

CLOSED-LOOP TESTING OF AUTOMATED DRIVING FUNCTIONS ON NDS MAPS USING OPENDRIVE

EF-251

MOTIVATION

SAE Level 0-2

- Support the driver
- Monitored by the driver
- Onedimensional movement
- Driver is fully responsible

SAE Level 3-5

- Driver needs to take over when asked
- Function drives autonomously
- Localisation with GNSS shortages and blocked line of sight
- Independend movement

Need for sophisticated ground truth

Convert artificial world
to simulation

Convert real world to
simulation

Headunit

NDS Map

ECU under
Test

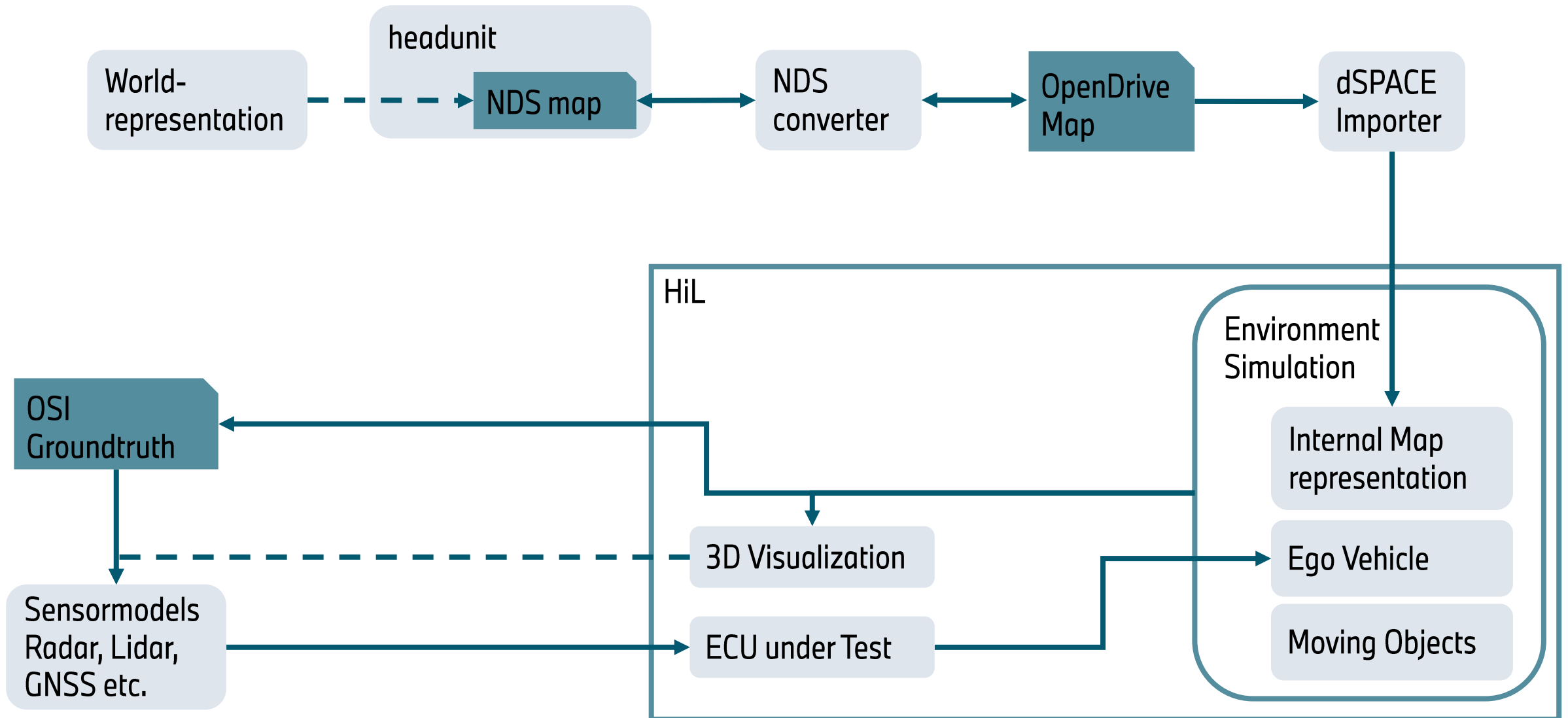
Simulated World

Map

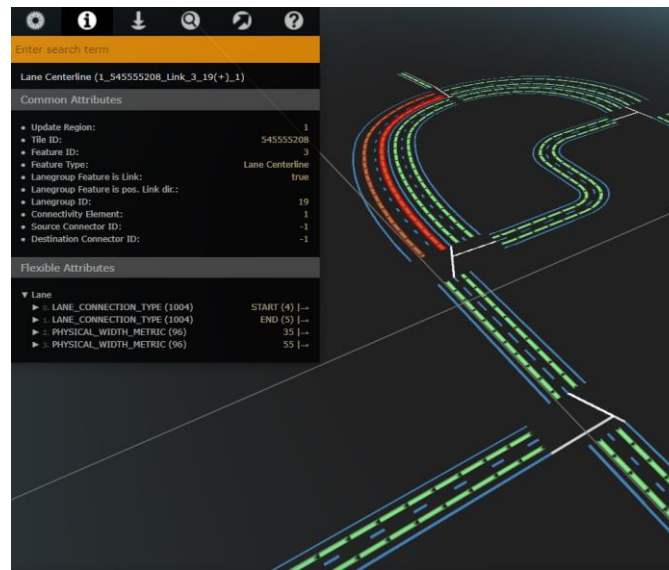
Ego-Vehicle

Traffic

HOW TO USE THE HIL TESTS



USECASE 1 SYNTHETIC WORLD

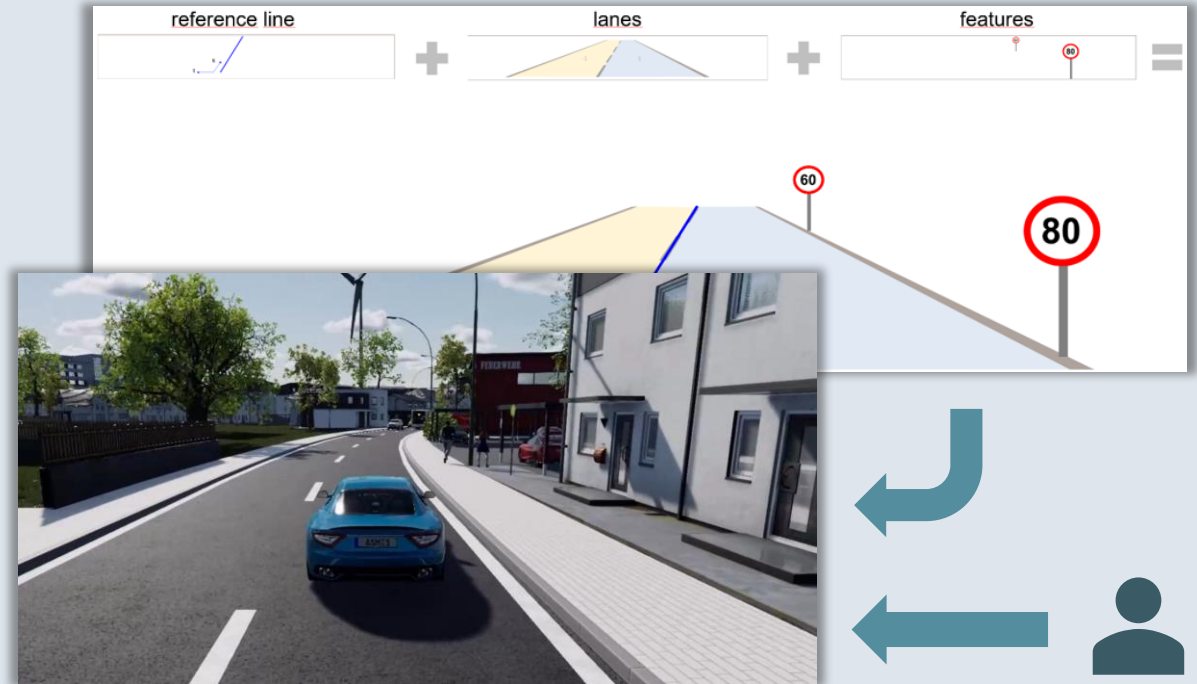


USECASE 1 SYNTHETIC WORLD

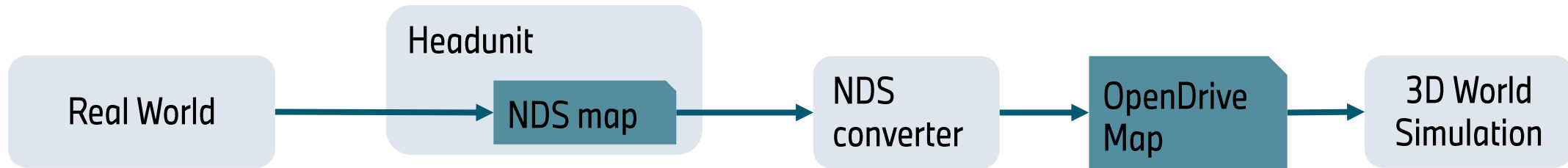


- OpenDRIVE is an “exchange format specification to describe static road networks for driving simulation applications”¹.
- An automatic generation of a 3D scenery is possible, but sometimes lacks detail next to the driving area.
- The option for manual 3D scene modification is necessary for some use cases.

¹: Official ASAM OpenDRIVE Specification



USECASE 2 REAL WORLD

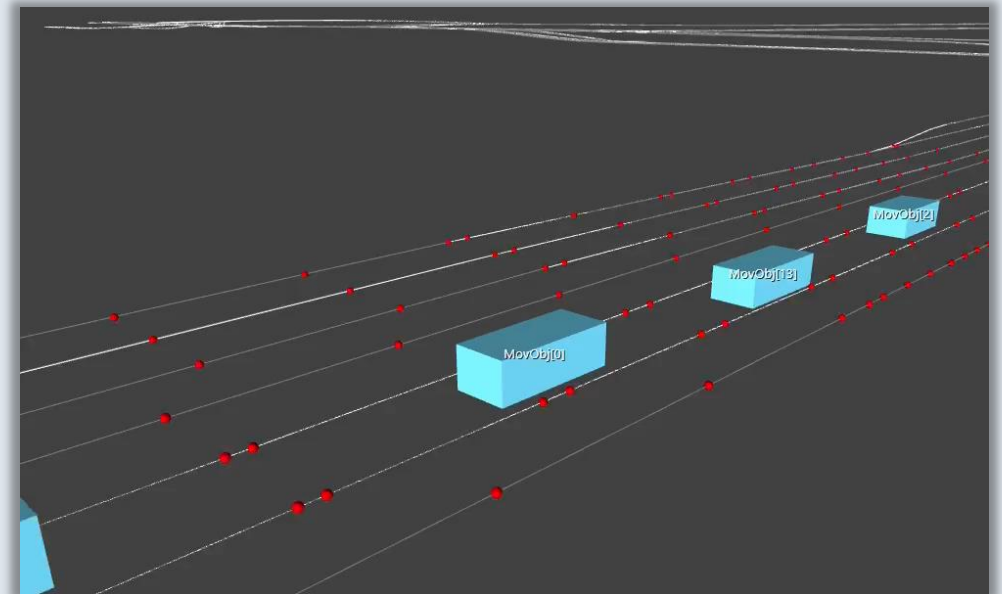
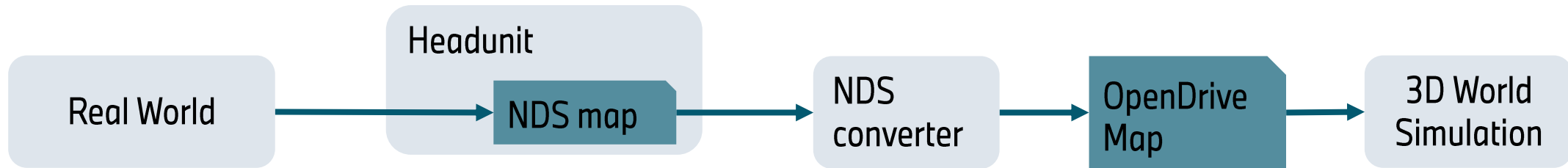


- Artificial scenarios will not be able to reflect the complexity of the real world.
- HD map data is the key to automatically create highly complex scenarios for HiL and SiL simulation.
- Localization for Level 3+ requires a high degree of details.
- (Real time) Simulation of complete cities is not feasible → Effective identification of relevant situations is crucial.



[File:Spaghetti-Junction-Crop.jpg - Wikimedia Commons](#)

USECASE 2 REAL WORLD



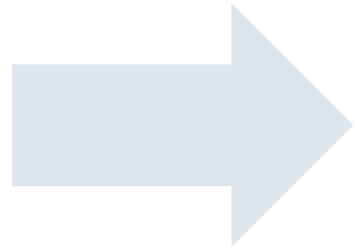
SUMMARY AND CHALLENGES

Artificial World

- Focus on specific test case / situation
- Cover all corner cases
- Idealized simplified world
- Manual effort for creating the maps

Real World

- Complex scenarios / environments
- Simulated situations can be compared with real world testing
- Identification of relevant situations in the map is crucial.
- Map changes have to be considered.



- Converters are successfully used in driving function development.
- Both directions of the NDS/OpenDRIVE conversion are necessary.
- Higher levels of AD require more details in the OpenDRIVE maps.

BMW
GROUP



Q&A

