System simulation for the pre-emption of emergency vehicles

MOTIVATION

Within the "SIRENE" project, funded by German Federal Ministry of Transport and Digital Infrastructure, a comprehensive system is being developed for the pre-emption of emergency vehicles. The resulting SIRENE system is to be applied in a complex urban environment together with the Braunschweig fire brigade.

The development work includes secured communication between emergency vehicles, traffic infrastructures and the mission control system of the Braunschweig fire brigade. Major aspects of the project are tests and validation of the overall system within a combined simulation basis. Therefore, a realistic modelling of system elements, especially traffic light signals and traffic situations, is essential. For this purpose, the simulation environment SUMO (Simulation of Urban MObility) is applied. Another pursued goal is to accelerate the system development processes and error handling by using the simulation.
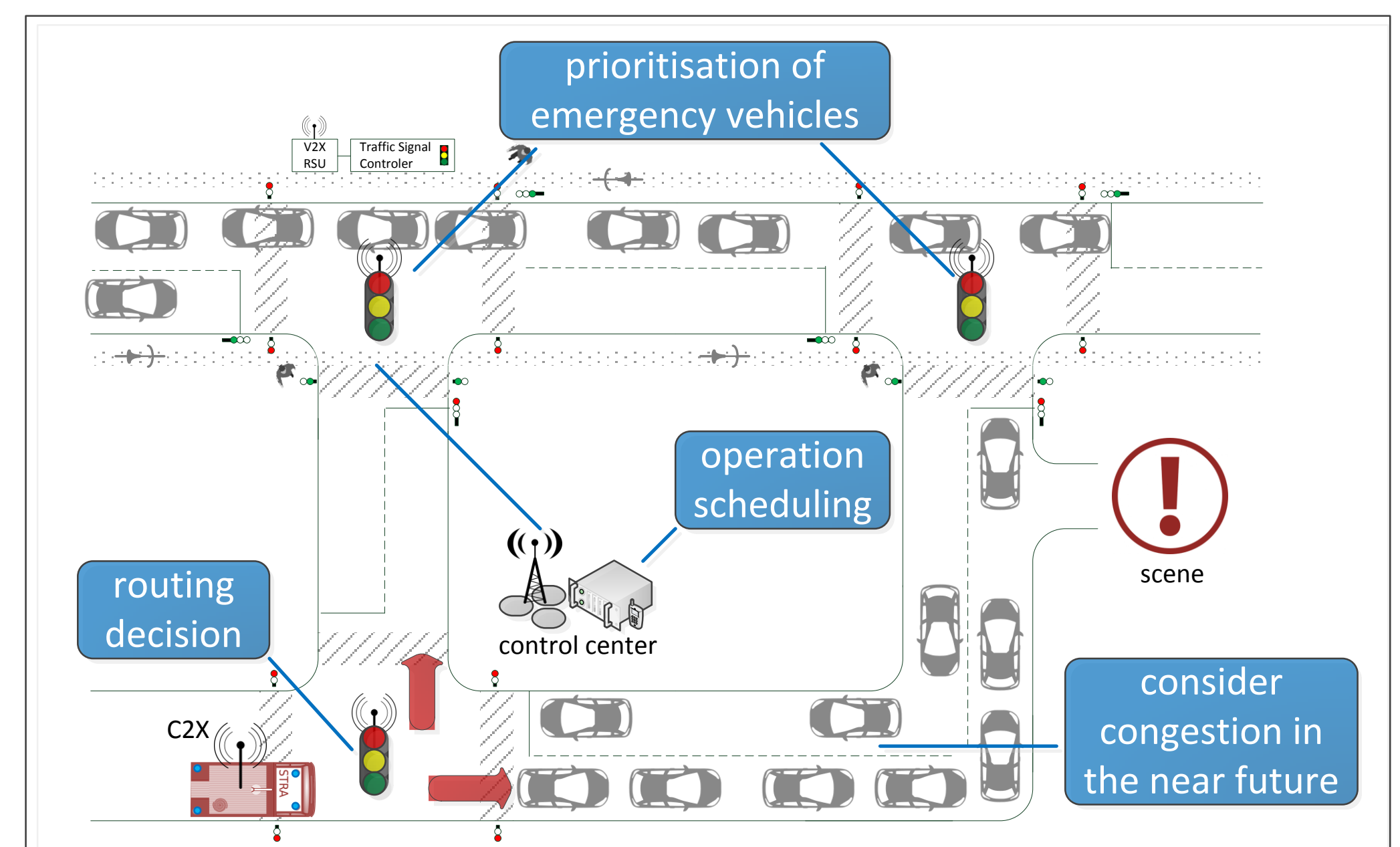

Pre-emption through V2X communication technologies and traffic state forecast

Ruppe, Sten und Nippold, Ronald und Trumpold, Jan (2018) SIRENE - Secure and Intelligent Road Emergency Network. SUMO User Conference 2018, 14.-16. Mai 2018, Berlin, Deutschland.

APPROACH

The objective of the SIRENE system simulation is to support the development process by early testing and verification of the interaction of all individual components. It is of importance that the elements of the system can be modelled realistically. In SIRENE, two different approaches are used to control the traffic signal systems: a central-based approach using a traffic computer and decentralized, direct adaption of the control unit on individual intersections. Therefore, particular importance is attached to the modelling of the information transmission and the control of the traffic signal systems. The simulation suite "SUMO" is used as the simulation tool for all traffic-related aspects.

By using the SIRENE system simulation, test data sets can be generated in a timely manner, which systematically reflect different traffic or environment conditions or further defined requirements and boundary conditions. The adjacent figure shows, for example, different levels of service on the inner city ring road and the motorway. In this way, the overall system to be developed can be continuously checked for compliance with various KPIs.
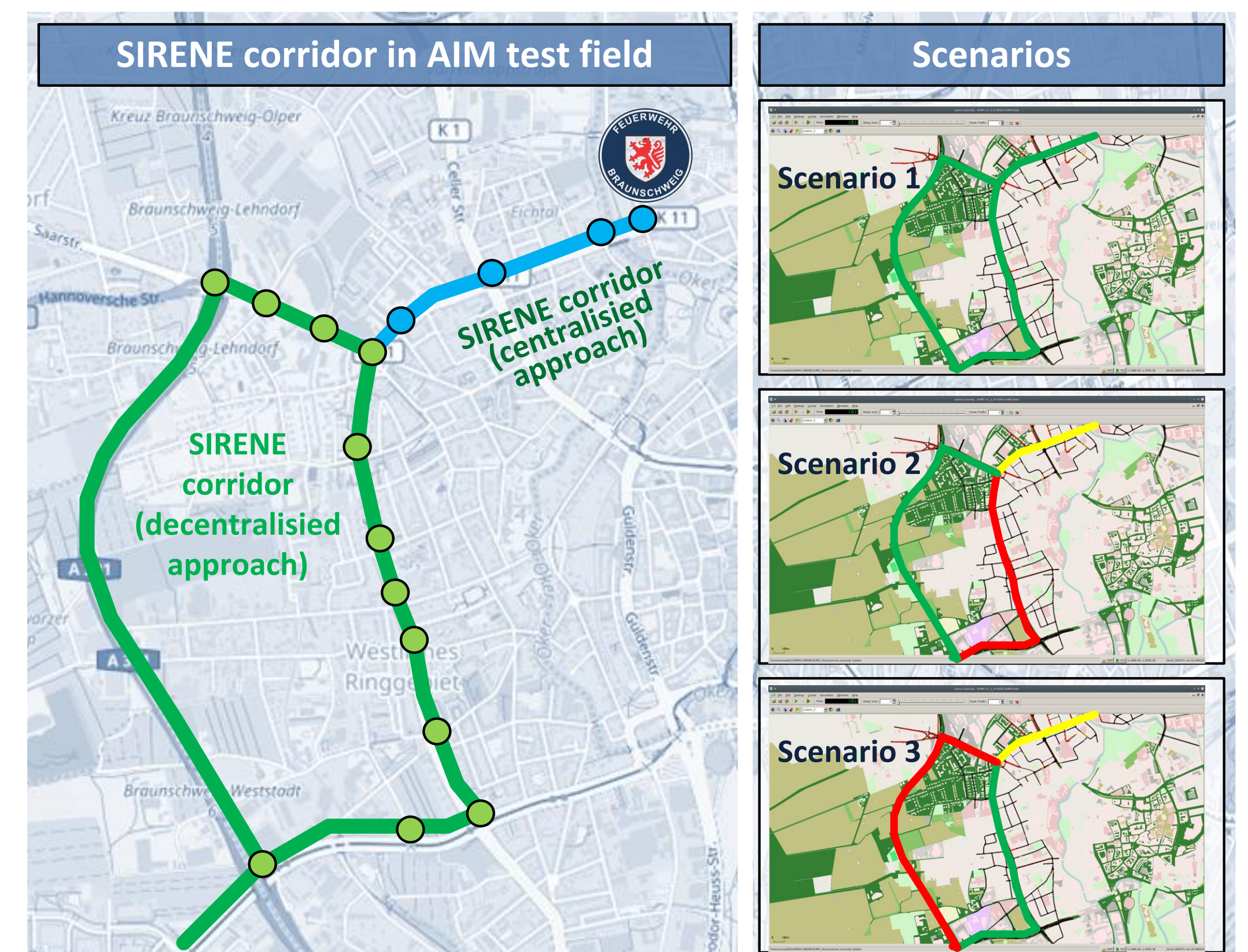

Different traffic scenarios and in the test field

SYSTEM INTEGRATION

The SIRENE system simulation consists of virtual representations of all subsequent system components, that is a traffic computer, traffic control infrastructure (traffic light control unit with existing signal programs, road side units, etc.), onboard units in emergency vehicles, the emergency vehicles themselves as well as the regular traffic volume in the test field of the city of Braunschweig. SUMO generates a traffic situation or traffic load in the sense of a certain level of service taking into account defined environmental conditions. This traffic simulation is connected with other components and information sources via a message broker (MQTT) for bi-directional data exchange.

Control and modulation of this simulation and its parameter can be done during runtime via a programmable interface.
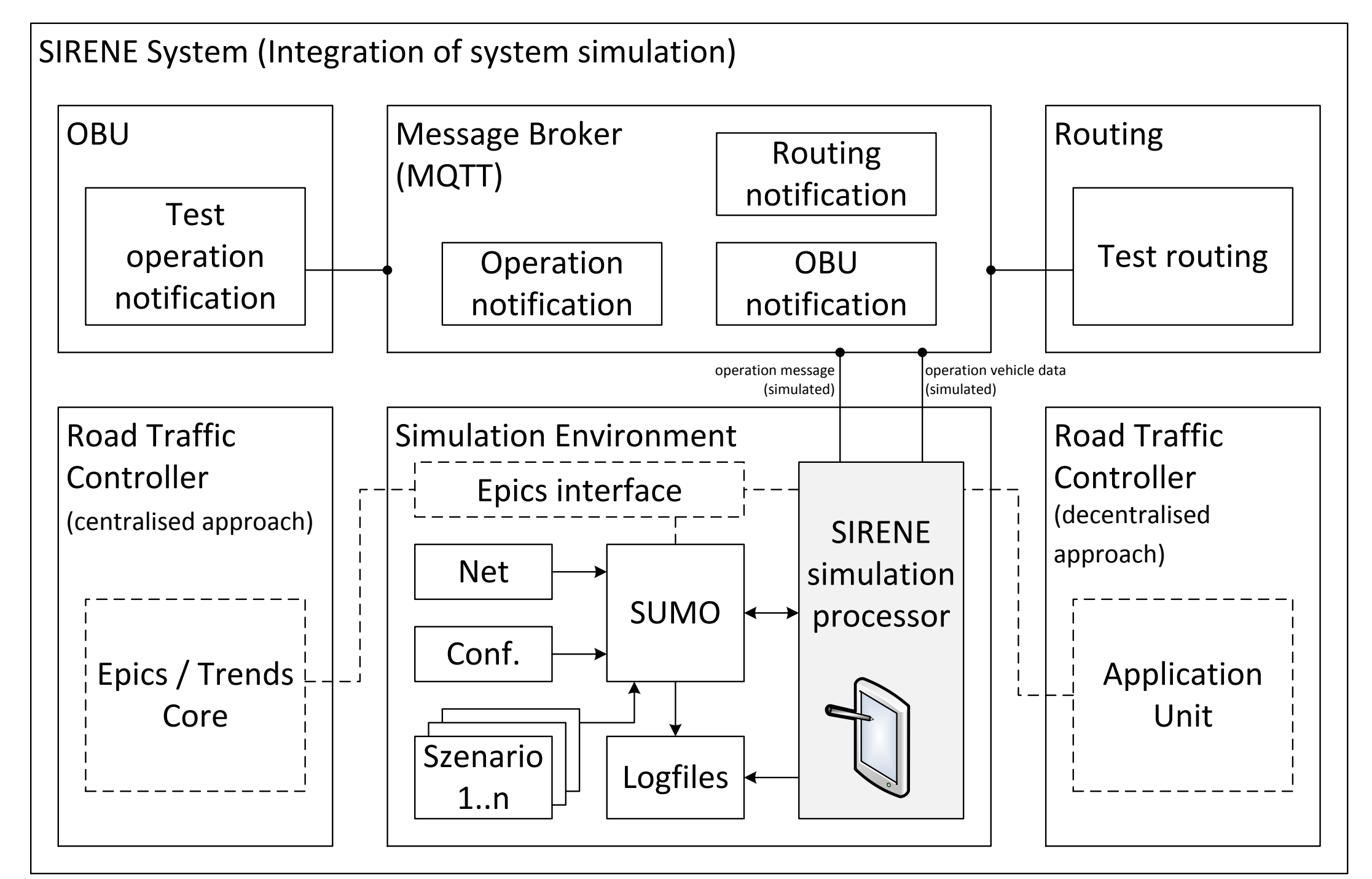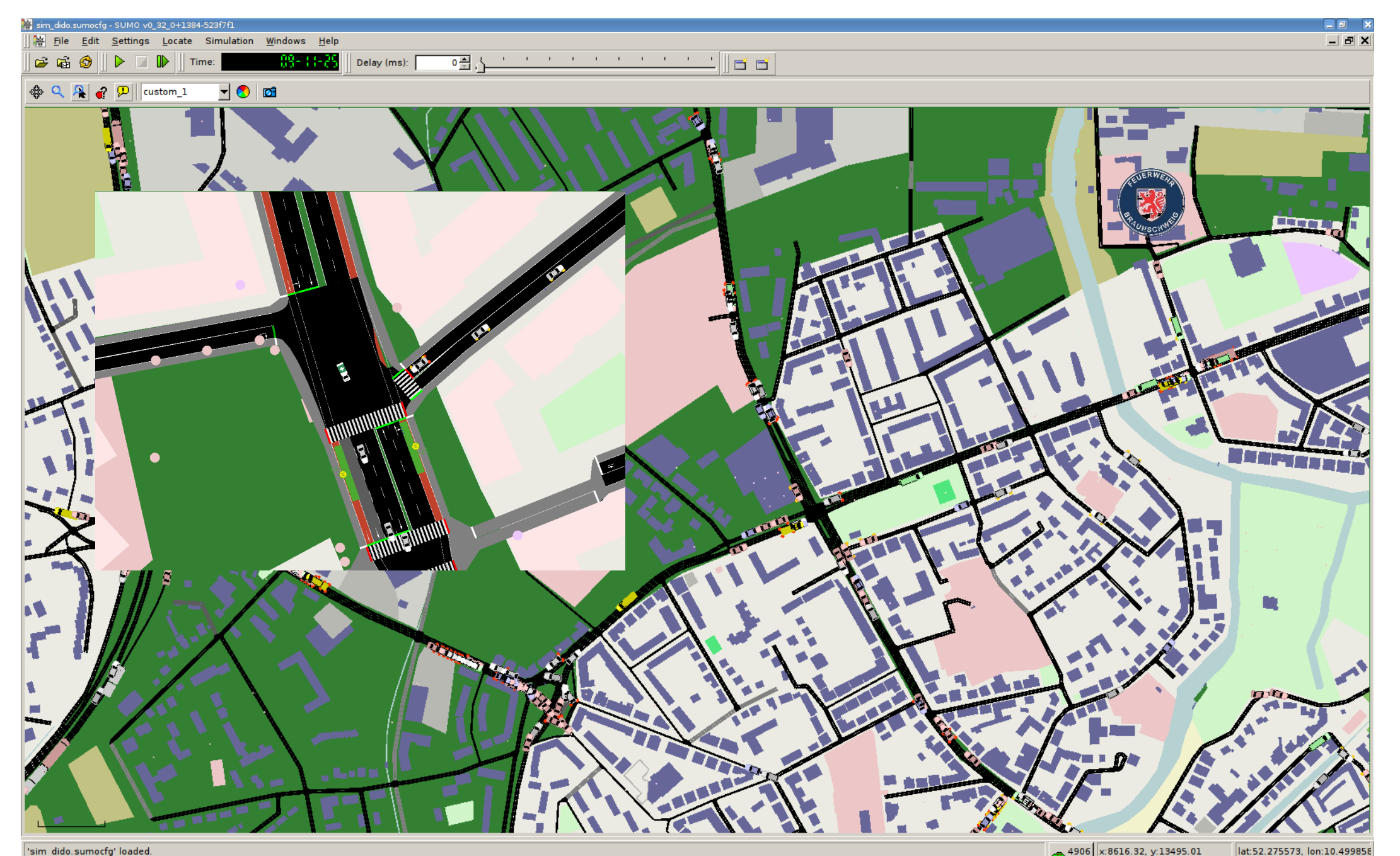

System architecture for system simulation

SIMULATION SETUP AND OUTLOOK

To set up the traffic simulation, the Braunschweig test field was mapped in detail in SUMO on the basis of Open Street Map (OSM 2018). In addition to extensive work on clearing the network of deviations from the real situation, a realistic demand for various load situations and the existing plans of the traffic signal systems were implemented. Furthermore, driving regime of emergency vehicles was analysed and adapted. For different, typical destinations in the area of the Braunschweig Weststadt, emergency missions were pre-defined.

In the further course of the project it is planned to link SUMO to the "TRENDS"-kernel of project partner GEVAS. This enables a realistic modeling of the traffic-adaptive control program "PTV-EPICS" of the TRENDS-kernel, which is used in the centralized-based approach. In addition, work is planned to improve the calibration of driving speeds for emergency missions with right of way and any special privileges.

Simulation of test field in Braunschweig in SUMO

Sten Ruppe, Ronald Nippold, Daniel Wesemeyer, Laura Bieker-Walz, and Louis Calvin Touko Tcheumadjeu
Institute of Transportation Systems
Rutherfordstr. 2
12489 Berlin, Germany
Sten.Ruppe@dlr.de
+49 30 67055-195