



Co-simulation of the virtual vehicle in virtual traffic considering tactical driver decisions

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Vehicle
simulation
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How do automated vehicles influence road capacity?

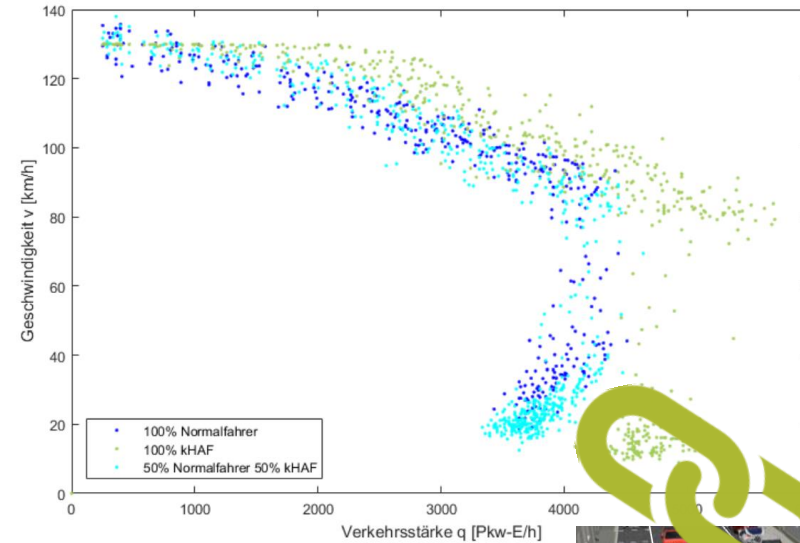
⇒ Microscopic traffic flow simulation, e.g. SUMO

What sensor set is necessary for the driving function to work safely?

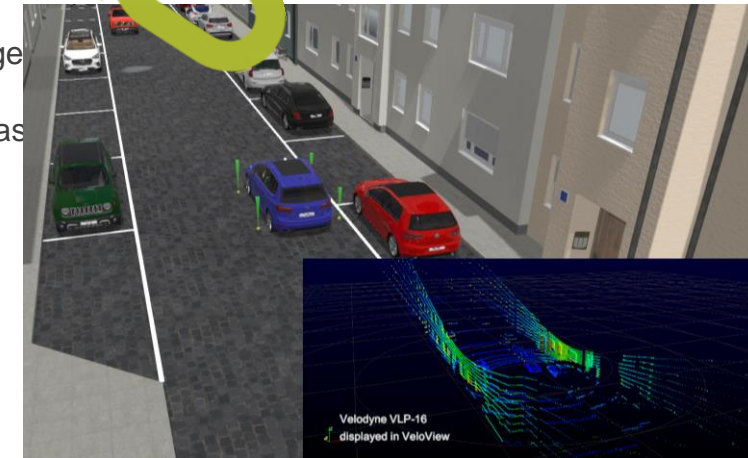
⇒ Vehicle and environment simulation, e.g. DYNA4

How does traffic influence the efficiency of assisted and automated driving?

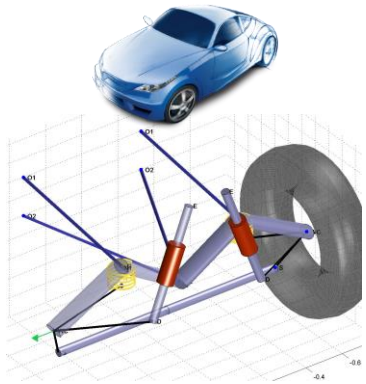
⇒ DYNA4 + SUMO



Source: Krause et al., Auswirkungen hochautomatisierten Fahrens auf die Kapazität der Fernstraßeninfrastruktur

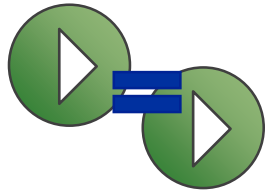


Vehicle Simulation vs. Microscopic Traffic Flow Simulation



virtual vehicle DYNA4

virtual vehicle with high fidelity driving dynamics, MBS axles, drivetrain and sensor models
→ yaw rate, wheel rotation...



testing in deterministic scenarios for accurate reproducibility

direct support of OpenDRIVE road format

integration of vehicular control systems from MiL to HiL for ECU tests



the virtual vehicle



in

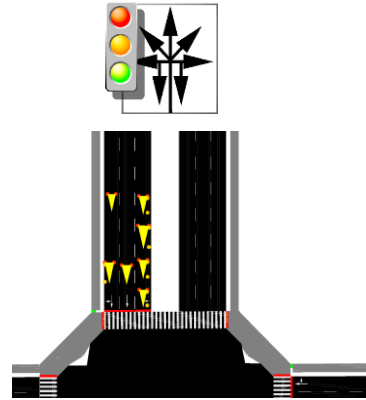
SiL integration of traffic signal controllers



the virtual traffic

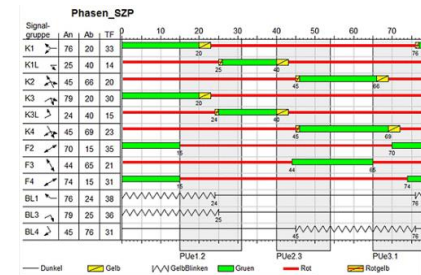
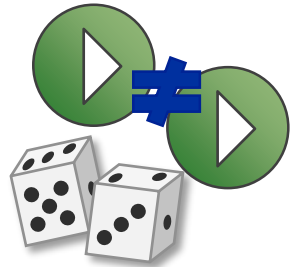
virtual traffic SUMO

hundreds of vehicles with human-like car following and lane changing behavior
→ number of stops, travel times, ...

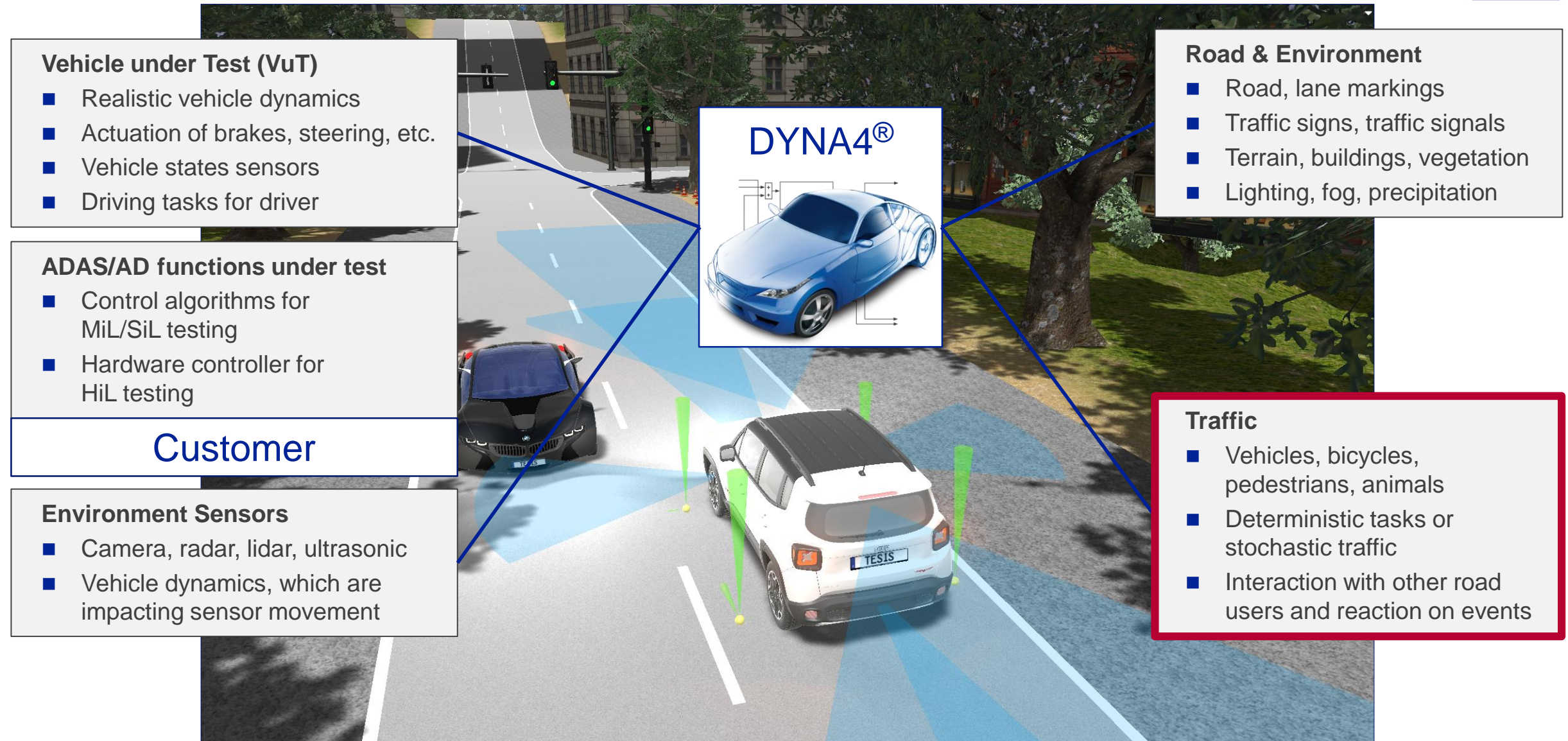


stochastic traffic scenarios to account for variation in real world

included conversion from OpenDRIVE format



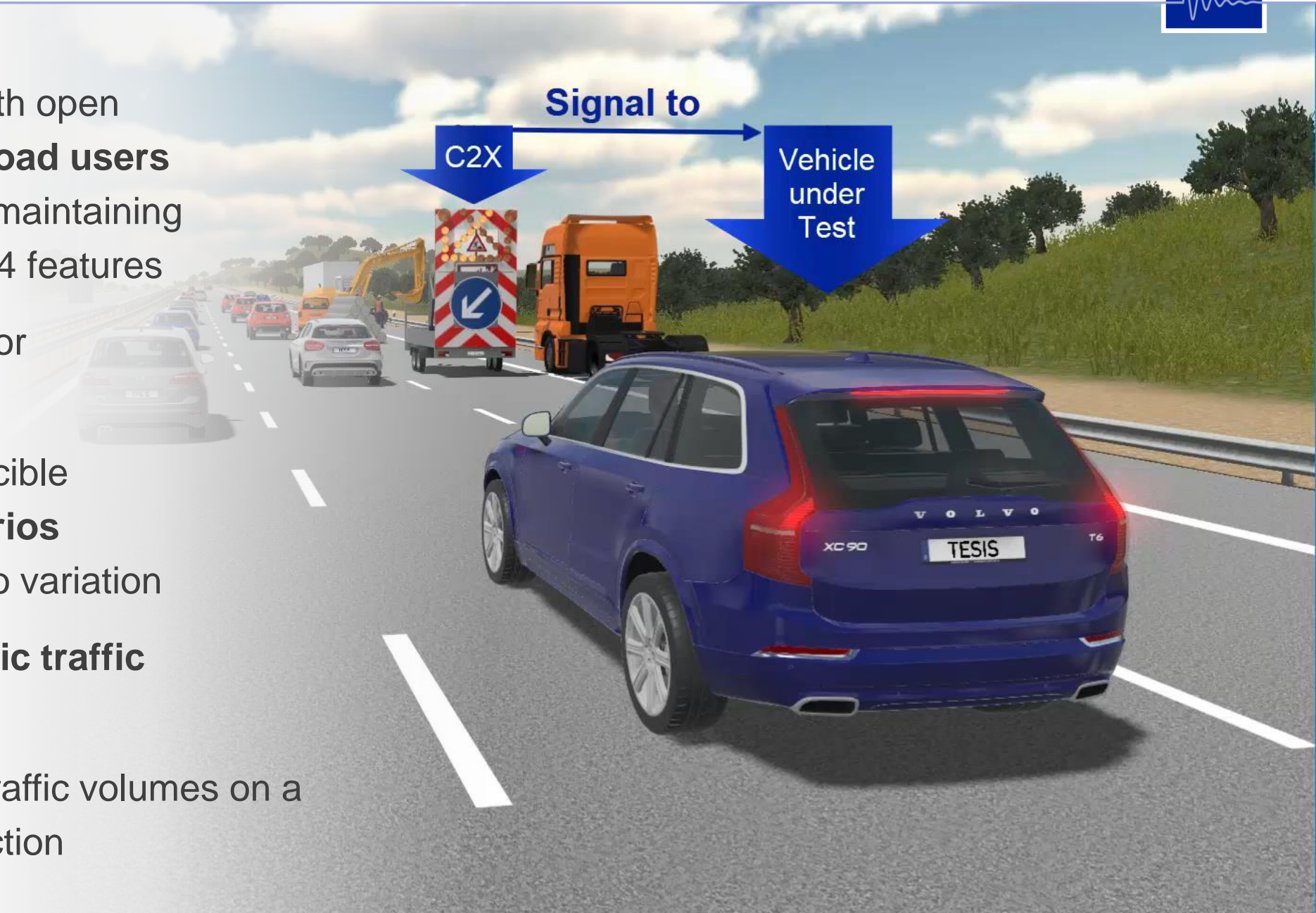
Key Components for Virtual Testing of ADAS and Automated Driving



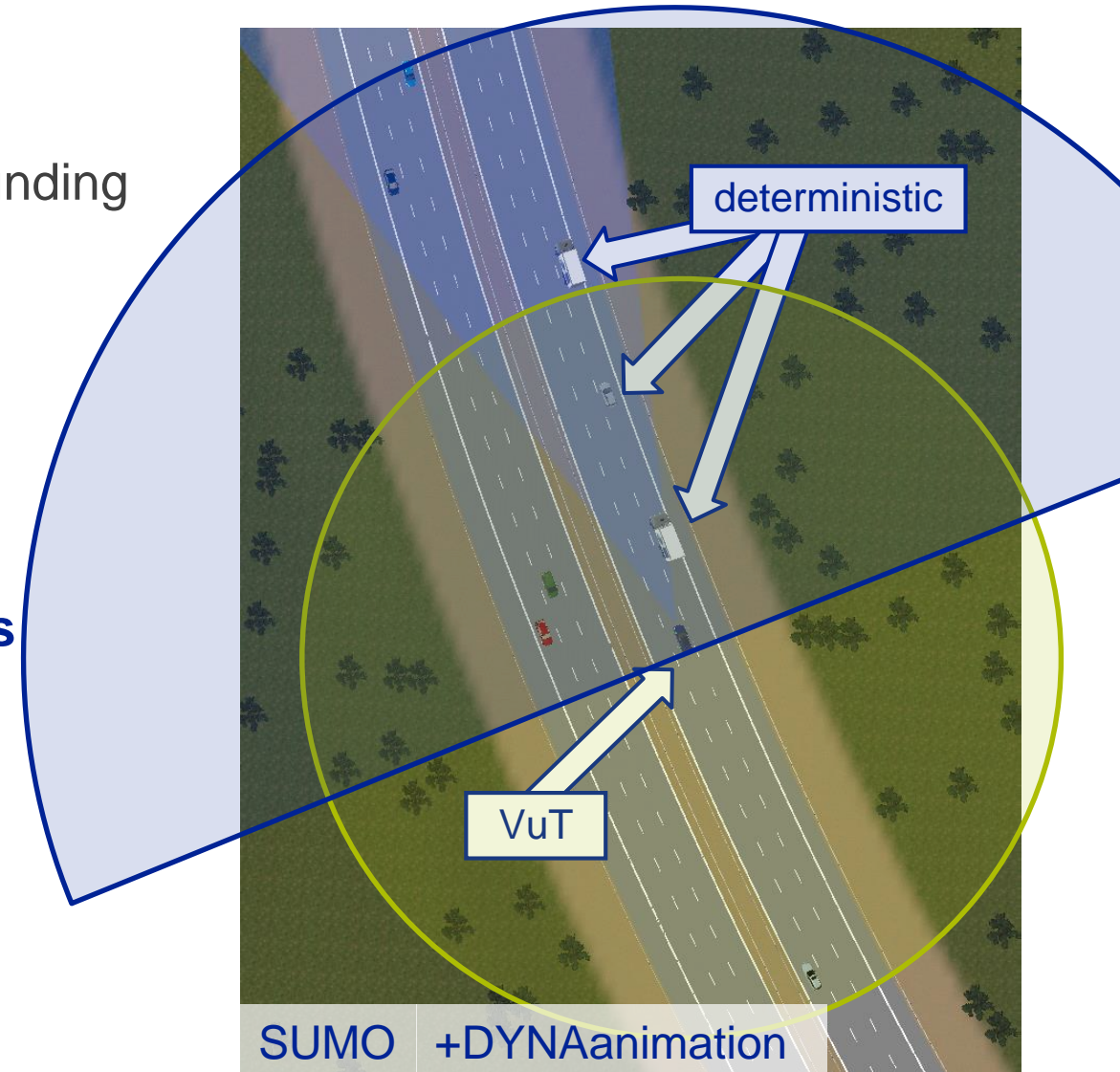
- Assign **paths or routes** to traffic participants
- Use deterministic events to **trigger longitudinal or lateral driving tasks** such as lane changes
- Control **lighting and weather** of the scene in simulation scenarios



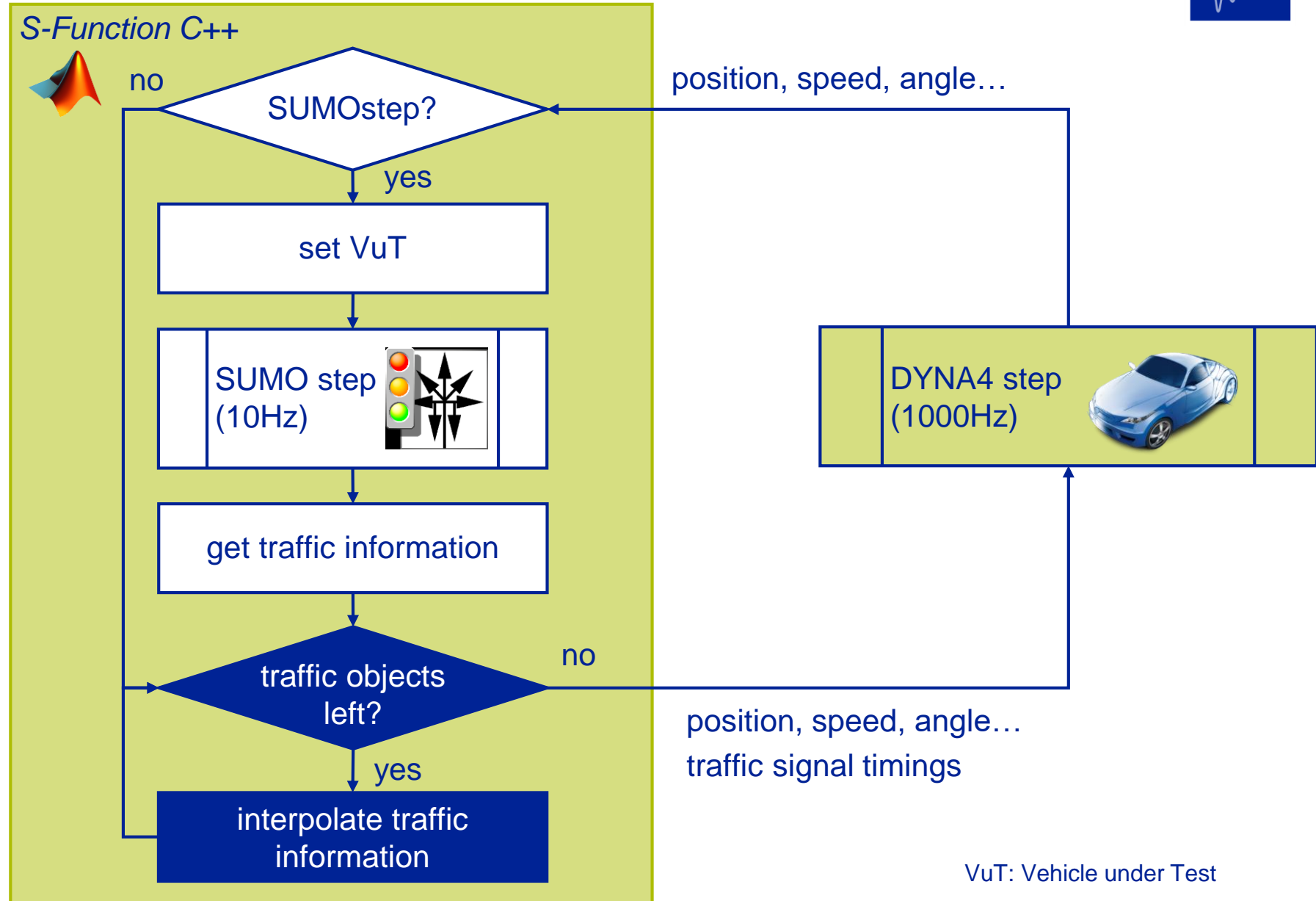
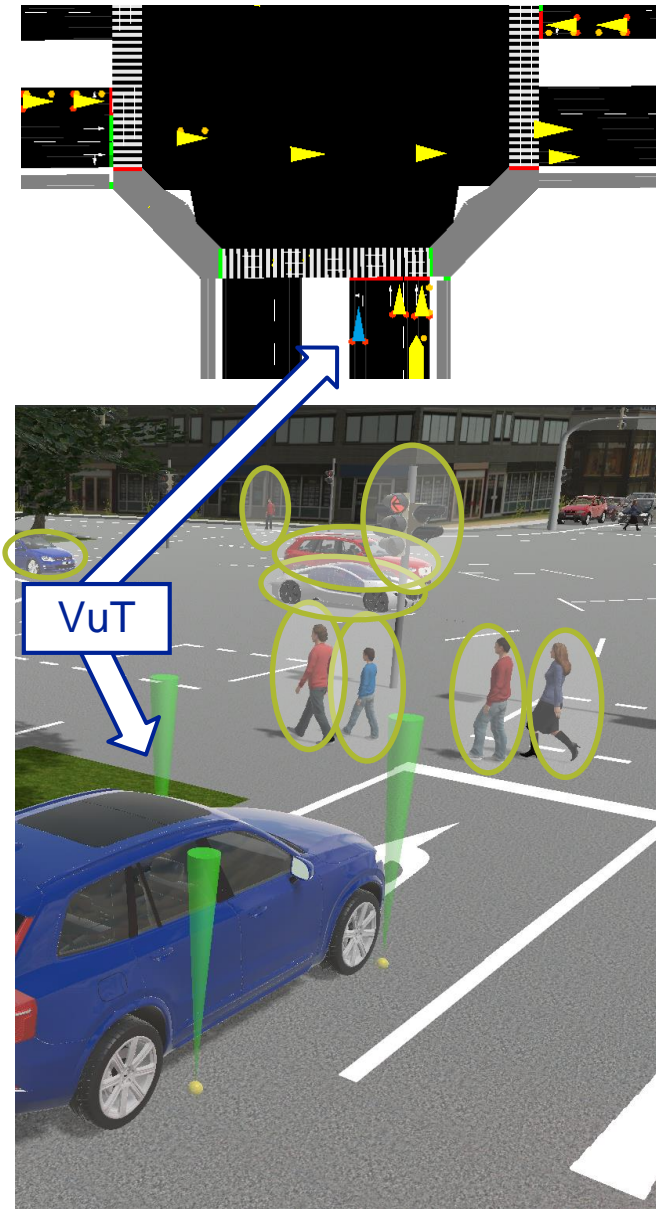
- Simulink traffic block with open **interfaces to control road users** with external software, maintaining full availability of DYNA4 features
- Ready-to-use solution for **SUMO**
- Stochastic, yet reproducible **complex traffic scenarios** with „one-click“ scenario variation
- Combining **deterministic traffic with stochastic traffic**
- Example: Influence of traffic volumes on a cooperative driving function



- ➔ **performant subscription to traffic objects** surrounding VuT with optional semi-circle extension
- ➔ combination with additional **deterministic traffic** by DYNA4
- ➔ full availability of DYNA4 features including **Simulink-based sensors** and **GPU-based sensors** by looping SUMO traffic through DYNA4 traffic
- ➔ **modular integration of SUMO** by using C++ TraCI API within Simulink S-Function



Co-Simulation of DYNA4 and SUMO (II)



Enhancing a Driver Model in times of AV?



Emlin Daw And stay on the middle line with nobody on right line...

Gefällt mir · Antworten · 5 W



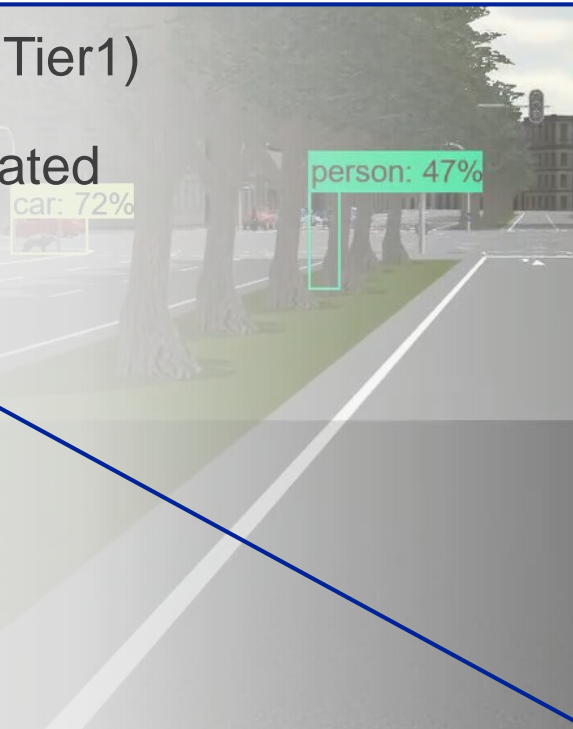
Jonathan Riley Bloody middle lane hoggers !! 😂😂

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different companies (OEM vs. Tier1)

- Early testing of parts of automated driving functions
- Example: Object detection in urban scenario



Virtual test driving on OpenDRIVE motorway with DYNA4 and SUMO traffic

Mehr dazu



2 Kommentare 1 Mal geteilt

Gefällt mir

Kommentieren

Teilen

Relevanteste zuerst ▾



Kommentieren ...



Emlin Daw And stay on the middle line with nobody on right line...

Gefällt mir · Antworten · 5 W

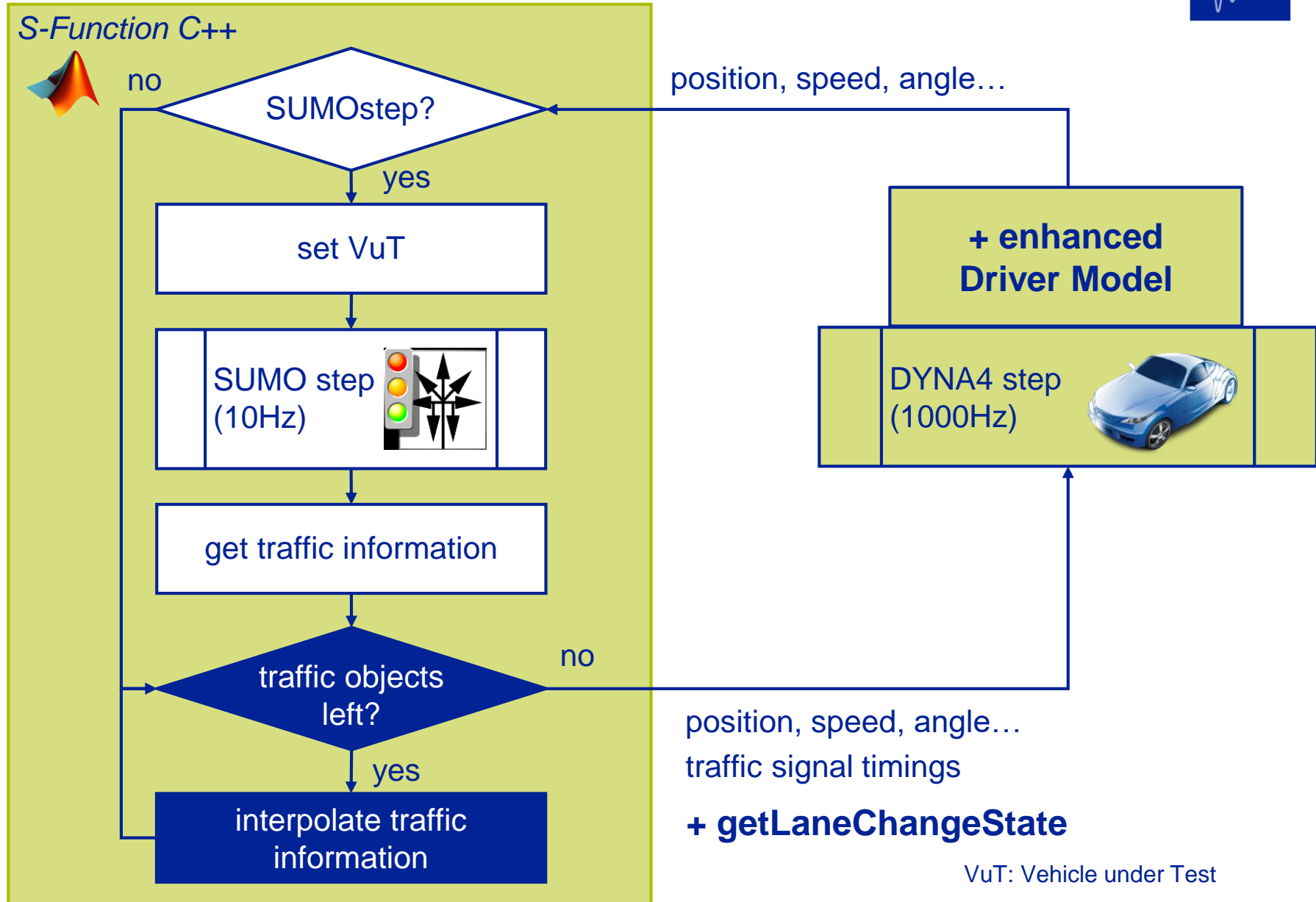
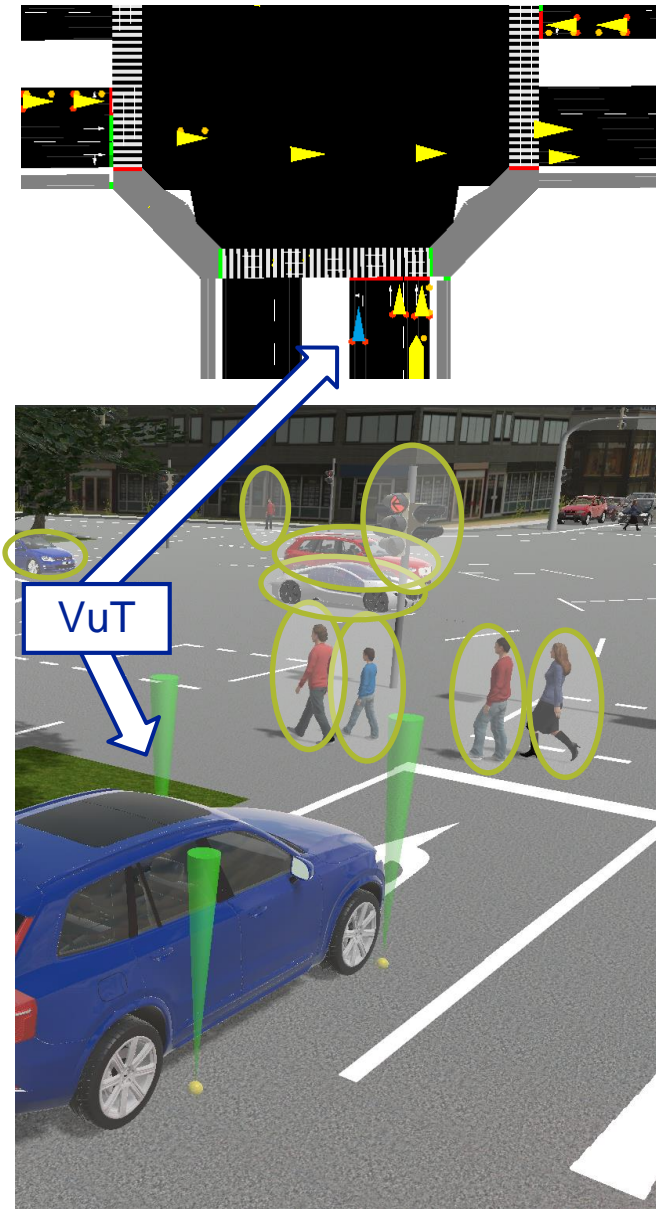


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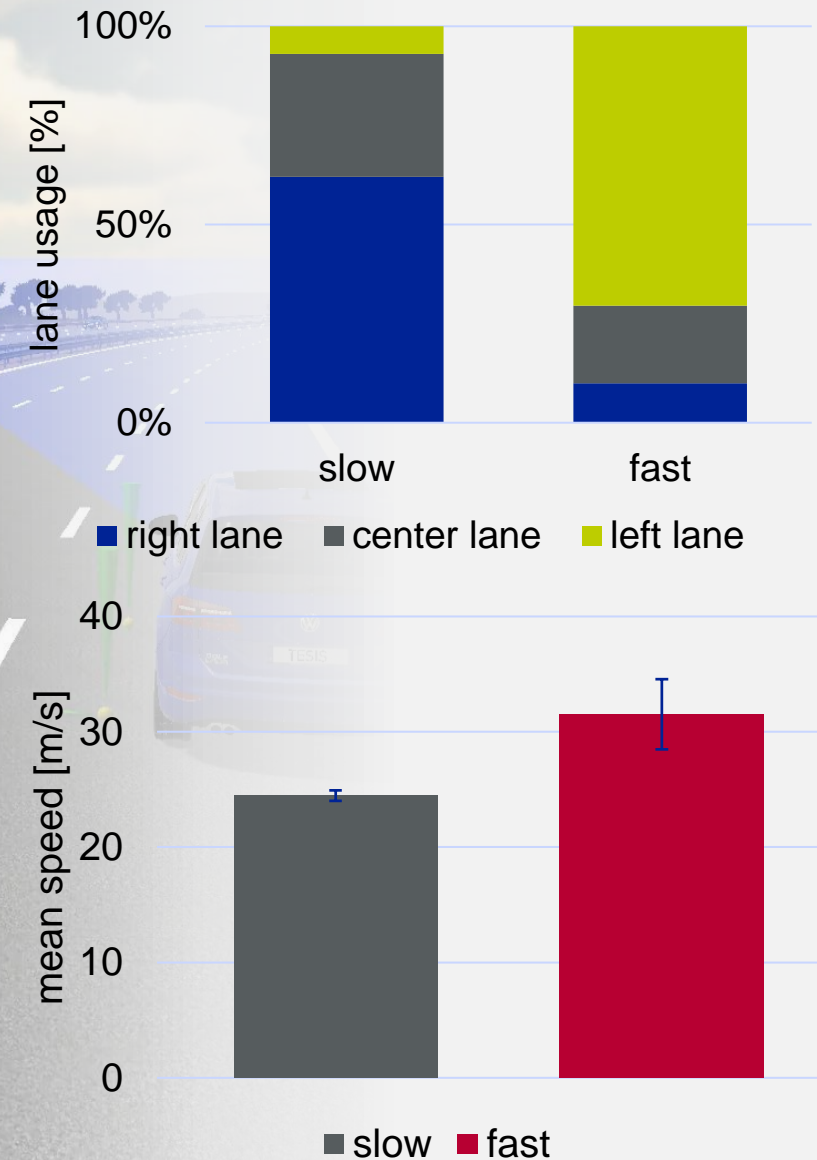


Including Tactical Lane Changes from SUMO



Tactical Driver Decisions for Lane Changing

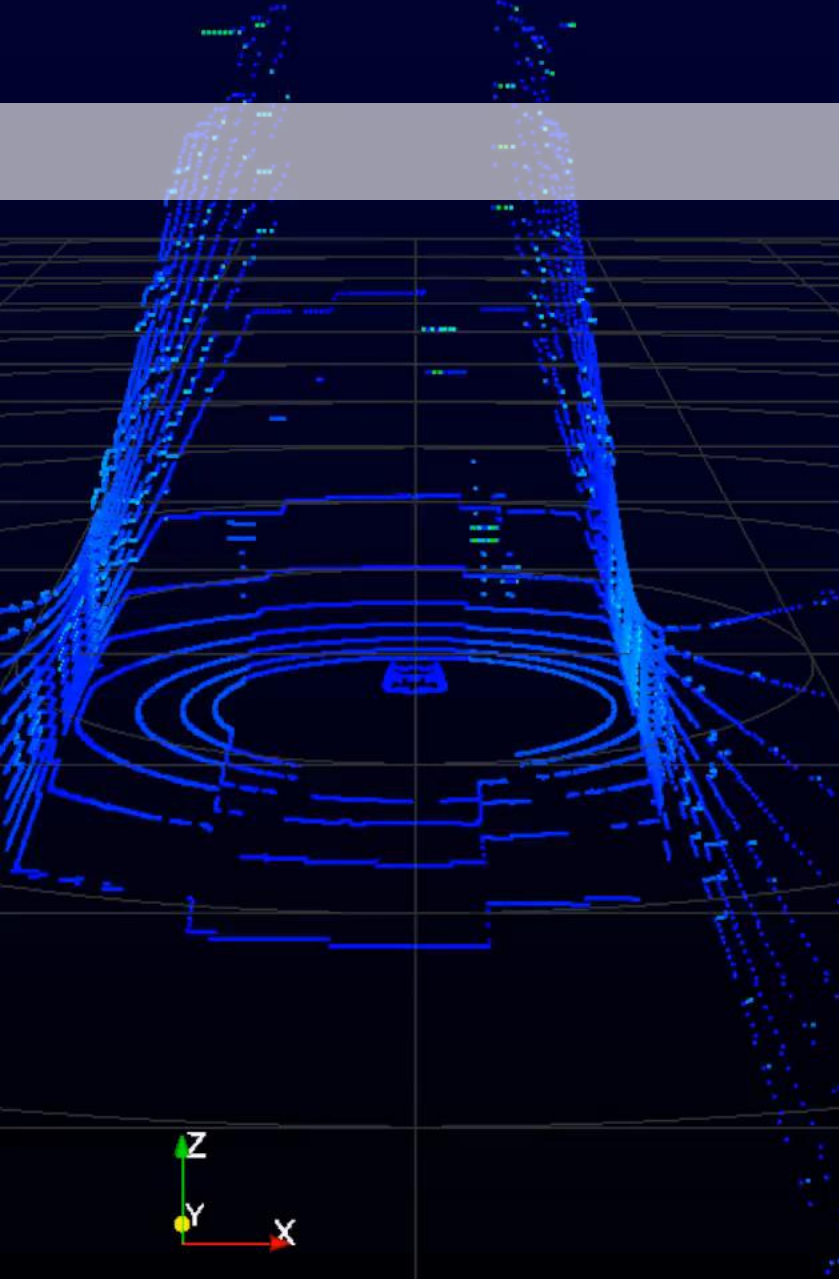
- Successful integration of SUMO's tactical lane choices
- At times behavior can be observed that purely SUMO controlled vehicles would not show
- SUMO lane-change parameters can be used to influence the Vehicle under Test efficiently



- DYNA4 and SUMO Co-Simulation extended by combining SUMO's tactical behavior with DYNA4's operational behavior
- In-depth analysis of information quality after moving Vehicle under Test (currently skipping move improves quality)
- Extension to SUMO's driver reaction on traffic signals and right-of-way (currently no TraCI equivalent to getLaneChange)
- Evaluate possibility to switch to libsumo to avoid TraCI communication overhead



Thank you for your attention!



Velodyne VLP-16 displayed in VeloView