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Vehicle-In-the-Loop Test Environment for Autonomous Driving with Microscopic Traffic Simulation

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Motivation

Autonomous vehicles just „start learning” the driving

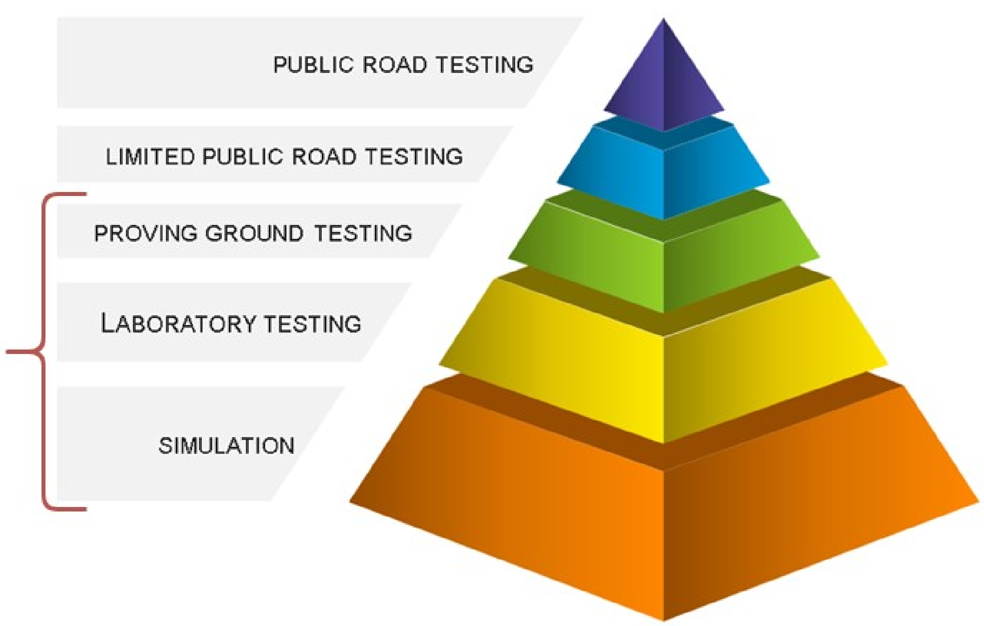
- enormous amount of experiences of autonomous cars are needed
- testing on public roads with traditional traffic is not safe enough and only allowed in a limited way

Hungary decided on the implementation of a test track for autonomous vehicles and technologies

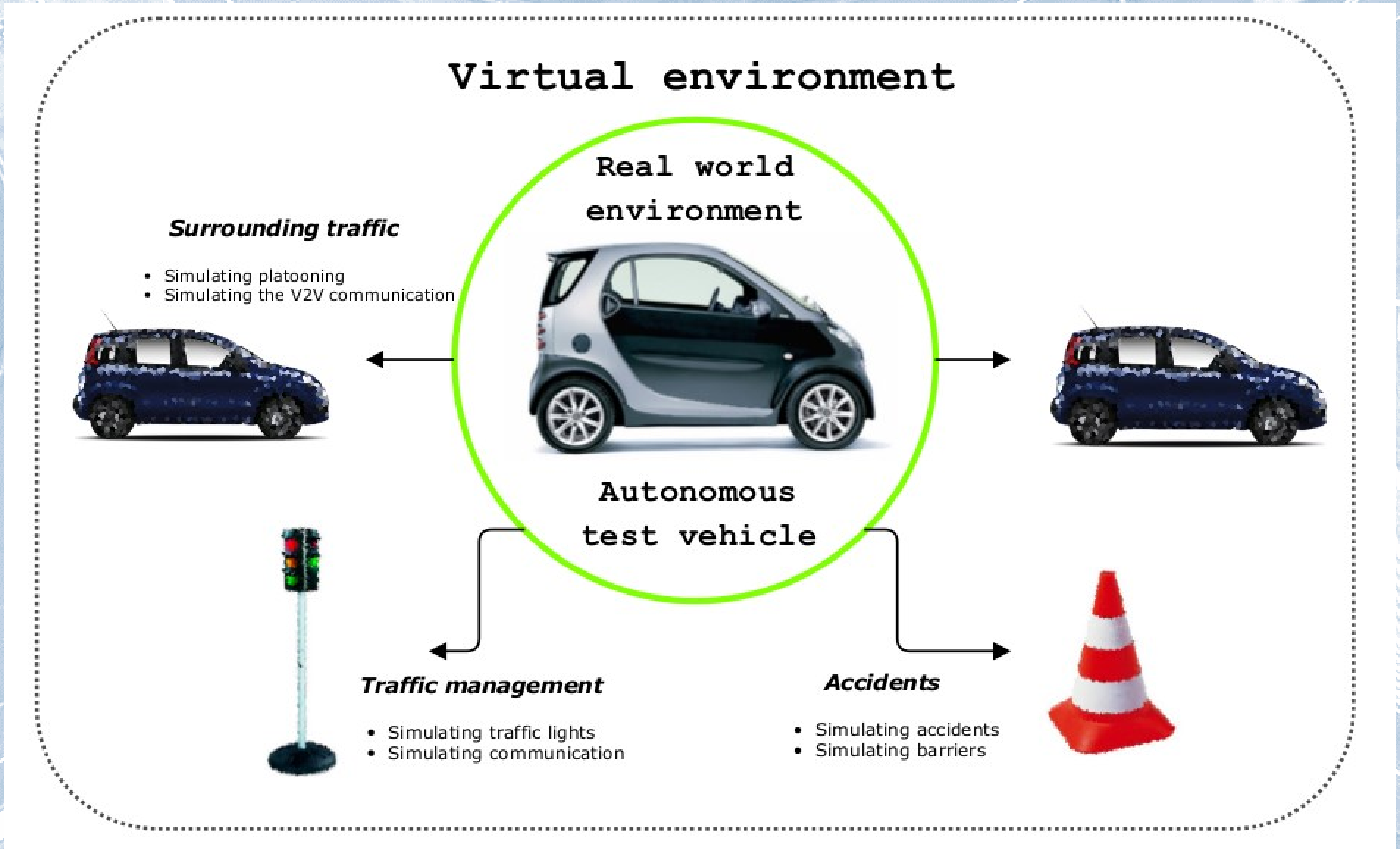
- testing connected and autonomous vehicle functionalities
- systems for Vehicle-In-the-Loop testing in virtual environments and virtual traffic

The meaning of VIL

- analogy of HIL (HW-In-the-Loop) testing
- inserting the self-driving car into the virtually generated traffic system
- the usual approach is limited to fully virtual testing
- solution that creates online connection between a moving test vehicle and valid road traffic simulator
- any simulation scenario is available, e.g. vehicle interactions, vehicle communication, intelligent crossroads or unexpected circumstances



Potential test scenarios



A final goal: application at ZalaZone

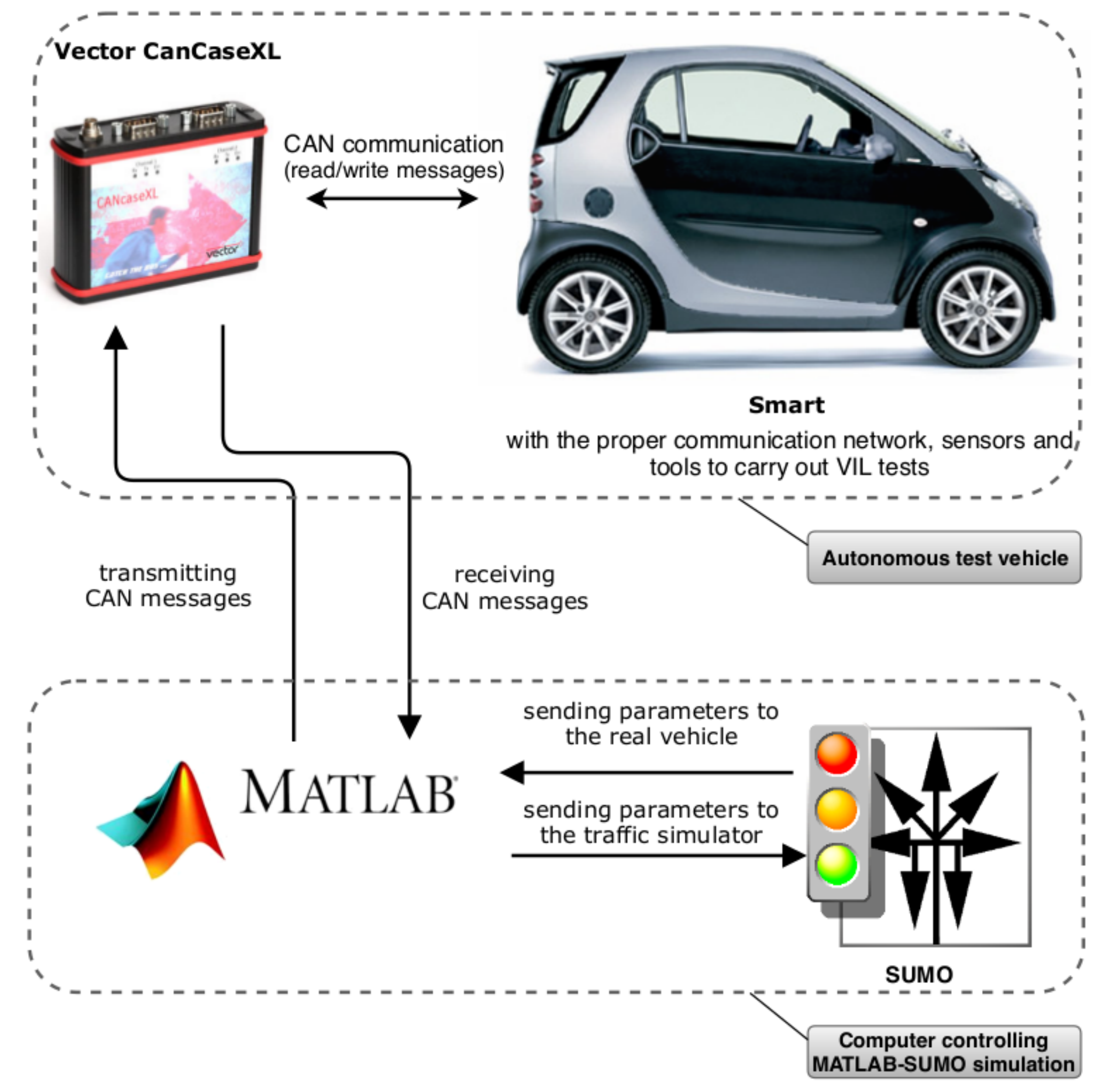
Proving ground for highly automated/autonomous vehicles in Zalaegerszeg (Hungary).

https://zalazone.hu/en

- **Designed to support the automotive industry throughout the whole process from prototype testing to mass production**
- **Dynamic platform, motorway, high speed oval, braking platform, etc.**
- **Smart City Zone with streets, buildings and special elements**

The elements of the VIL testing environment

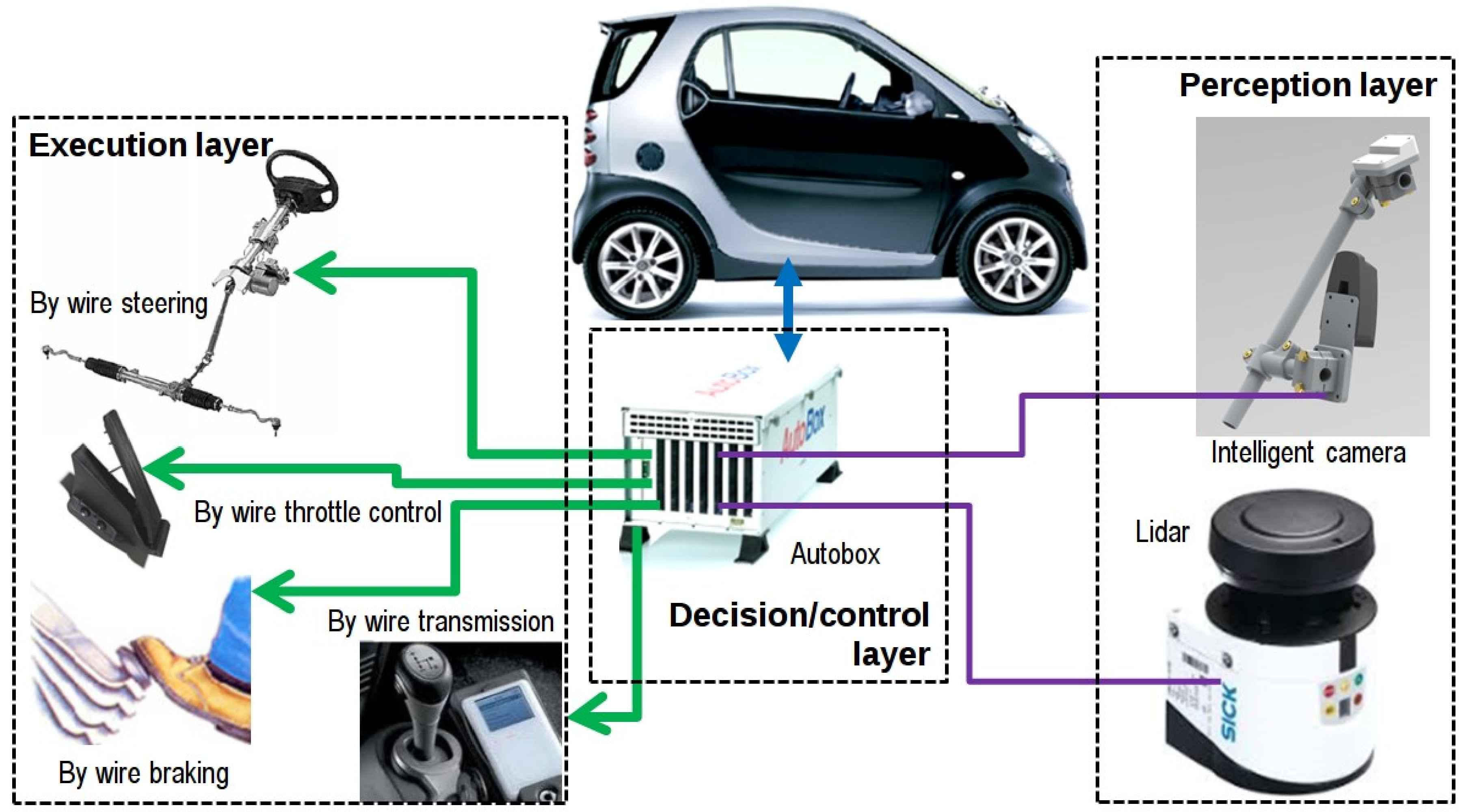
- **SUMO:**
  - microscopic traffic simulator
  - open source
  - XML based configuration



- **CAN network**
  - Receiving and transmitting messages by using MATLAB
- **Autonomous test vehicle**

The test Vehicle

- Sensors and controls for autonomous driving
- CAN network and easy connection to a computer with Vector CANCase



The developed interface

Requirements of the interface:

- Online operation
- Creating connection between the test elements (hardware, software)
- Enable the two-way communication

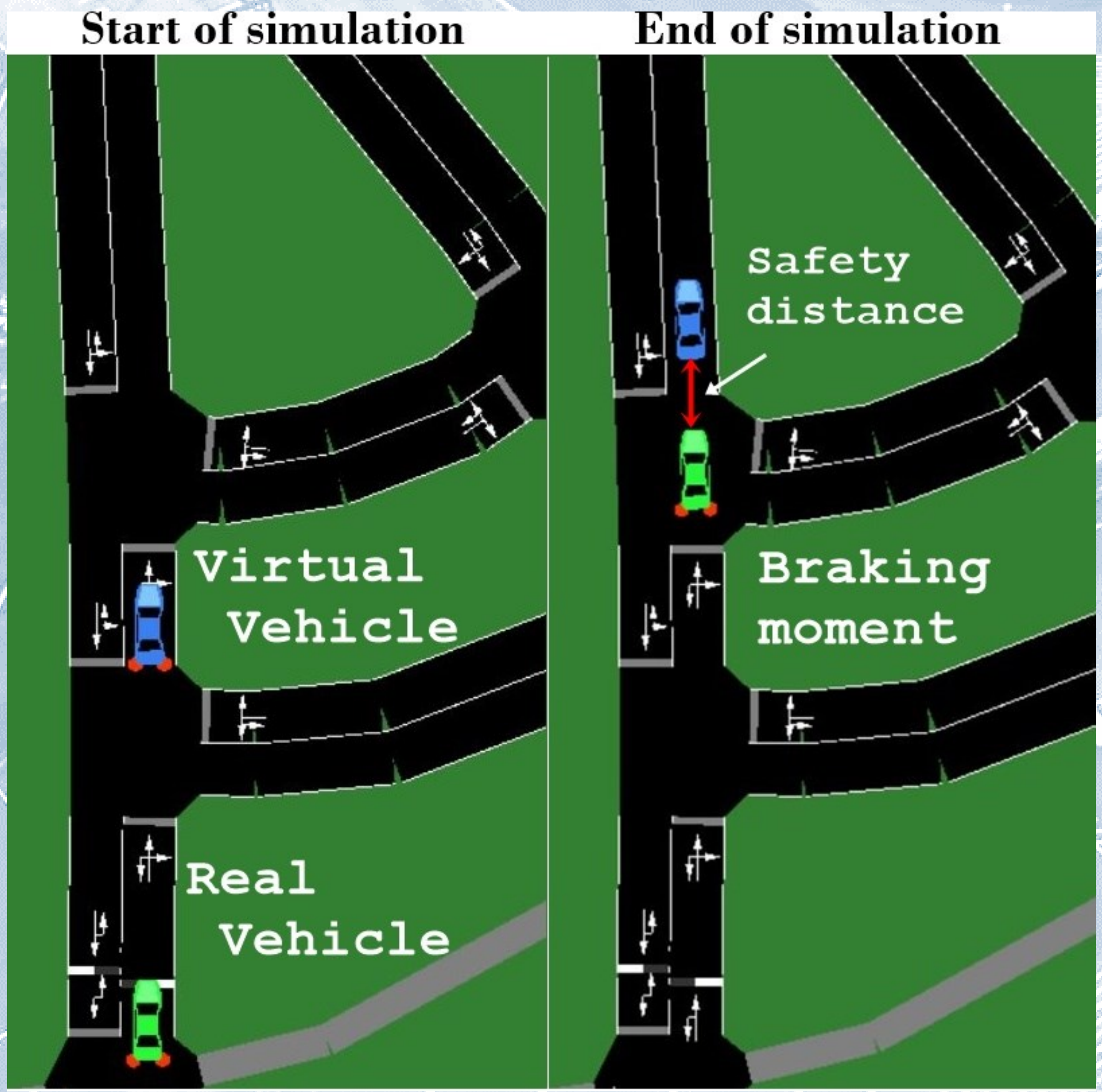
Quality of our interface:

- Well working connection
- Low, but adequate working frequency (5 Hz) for now

The real-world test

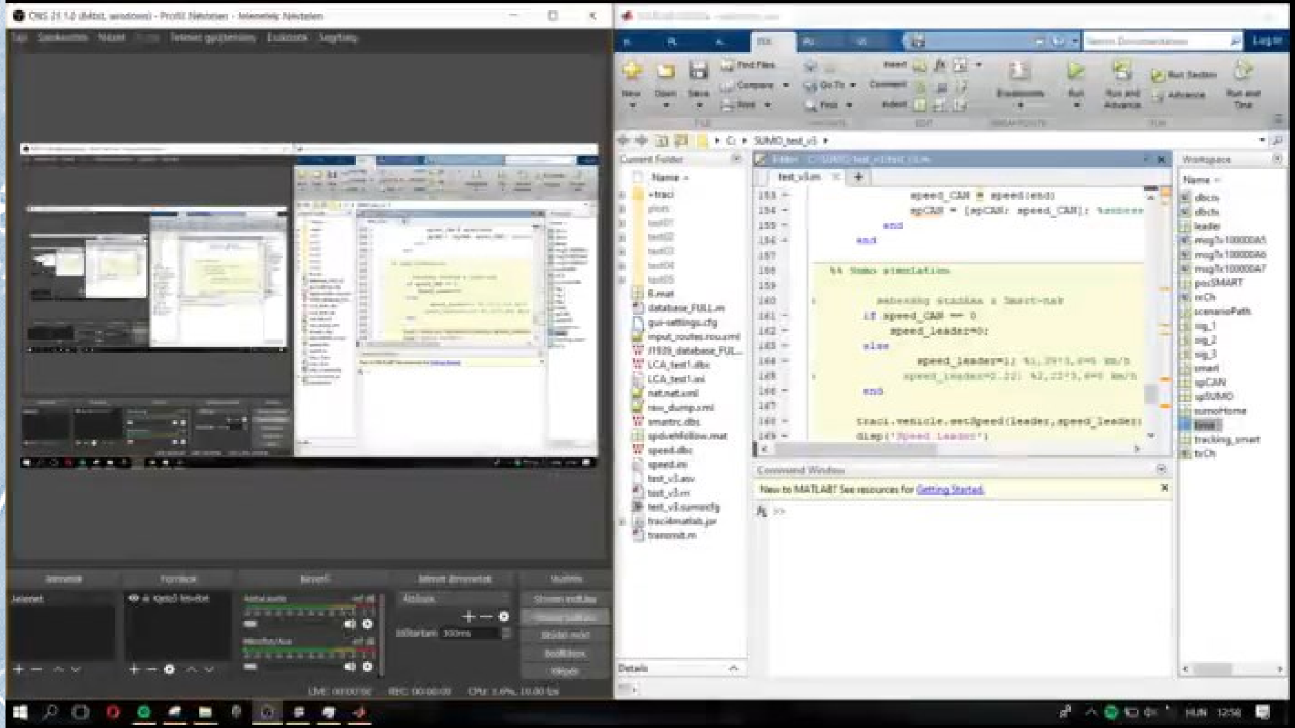
- Car parking area in university campus modelled in SUMO

The test scenario

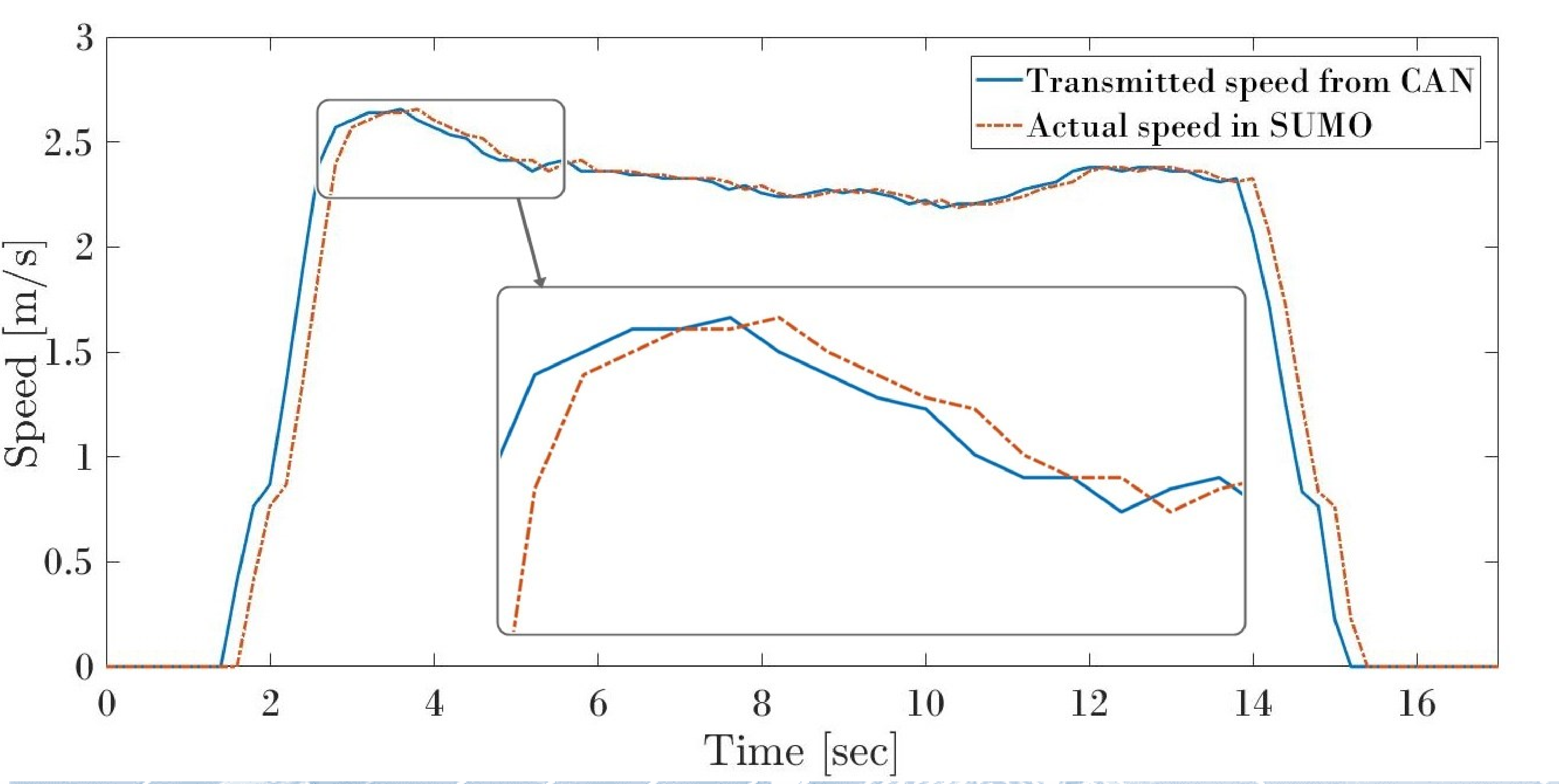


- The acceleration and braking maneuvers of the real vehicle was directly fitted into the traffic simulator while the motion of the virtual car was simulated by SUMO

- A safe braking maneuver occurred when the real vehicle reached the minimum safety distance allowed to be compared to the car ahead.

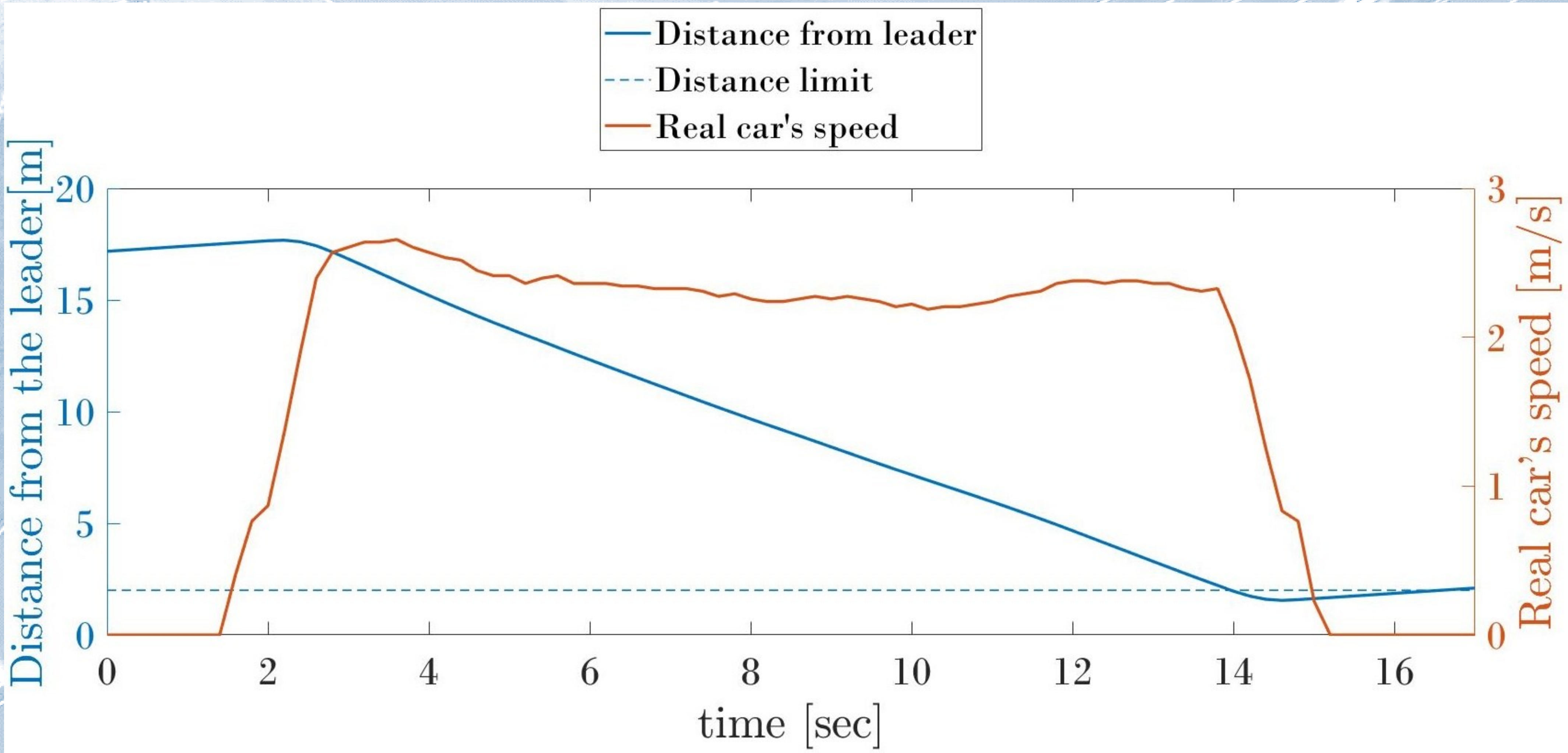


Transmitting the real speed to SUMO

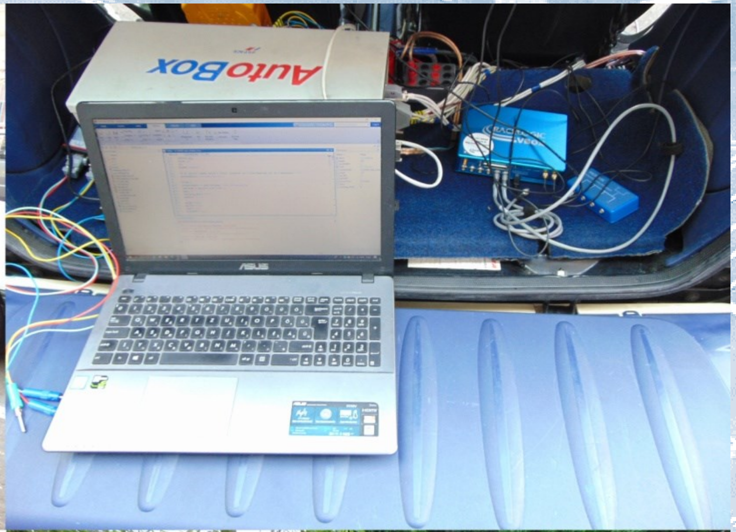


- The real moving vehicle's speed was transmitted to the simulator correctly
- Only a time delay is noticeable due the used low frequency

A test result



The test environment



- The test vehicle and the used systems

Future works

Implementation of car-following models

Use of GPS system to determine the real position and to correct the speed measurement

Increase of the communication frequency

Extending Testing Opportunities

Use of Unity 3D simulation platform

Thank You for your attention!

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