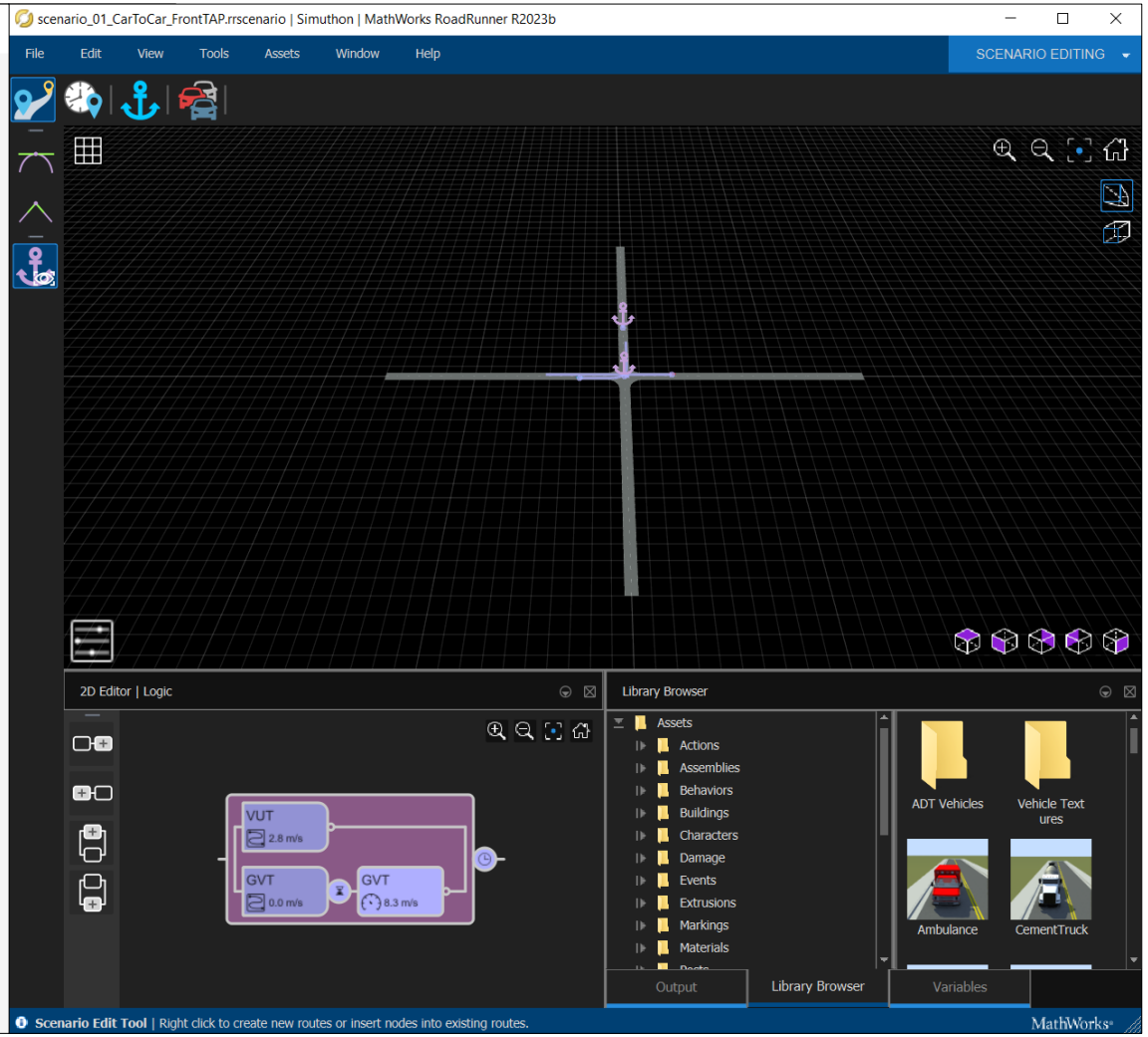
„Ok, I've got the scene and the scenario, now what?"



- **Actors can read:** actions, pose, velocity, actors dimensions, lanes and boudaries
- **Actors can write**: pose and velocity for each scenario simulation step

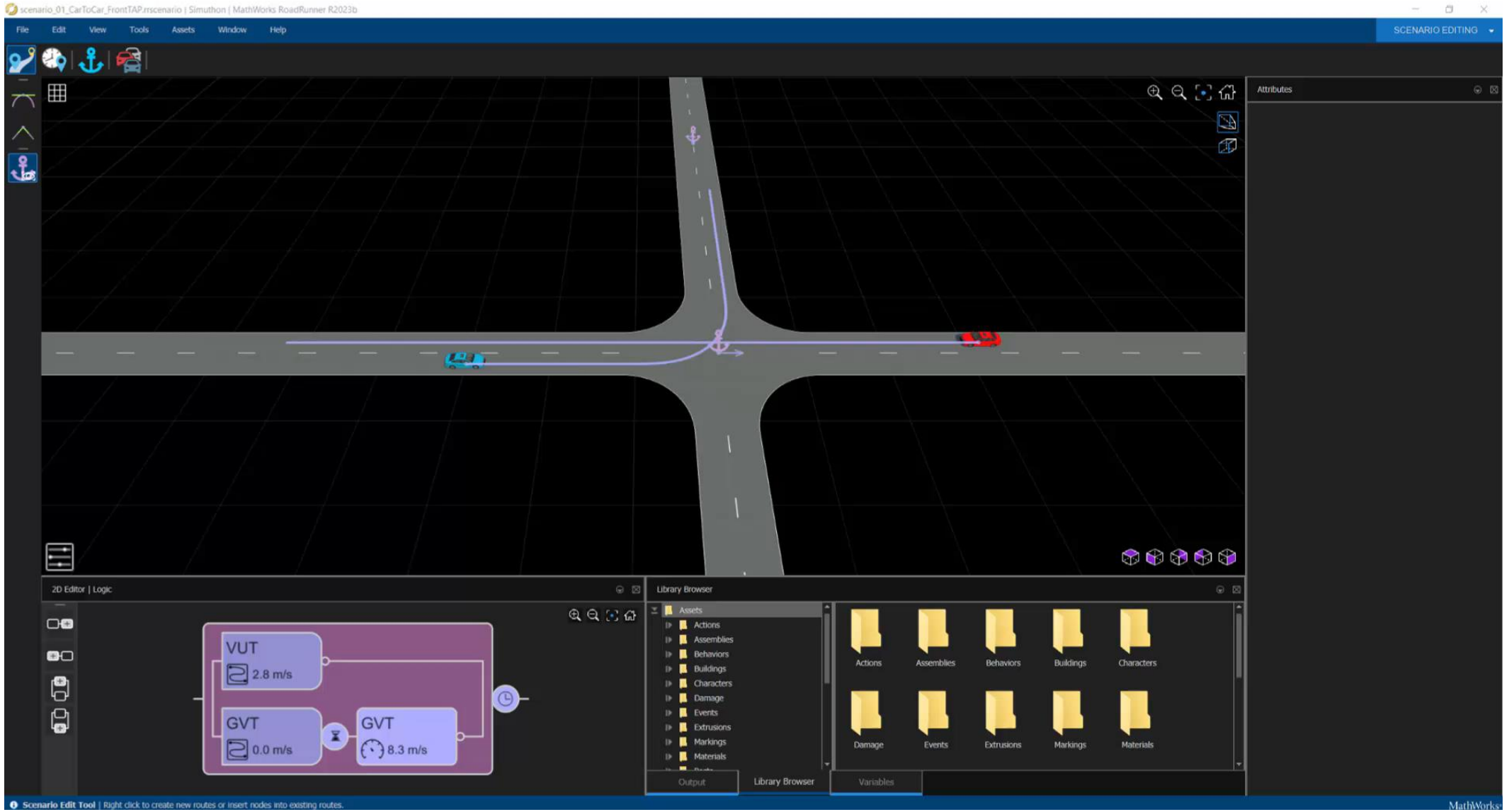
Step 1: Connect MATLAB to RoadRunner



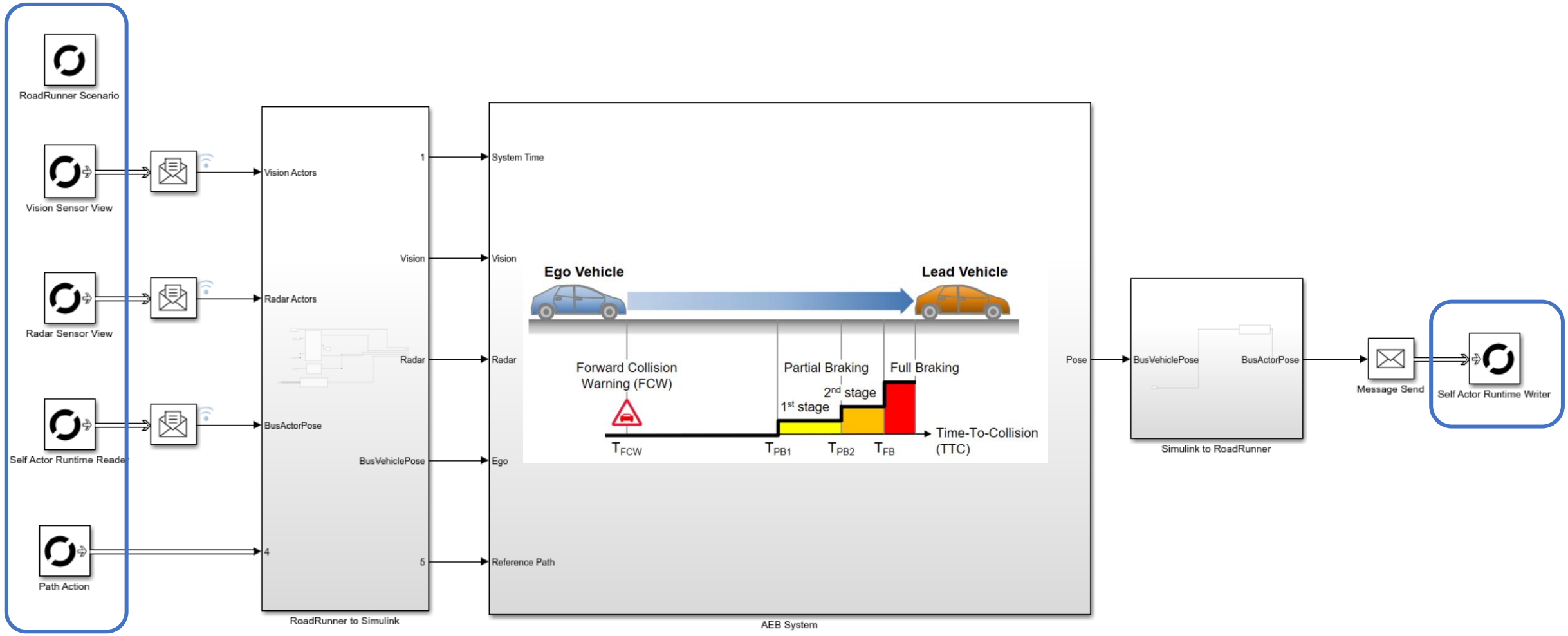



```
» rrApp = roadrunnerSetup
```

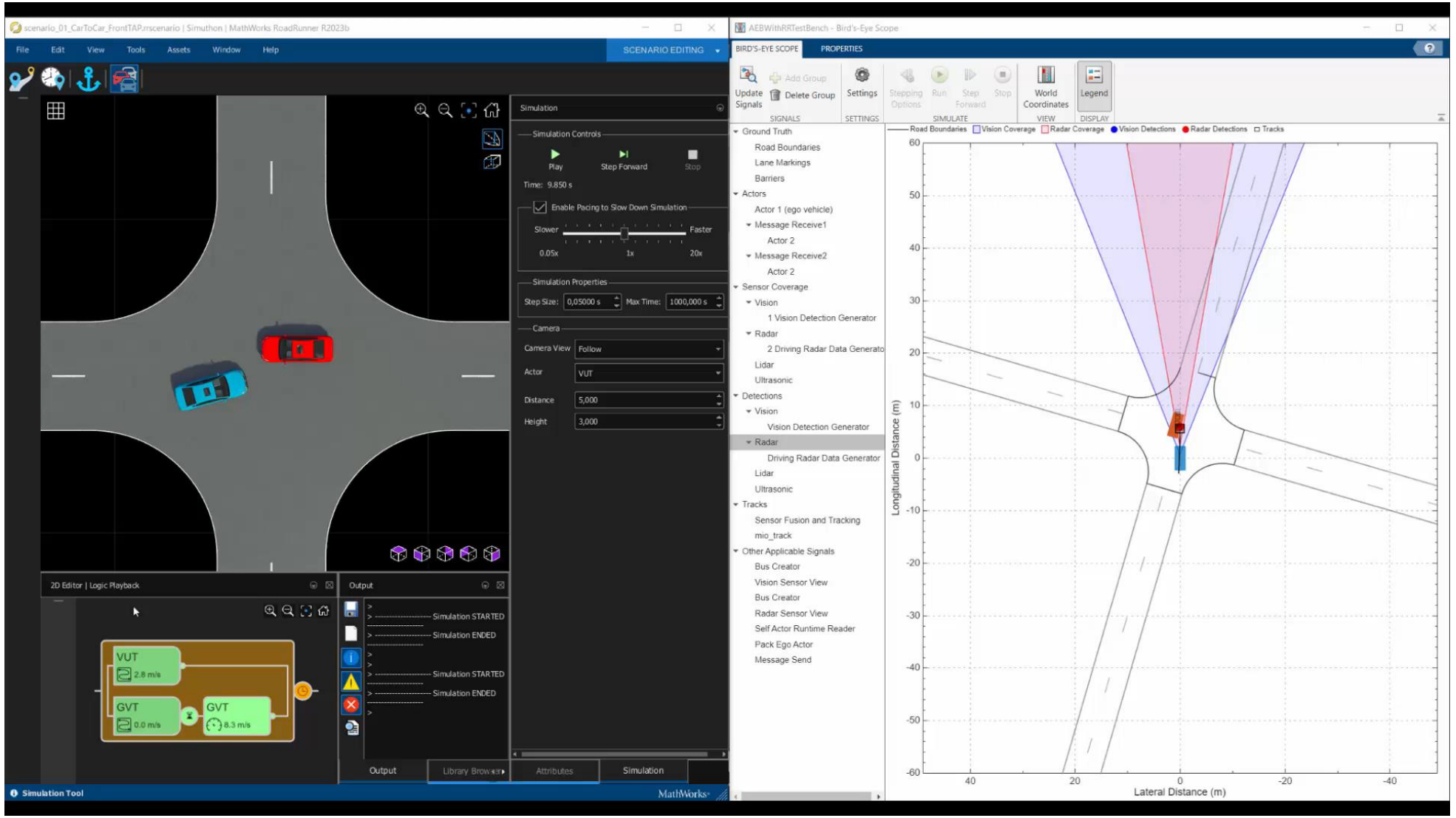
Step 2: Define VUT Behavior – RoadRunner



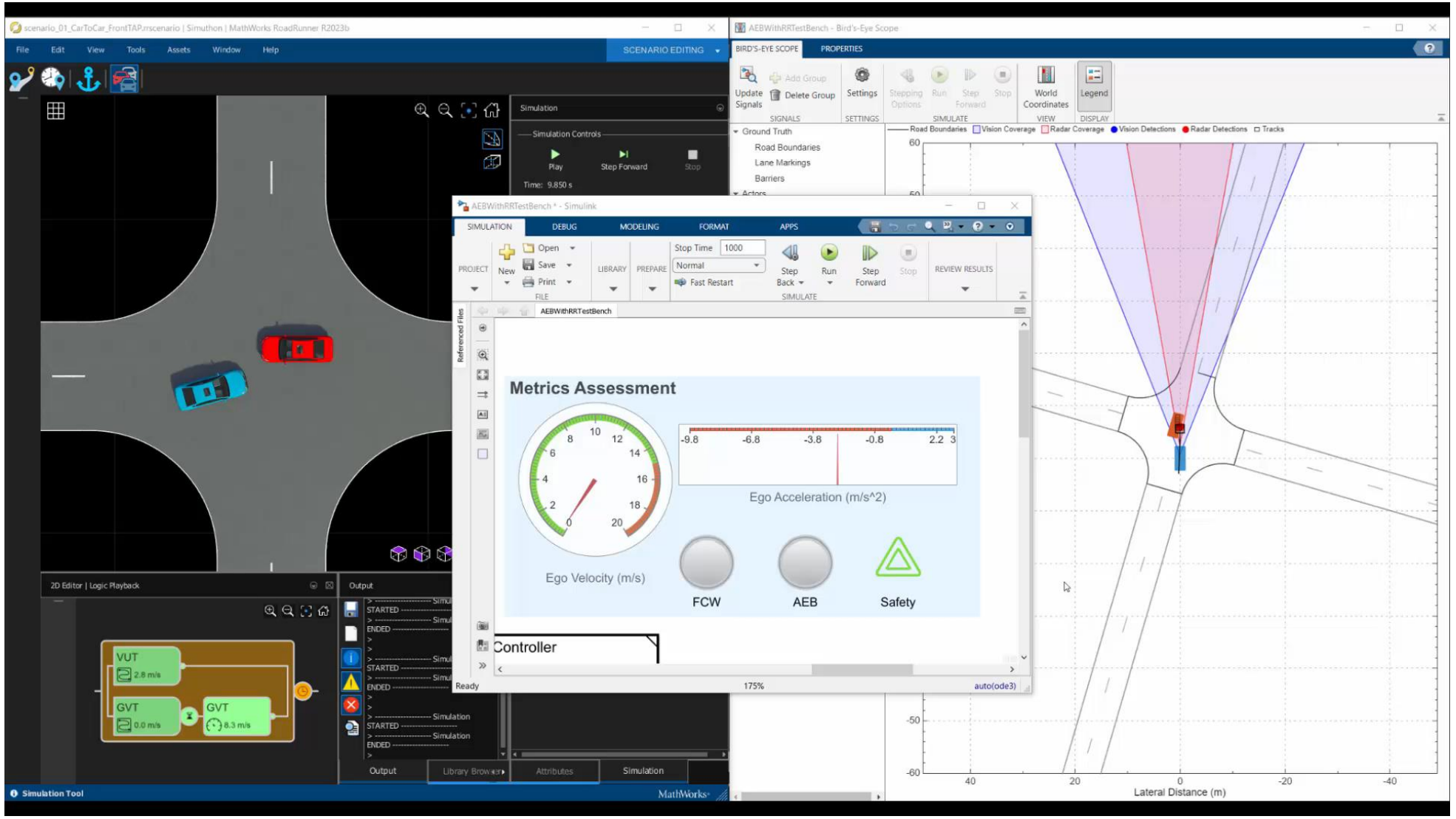
Step 2: Define VUT Behavior – MATLAB & Simulink



Step 3: Run Simulation



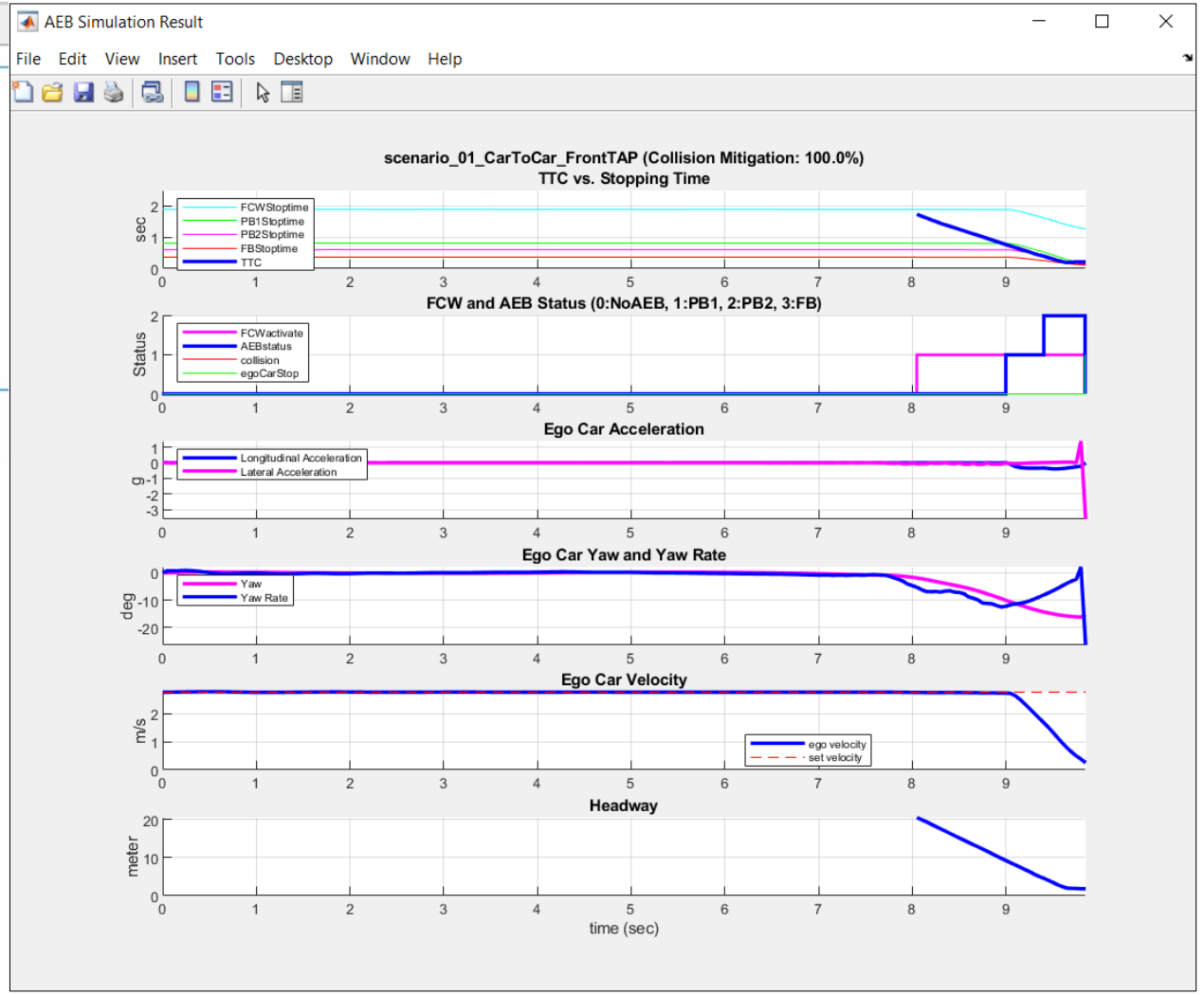
Step 3: Run Simulation



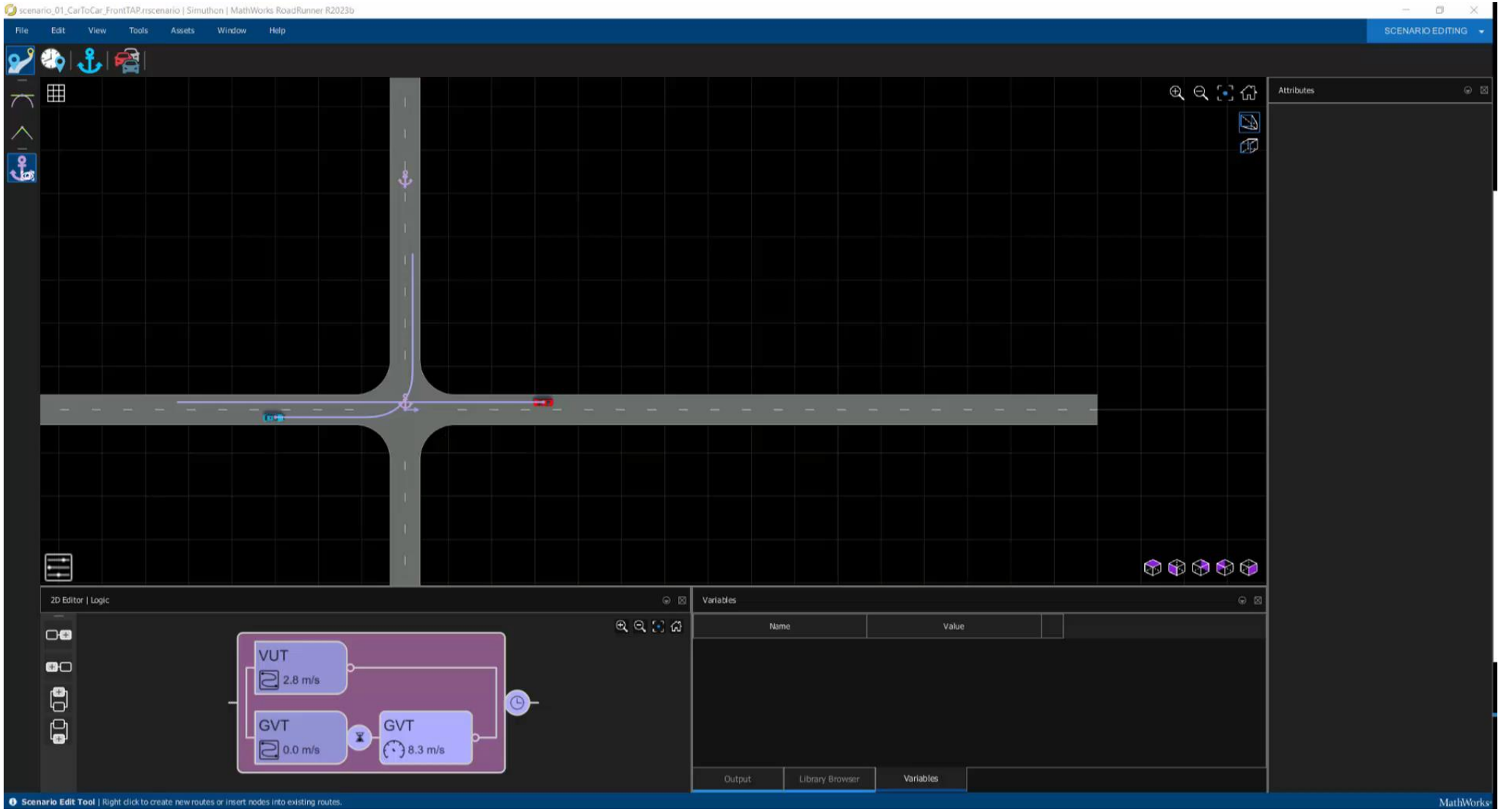
Step 3: Run Simulation – Data Postprocessing

helperSLAEBWithRRSetup.m | helperPlotAEBResults.m

```
function helperPlotAEBResults(logsout, scenarioFcnName)
%helperPlotAEBResults A helper function for plotting the results of the AEB
% example
%   This is a helper function for example purposes and may be removed or
%   modified in the future.
%
% The function assumes that the demo outputs the Simulink log, logsout,
% containing several signals.

% Copyright 2018-2022 The MathWorks, Inc.

if nargin < 2
    scenarioFcnName = '';
end


%% Get the data from simulation
ttc = logsout.getElement('TTC'); % TTC : time-to-collision
FCWtime = logsout.getElement('FCWstoppingTime'); % stopping times
PB1time = logsout.getElement('PB1stoppingTime');
PB2time = logsout.getElement('PB2stoppingTime');
FBtime  = logsout.getElement('FBstoppingTime');


FCWactivate = logsout.getElement('fcw_activate'); % AEB status flags
AEBstatus = logsout.getElement('aeb_status');
collision = logsout.getElement('collision');
egoCarStop = logsout.getElement('ego_car_stop');

longitudinalAcceleration = logsout.getElement('<ax>');  % longitudinal acceleration of ego car
lateralAcceleration = logsout.getElement('<ay>');  % lateral acceleration of ego car

yaw = logsout.getElement('yaw'); % ego yaw rate
yawRate = logsout.getElement('yaw_rate'); % ego yaw rate

ego_velocity = logsout.getElement('ego_velocity'); % velocity of ego car
driver_set_velocity = logsout.getElement('driver_set_velocity'); % driver-set velocity

headway = logsout.getElement('headway'); % headway between ego car and MIO

collisionMitigation = logsout.getElement('collisionMitigation'); % collision mitigation

TTC = ttc.Values.Data;
TTC(TTC>1000) = inf;
```



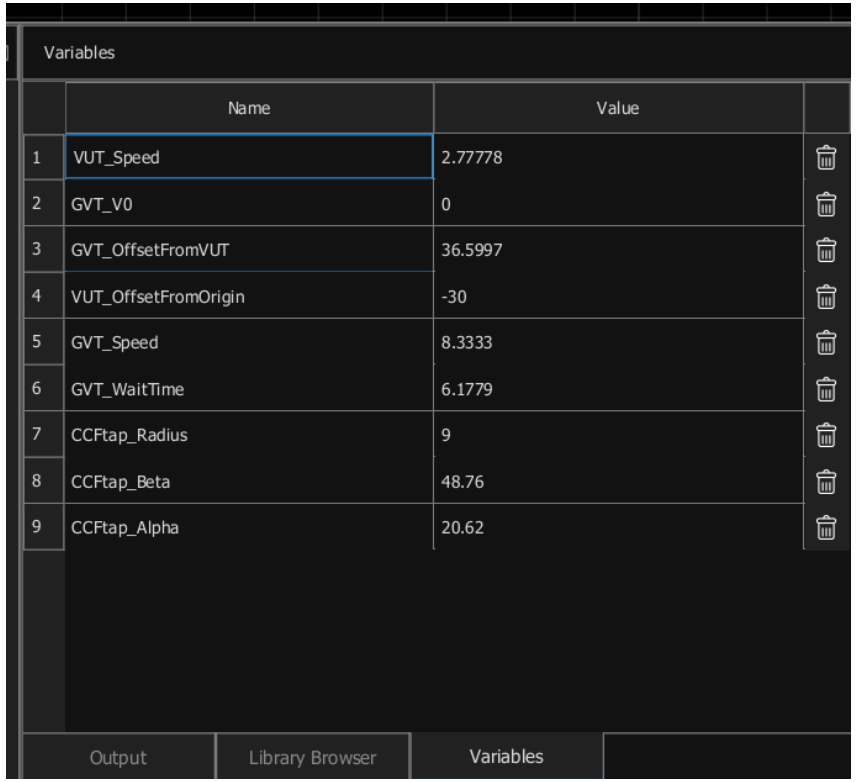
Step 4: Scenario Variation – Variables in RoadRunner



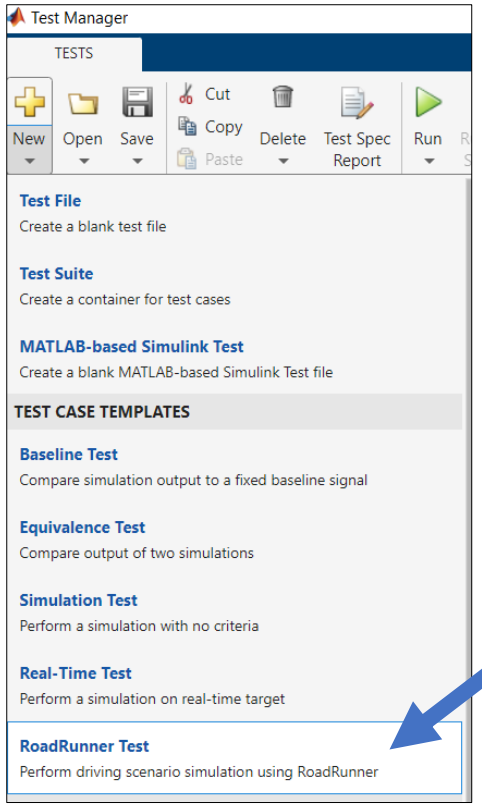
Step 4: Scenario Variation – Variables in MATLAB

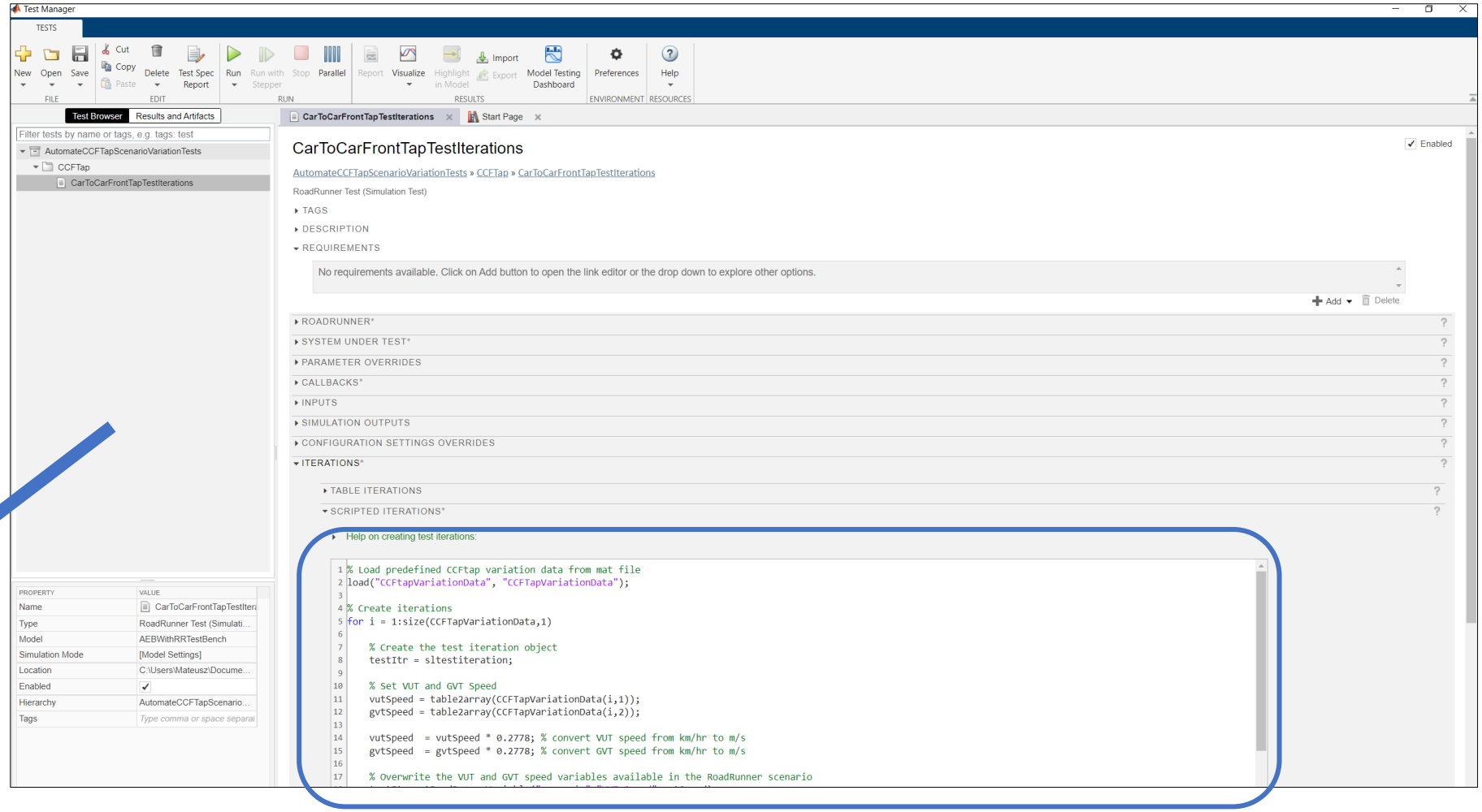
```
%%
load("CCFtapVariationData.mat")
%%
variantID = 9;
vutSpeed = table2array(CCFTapVariationData(variantID,1));
gvtSpeed = table2array(CCFTapVariationData(variantID,2));

vutSpeed  = vutSpeed * 0.2778; % convert VUT speed from km/hr to m/s
gvtSpeed  = gvtSpeed * 0.2778; % convert GVT speed from km/hr to m/s
rrApp.setScenarioVariable("VUT_Speed",num2str(vutSpeed))
rrApp.setScenarioVariable("GVT_Speed",num2str(gvtSpeed))
%%
% 2. Get the GVT wait time value from |CCFtapVariationData|.
%%
gvtWaitTime = table2array(CCFTapVariationData(variantID,6));
%%
% Update the |GVT_WaitTime| variable of RoadRunner Scenario.
%%
rrApp.setScenarioVariable("GVT_WaitTime",num2str(gvtWaitTime))
%%
% Based on the VUT speed, set the Euro NCAP path parameters in the
% RoadRunner Scenario.
%%
rrApp.setScenarioVariable("CCFtap_Alpha",num2str(table2array(CCFTapVariationData(variantID,3))))
rrApp.setScenarioVariable("CCFtap_Beta",num2str(table2array(CCFTapVariationData(variantID,4))))
rrApp.setScenarioVariable("CCFtap_Radius",num2str(table2array(CCFTapVariationData(variantID,5))))
%%
% 3. Run the setup script to initialize the required variables for the test
% bench.
```

vutSpeed	gvtSpeed	vutAlpha	vutBeta	vutRadius	gvtWaitTime
10	30	20.62	48.76	9	6.1779
10	45	20.62	48.76	9	7.4019
10	55	20.62	48.76	9	7.847
15	30	20.93	48.14	11.75	2.2
15	45	20.93	48.14	11.75	3.5
15	55	20.93	48.14	11.75	3.9728
20	30	21.79	46.42	14.75	0
20	45	21.79	46.42	14.75	1.3668
20	55	21.79	46.42	14.75	1.8728

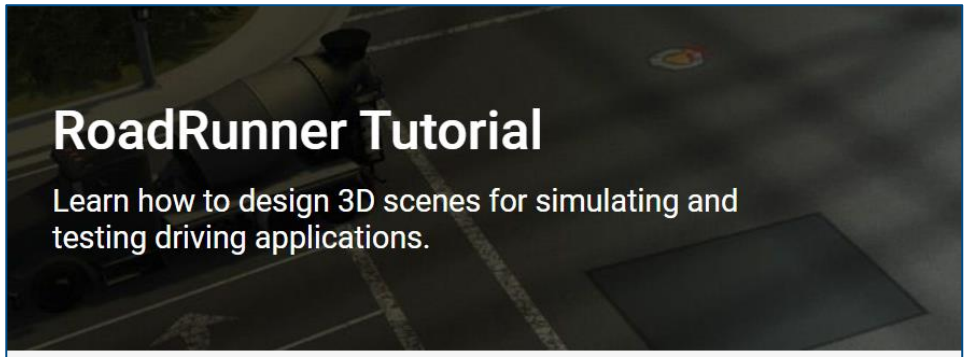


Step 4: Scenario Variation – Simulink Test Manager



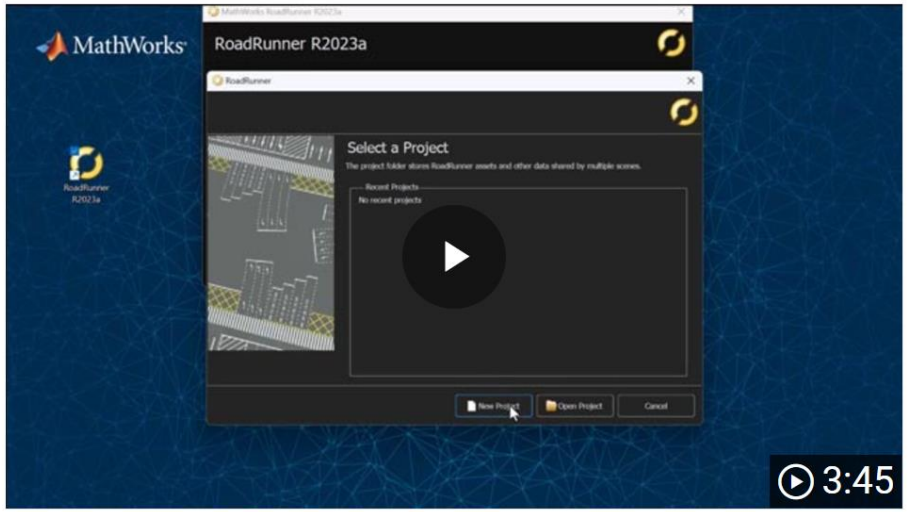


RoadRunner Online Training



1. Launching RoadRunner

RoadRunner is an interactive editor that lets you design 3D scenes for simulating and testing automated driving systems. This module describes how to launch RoadRunner, create a new project and scene, and identify the different panes in the RoadRunner interface.



Summary

- Launch RoadRunner and create new projects and scenes.
- Load prebuilt scenes.
- Identify the toolstrip and other panes in the RoadRunner interface.

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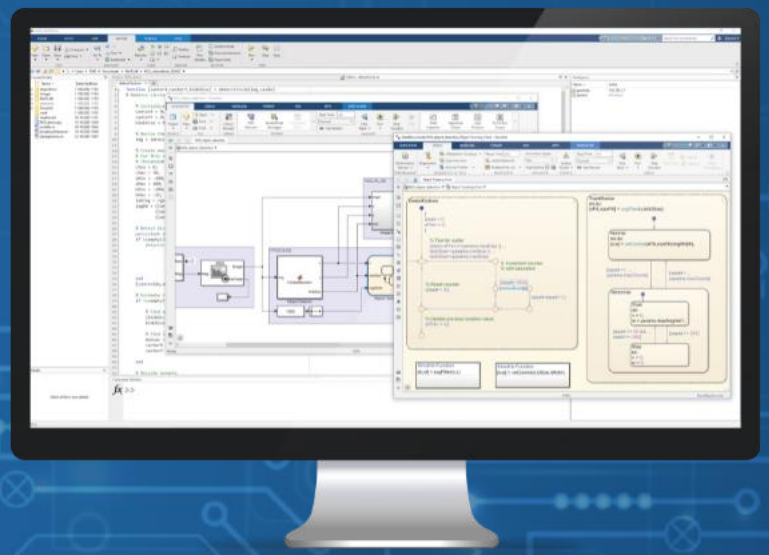

APPLICATIONS

- Robotics and Automation
- Computational Finance
- Autonomous Vehicles
- Electronics
- Artificial Intelligence
- Biomedical Engineering
- Systems Engineering and certification
- Power Electronics and Systems
- Communications and Radar Systems

Let's stay in touch

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