Specialized Simulators in a Distributed V2X Simulation Environment

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I. Introduction and problem descricption

Vehicle-2-X Simulation is a comparative new research area which tries to analyse the impact of communicating cars on the traffic flow. The recent developments in the field of V2X simulations show, that there is a high demand for realistic data concerning specific traffic situations but also common scenarios. Realistic data in this field means data obtained by real vehicles, either full size cars driving on streets or miniature vehicles in a testbed. The data acquired by these experiments includes physical characteristics which can be hardly simulated. This information comprises sensor data such as distance to other vehicles or obstacles, position, direction and speed or environment properties, e.g. road conditions or weather information. Up to now, mainly generated, preconceived data was used for these simulations.

Furthermore, existing solutions are specialized for one or more specific traffic situations, e.g. a highway crossing or a small inner city area but no one is perfect in simulating all aspects together. If it is possible to combine different simulators of the same domain, e.g. traffic simulators for highway networks and traffic simulators for inner city traffic, larger areas can be simulated causing much more realistic scenarios and data, e.g. the SUMO traffic simulator, which is currently used by the VSimRTI[1] is only able to simulate traffic flow but has no possibilities to simulate crashes or exact positions on crossings.

Another challenge is that especially Vehicle-2-X communication scenarios have high computational costs because of the amount of simulators used and the corresponding overhead to synchronize them. There are solutions, which are able to compute Vehicle-2-X scenarios, but these can only compute the simulation in real time when there are only a few vehicles. If one wants to combine simulation and real world in a way, that both systems communicate with each other it is necessary that the simulations runs at least in real time. Therefore it is important to enhance the already existent simulation frameworks in a way, that results can be gained in shorter time.

If it is possible to accelerate the simulation execution that it can be simulated faster than real time new possibilities come up. Simulations can be combined with real world data or advanced Vehicle-2-X simulations scenarios can be tested.

II. Solution ideas

My solution idea to these two challenges, parallelization of simulators of the same domain but different specializations and using external data from real cars in V2X simulations can be subdivided into four major parts:

1) Develop a concept to distribute a scenario on to unique software components, e.g. distribute the map in a way, that two or more traffic simulators can compute an area. Therefore, some synchronization component is necessary, which has the global view about the system.
2) Allow the exchange of a traffic simulator with another, different specialized simulator. These simulators have to communicate using a common universal message concept which integrates both macroscopic and microscopic simulators.
3) Adapt the concept to other simulator parts such as network simulators or environment simulators. Executing network simulators in parallel has been analyzed before and there are a lot of things which have to be considered before this can be implemented, particularly in a specialized environment such as Vehicle-2-X simulations. Maybe there are simplifications which can be used to solve these problems.
4) Exchange parts of the simulation with components which are connected to the outside, e.g. use the output from a V2X testbed as input for other simulation parts.

To proof, that my developed concepts have an impact on existing solutions, the VSimRTI concept developed by Tobias Queck[1] will be extended. The framework offers functionality to integrate and synchronize the necessary simulators for V2X simulations (application-, traffic-, network- and environment simulators) in one solution.

Other promising standards and concepts which include interesting ideas are coming from the area of Distributed Virtual Environments (DVE) or Distributed Interactive Simulations (DIS)[2]. They offer techniques for effective data management and distribution but also concepts for interaction with the environment.

My thesis aims to develop a concept for effectively simulating different areas or using different simulators as described above. The area of interest can be subdivided into parts, which then will be simulated using specialized simulator federates.

Therefore it is possible to simulate greater areas with more vehicles and increased accuracy because every simulator can use its special capabilities. Another important point is the performance as it should be possible at some time to integrate simulators into cars and have every car simulating its own route. Considerations to this idea will also be part of my thesis.

III. Thesis

It is possible to combine different simulator types in one simulation environment to achieve higher performance and more realistic results. This concept can also be extended to integrate real world data into Vehicle-2-X simulations.

References

[1] T. Queck, *Runtime Infrastructure for Simulating Vehicle-2-X Communication Scenarios* Hasso Plattner Institute for IT Systems Engineering, 2008

[2] R. Fujimoto, *Parallel and Distributed Simulation Systems* , John Wiley & Sons, Inc., 2000