



SUC 2 – Closed-Loop System Simulation for Integration Test and Validation

Model Integration in CarMaker Simulation Platform

Model Integration Concept

The goal of the SET Level simulation architecture was to enable modular and flexible tooling for scenario-based testing of automated driving functions. The modelling standards FMI (Functional Mock-up Interface, <https://fmi-standard.org/>) and OSI (Open Simulation Interface) offer the possibility to exchange models by different software modelling tools in a standardized form.

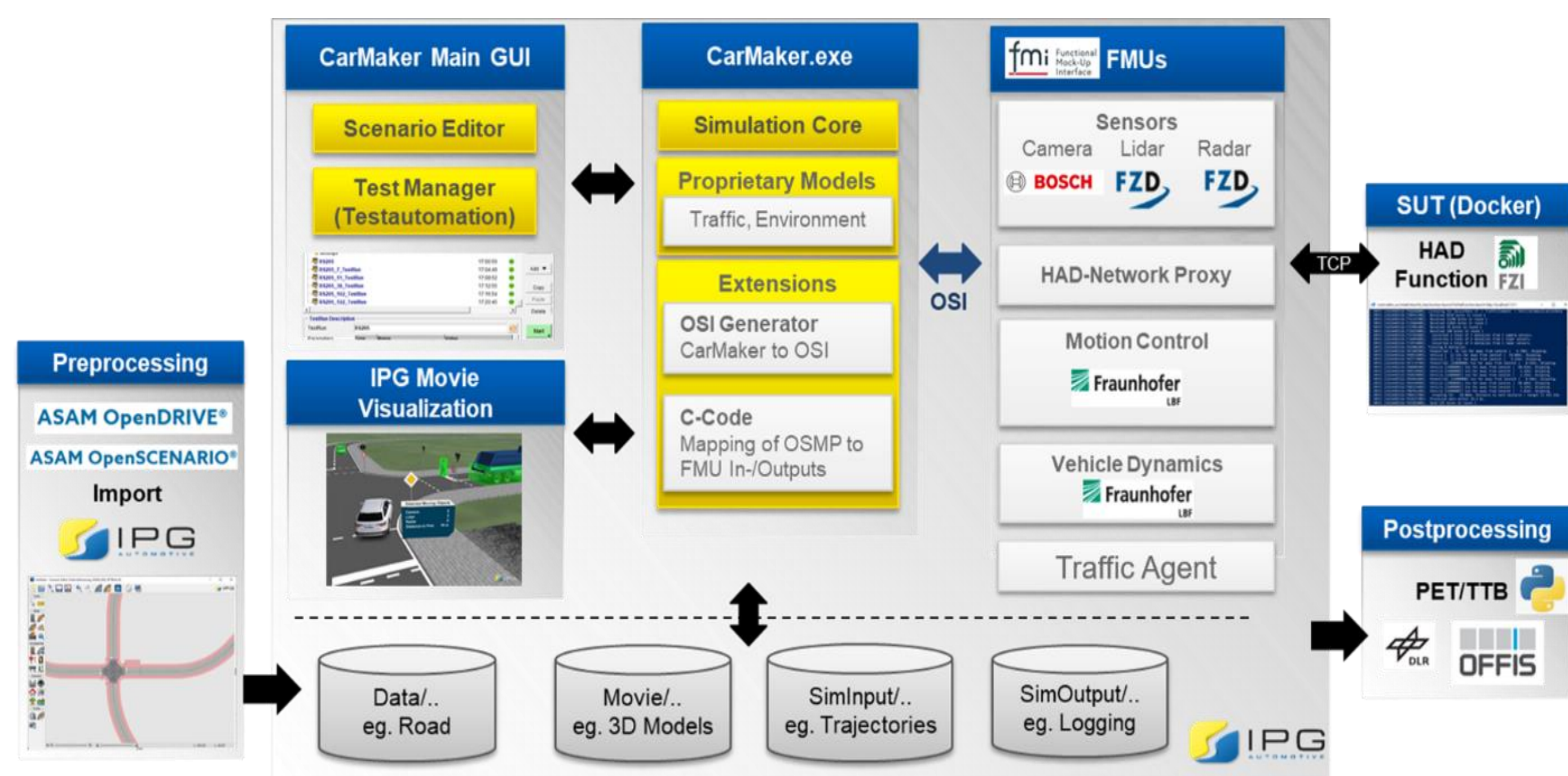


Figure 1: CarMaker simulation platform utilizing SET Level simulation standards

An application of the Open Simulation Interface is the OSI Sensor Model Packaging (OSMP). It enables the integration of sensor models using OSI communication via FMI 2.0. For communication via FMI, the memory address and the memory size of the created protobuffer containing serialized data are provided for the FMU (Functional Mock-Up Unit). The FMU reads the memory of the specified address in each simulation step and makes it available to the model implemented in the FMU.

Using the CarMaker FMI 2.0 interface, which supports FMUs that are packed according to the OSMP specification, different FMUs can be integrated in CarMaker to perform a specific closed-loop simulation.

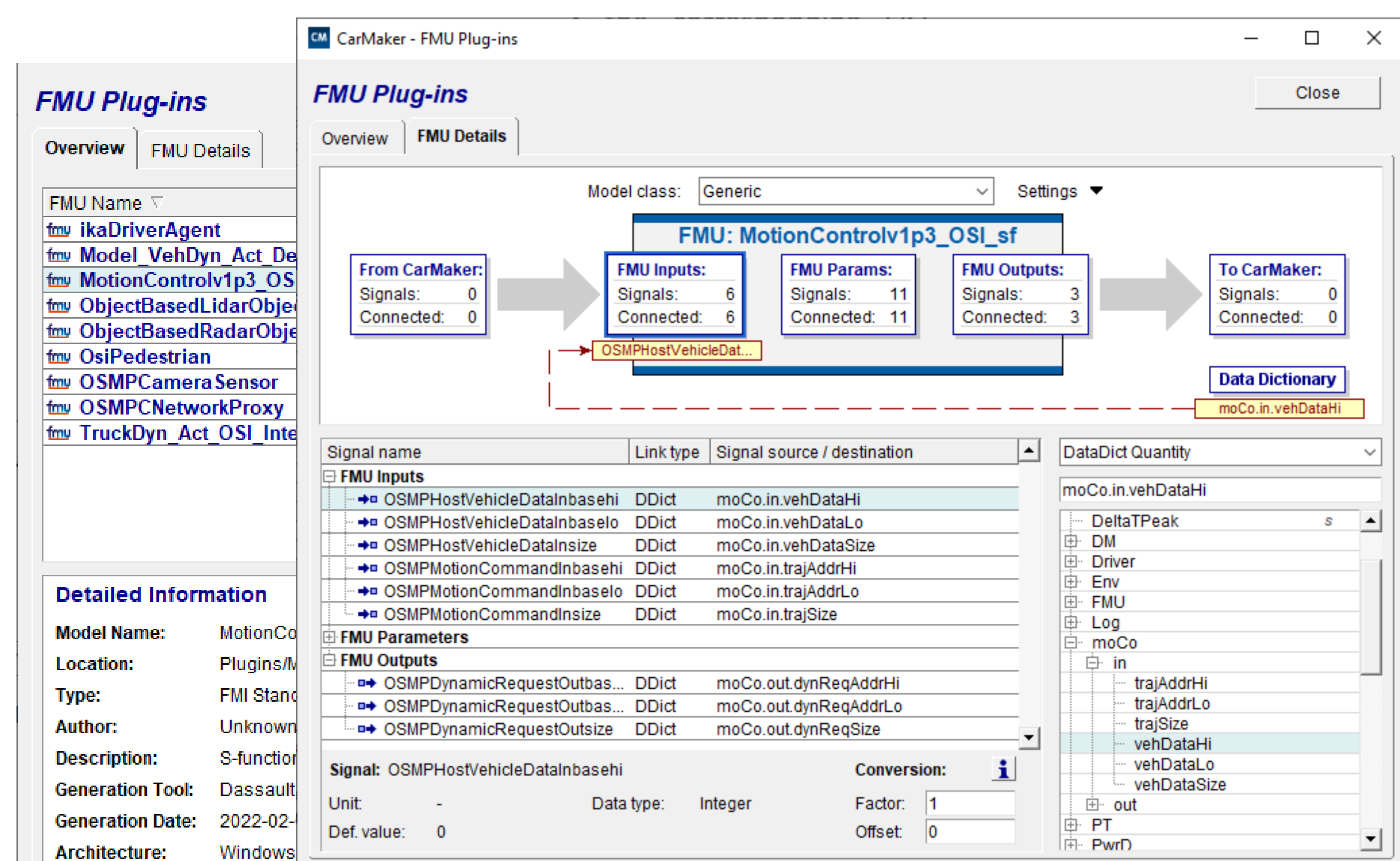


Figure 2: FMU Interface in CarMaker

Simulation Architecture

The SET Level simulation architecture consists of FMUs from different project partners.

- highly automated driving (HAD) function + motion control
- sensor models
- actuators and vehicle dynamics models
- traffic agent models

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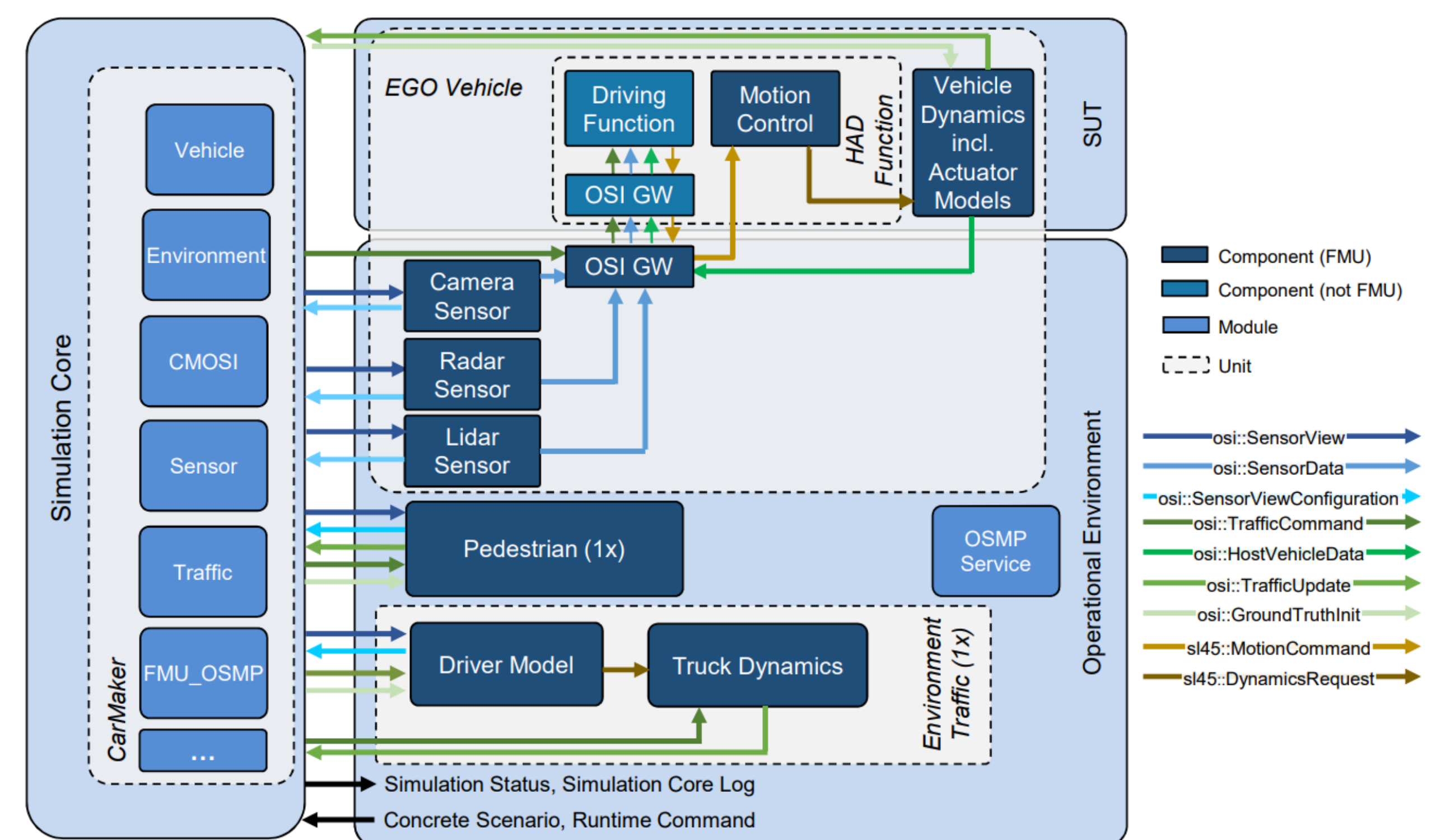


Figure 3: Model integration architecture for a closed-loop simulation with CarMaker

The simulation environment CarMaker was extended accordingly for the realization of the SET Level Simulation Use Case 2. Based on this extension, the sensor models, HAD function, Motion Control, Vehicle Dynamics and Traffic Agent Model are integrated into CarMaker as FMU via the FMU Plug-ins Interface to enable the closed-loop simulation.

For example, the CarMaker OSI extension provides the OSI::SensorView to the sensor models by selecting the required OSI::GroundTruth section and translating CarMaker internal variables into the corresponding OSI messages.

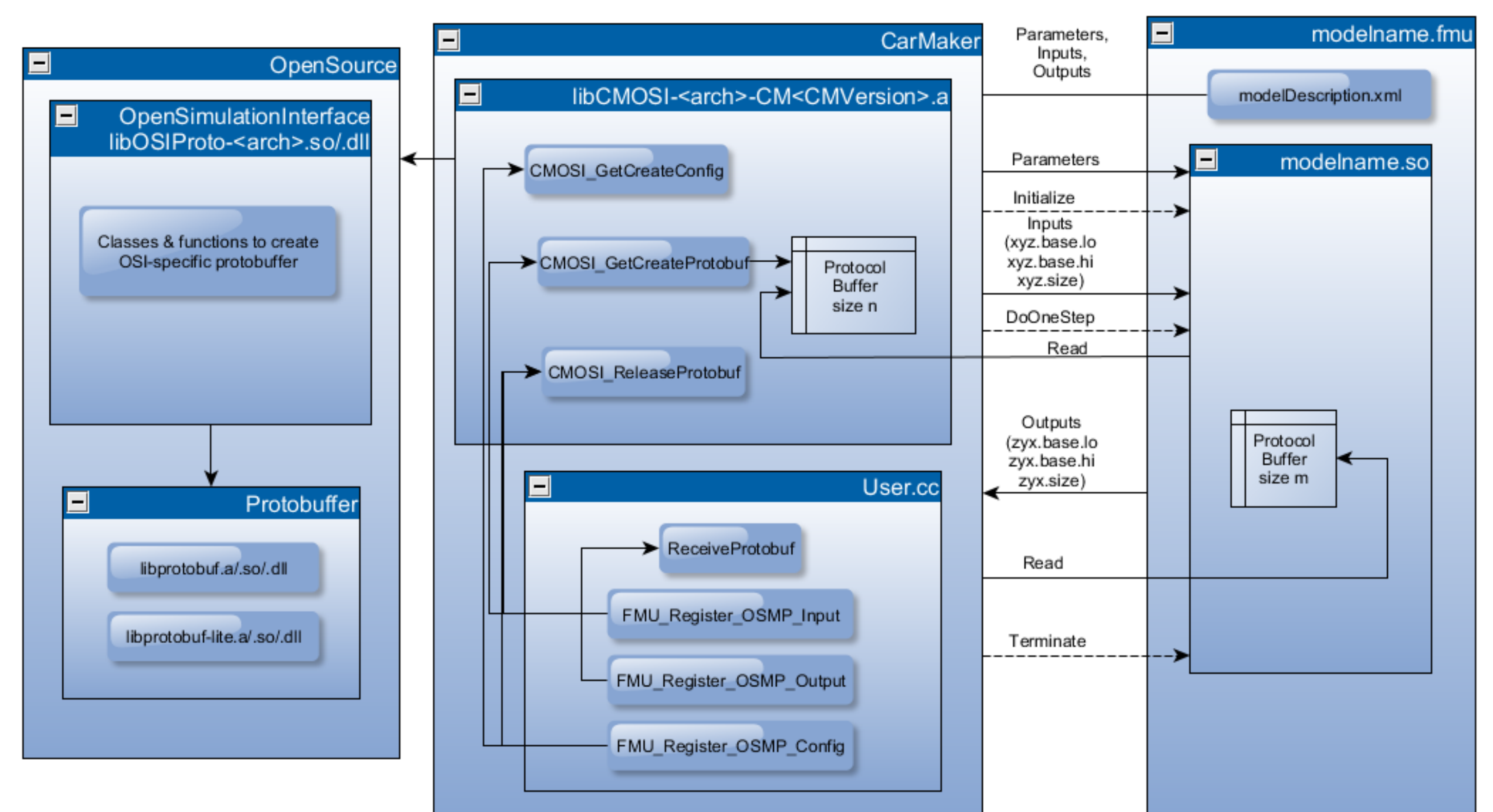


Figure 4: CarMaker OSI/OSMP interface implementation