# Testing Adaptive Lane-Change Planners in Realistic Traffic: A Co-Simulation Framework using SUMO, Simulink, and RoadRunner

Philipp Hafemann, Anusha Ailuri, Surya Talluri, Simone Hämmerle and Naga Pemmaraju

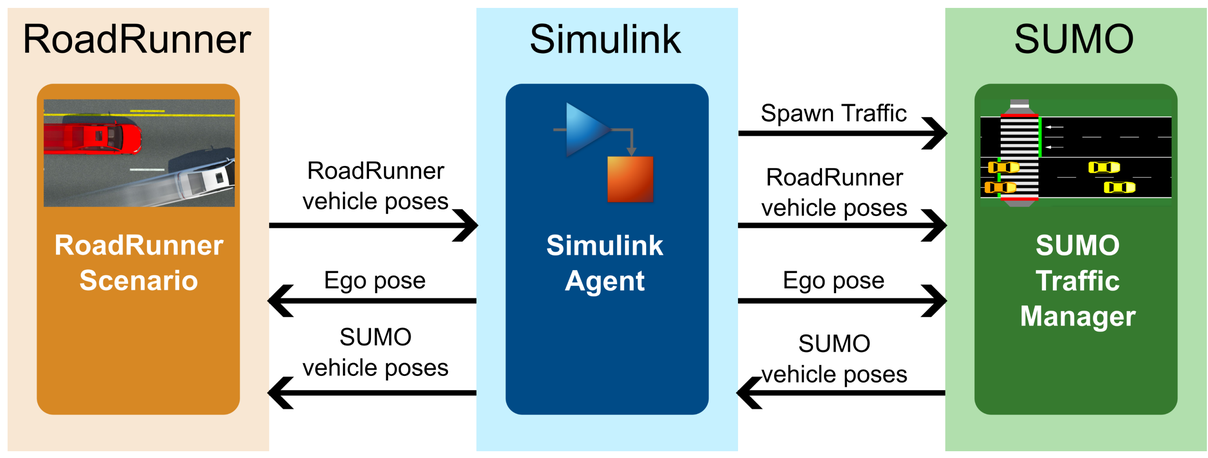
## INTRODUCTION

- ADAS testing often needs a balance between microscopic traffic realism and high-fidelity physics and environment visualization
- This co-simulation framework combines SUMO for realistic and dense traffic simulation, RoadRunner for creating and visualizing scenes and scenarios, and Simulink for the development of specific ADAS algorithm and functions
- Closed-loop simulation environment allows for early testing of ADAS functions, e.g., a Highway Lane Change planner in complex maneuvers under realistic traffic conditions

## OBJECTIVES

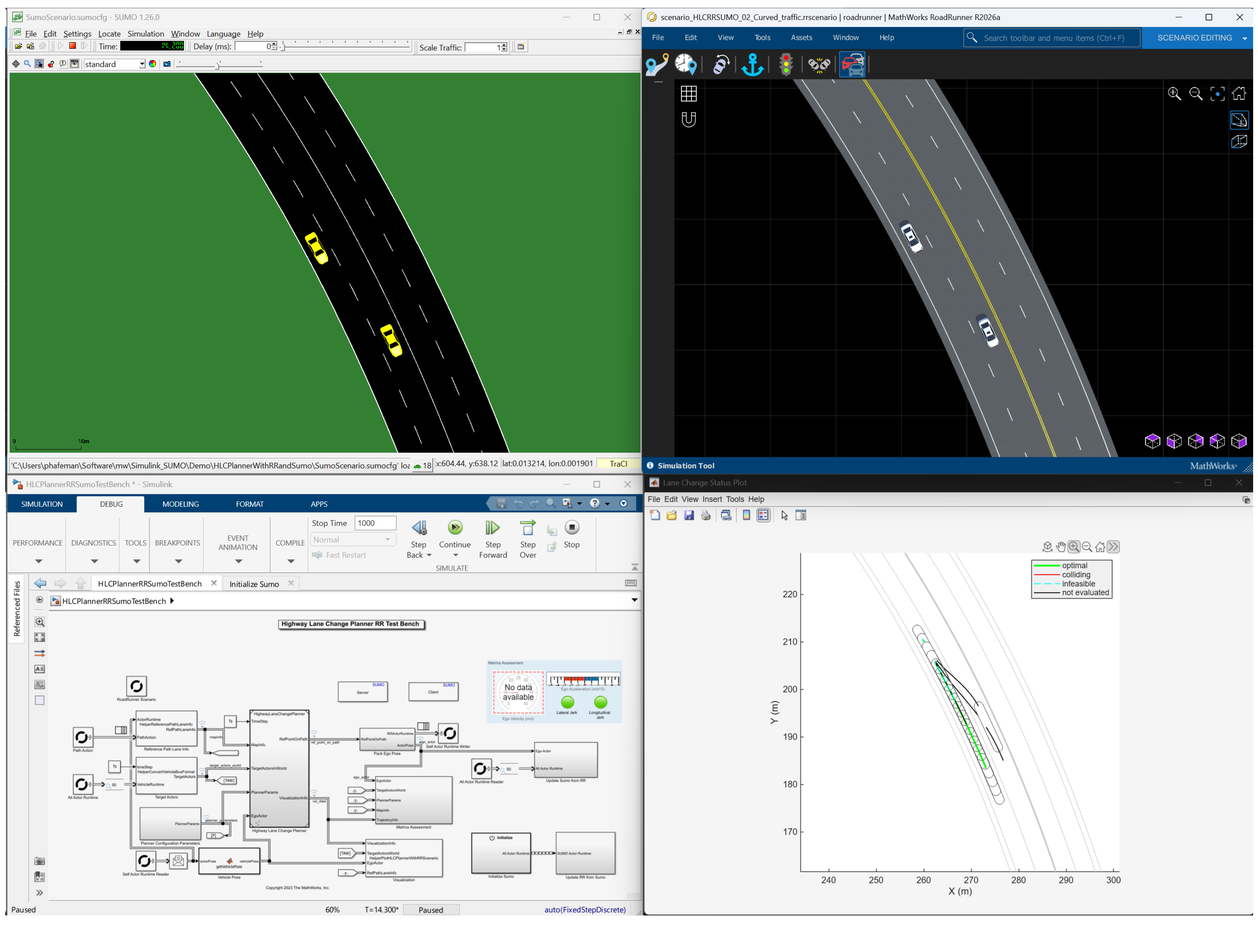
- Validate ADAS and autonomous driving systems in realistic traffic conditions
- Combine SUMO's detailed traffic modeling with Simulink as simulation environment
- Accelerate research and prototyping with an integrated simulation environment for closed-loop algorithm testing

## METHOD



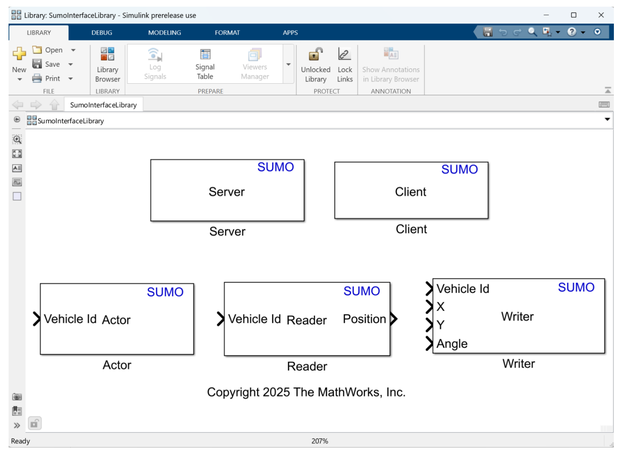

- Client-server architecture with SUMO as traffic server and Simulink as central client
- Road network is imported via RoadRunner OpenDRIVE export to SUMO
- Synchronized time-stepping between discrete traffic updates and continuous trajectory planning
- Sampling-based approach for trajectory planning using SUMO actors poses
- Closed-loop interaction between ego-vehicle logic and microscopic traffic flow

## RESULTS




- Closed-loop co-simulation synchronizes ego and traffic actors across SUMO, Simulink, and RoadRunner
- Dense-traffic lane-change scenarios are reproducible and replayable with adjustable traffic density
- Frenet-based lane change planner behavior can be stressed to reveal edge cases that are hard to reproduce in single-tool simulations
- Safety metrics (e.g., time-to-collision and comfort bounds) can be verified automatically across traffic densities

## TECHNICAL IMPLEMENTATION




- Connection to SUMO via TCP/IP-based message blocks
- Coordinate transformation between RoadRunner and SUMO reference frames
- Real-time actor matching (ID, position, speed)
- Ego pose injection into SUMO engine using Writer blocks
- Dynamic actor management (spawning, removing) for cross-platform consistency in visualization

## CONCLUSION

- We present a SUMO-Simulink-RoadRunner co-simulation framework for closed-loop validation of a highway lane-change planner in dense traffic
- Native Simulink-to-SUMO communication blocks enable repeatable testing to identify edge cases and verify safety metrics across traffic densities

## Contact Information

Dr. Philipp Hafemann
Senior Application Engineer Automotive, The Mathworks GmbH
phafeman@mathworks.com

## REFERENCES

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