Towards a Domain-Specific Language for the Virtual Validation of Cloud-native Mobility Services

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CONNECTED VEHICLES

IoT-Devices on Wheels

- High-performance computation resources
- Various sensing devices
- Data-driven software architecture
- Connectivity
CONNECTED VEHICLE SERVICES

- Connectivity, Security, Scalability, Reliability
- Processing multi-modal mass data
- Distributed system with various components
TESTING CONNECTED VEHICLE SERVICES

- Network Conditions (Latency & Bandwidth)
- Network Protocols & Infrastructure
- Security
- Scalability & Reliability
- Vast number of potential traffic situations
TESTING STRATEGIES

- Dummy data
- On-road testing via vehicle fleet
- Hardware/Vehicle nodes
- Simulation
  - Creation of multi-modal traffic scenarios
  - Simulations running in the cloud
  - Co-simulation
VIRTUAL TESTING
CLOUD-NATIVE
MOBILITY SERVICES
Additional properties relevant for testing connected vehicle services

Model-based description of road networks and traffic demand

Generate simulation environments for multi-modal traffic scenarios
open-source
microscopic traffic simulation
controllable via TraCI
open-source, real-world scenarios
open-source

coupling of different simulators

traffic communication environment

visualization evaluation
Xtext

- open-source
- language workbench
- parser
- linter
- typechecker
- compiler
- editor support
Structure of the DSL
by Example
mode MOSAIC

configure SUMO {
    input {
        generate RANDOM size 40
    }

    processing {
        scale 2
    }

    routing {
        algorithm dijkstra
    }
}

USE CASE
RESTRICTED TRAFFIC ZONE

- Geographical area in which only authorized vehicles are allowed to enter
- Monitored by a local roadside unit
- Cloud service process the data and determine if vehicles are allowed to enter
- Vehicles listening to incoming commands
RESTRICTED TRAFFIC ZONE

MOSAIC Runtime

Traffic Simulator

Application Simulator

Simple Network Simulator

Vehicles

In-Vehicle Application

Roadside Unit

Cloud Service
mode MOSAIC

configure SUMO {
    input {
        netFile "highway.net.xml"
        routeFiles "highway.rou.xml"
    }

time {
    start_at 0 seconds
    end_at 1000 seconds
}
}
DSL PROTOTYPE

- Description of minimal traffic scenario for testing connected vehicle services
- Generation of a Co-simulation environment via MOSAIC
- Editor with good usability & Docker support
DSL DRAWBACKS

- Strong dependency on SUMO. How to describe general-purpose traffic scenarios?
- Running SUMO scenarios within Eclipse MOSAIC has some minor limitations.
- Balancing functionality and complexity. Cover the whole domain?
FUTURE WORK

- Consideration of open standards and formats, e.g. OpenSCENARIO or Vehicle Signal Specification
- Web-based user interface and new building blocks
- Definition of metrics to assess the architecture against non-functional requirements
THANKS FOR YOUR ATTENTION

ARE THERE ANY QUESTIONS?

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