An Integrated and Realistic Simulation Platform for Vehicular Networks

(Poster Abstract)

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ABSTRACT

We propose an open-source integrated simulation platform namely simITS aiming at a realistic evaluation of communication protocols for large scale vehicular networking. Using ns-3 as network simulator and SUMO as road traffic simulator, the main idea is to integrate these two simulation environments in order to make the simulation more realistic. Moreover, we propose to add a new protocol stack designed for vehicular communications and compliant with the draft of ETSI/ITS. Finally, we validate simITS by a basic simulation study.

Categories and Subject Descriptors

I.6.m [**Computing Methodologies**]: Simulation and Modeling—*Miscellaneous*; C.2.1 [**Computer Systems Organization**]: Computer-Communication Networks—*Network Architecture and Design, Wireless Communication.*

General Terms

Performance, Design.

Keywords

Realistic simulation, Network simulation, Road traffic simulation, Wireless vehicular networks.

1. MOTIVATION

Studying vehicular networks often requires an assessment of various network architectures, proposed protocols and applications. These evaluations must take road traffic details and conditions, wireless communication characteristics and drivers' behavior into consideration. In particular, the performance evaluation of research on vehicular networks depends mainly on simulation. In the literature, much effort has been spent to address the design of realistic simulation tools for vehicular networks. There have been some works that developed integrated simulators achieving the interaction between traffic and network simulation environment. For instance, TraNS [4] links two open-source simulators SUMO [3] and ns2 [1] using an interface called TraCI [6]. In this work, we propose to apply the same methodology to design a new, open-source and realistic simulation tool for vehicular networks. We use ns-3 [2] as network simulator since it ensures large scale simulation and supports emulation and distributed simulation. Furthermore, in order to retrieve traffic data and influence SUMO behavior in real time, we provide an interface ensuring the interaction between ns-3 and SUMO and a new ns-3 mobility model. We implement also a new communication protocol stack in ns-3 consistent with the current draft of ETSI/ITS to use it instead of existing TCP/IP stack since this latter is not suitable for vehicular networks especially in case of safety applications.

2. SIMITS ARCHITECTURE

The simITS general view is illustrated in Figure 1. The main idea consists in periodically producing realistic traffic traces, based on SUMO, and using them as an input for ns-3. A realistic flavor is given by allowing ns-3 to control the behavior of SUMO in real time. Thus, both simulators run at the same time. This can be ensured by an enhanced interface that relies at its core on TraCI. Moreover, Two additional building blocks have been added to ns-3: the new mobility model SUMOMobilityModel and the novel ITS communication protocol stack.

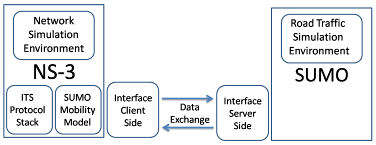


Figure 1: General architecture

2.1 Mobility model: Interaction with vehicular simulation

The classes involved in the mobility model block are visualized in Figure 2. SUMO uses TraCI server to communicate with ns-3. In the other side, *SUMOMobilityModel* class makes use of the client of the amended interface to obtain mobility traces in real time. This class inherits from the generic ns-3 *MobilityModel* class that keeps track of the cur-

SIMUTools 2010 March 15–19, Torremolinos, Malaga, Spain.

Digital Object Identifier: 10.4108/ICST.SIMUTOOLS2010.8697
http://dx.doi.org/10.4108/ICST.SIMUTOOLS2010.8697

rent position of a node. Furthermore, it defines appropriate methods to receive simulation data from SUMO and then use them to update simulation parameters in ns-3. *SUMOHelper* is used by *SUMOMobilityModel* to update position data of each node. To comply with the ns-3 conceptual model, we designed a helper *SUMOMobilityHelper* for our new mobility model in order to facilitate its use in simulation

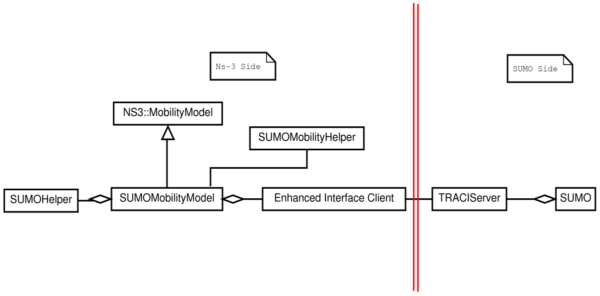


Figure 2: Class diagram of SUMO Mobility Model

2.2 ITS protocol stack

Figure 3 shows the class diagram of the ITS stack. The current design of the stack aims basically to support safety applications. We believe that such applications can be supported by two means: by the periodic transmission of beacons which contain position information and by the dissemination of safety messages once a potential danger has been detected. Accordingly, at the application layer, we designed a beaconing application represented by *Beaconing-Protocol* class and a *PostCrashWarning* application [5] which consists in alerting other approaching vehicles of the risk when an accident is happening using a multi-hop strategy. At the network layer, the current implementation comprises geo-broadcast and topo-broadcast, other geo-routing schemes are planned to be implemented in future work.

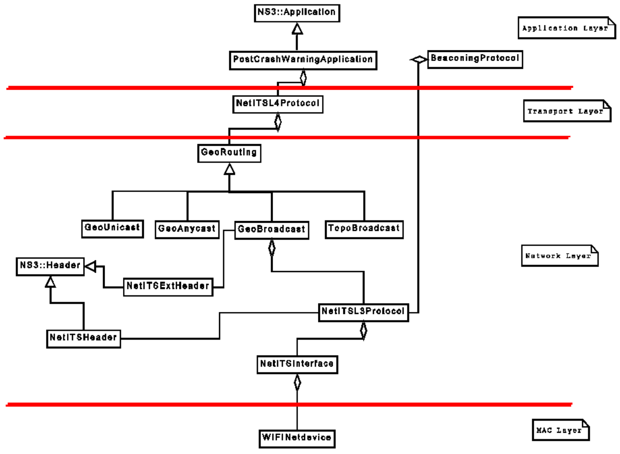
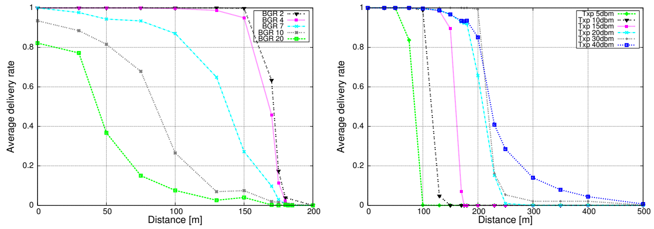


Figure 3: Class diagram of ITS protocol stack

3. VALIDATION

We provide simulation results that validate the new vehicular stack by the simulation of a beaconing protocol. We used the new mobility model *SUMOMobilityModel* and, consequently, the retrieved traffic data to create realistic data packets. We considered a scenario composed of a highway with length of 10km. Moreover, we configured each vehicle to send beacon in a shared wireless channel using 802.11a with a data rate of 6 Mbps. We define the Beacon Generation Rate (BGR) as the number of beacons sent per second. Furthermore, we measured the Beacon Delivery Rate (BDR) which is the percentage of vehicles that successfully received a packet amongst all vehicles positioned at a specific distance from the sender. Figure 4(a) illustrates the average BDR with respect to the distance from the transmitter for four different BGR. A constant transmission power is used to send beacons. The simulation results demonstrate that the BGR 2 beacons/s performs better than other BGRs. Figure 4(b) depicts the average BDR varying the transmission power. We observe that, while the channel is not saturated, increasing the transmission power does not decrease BDR at close distances, and provides improved reception rates at further ones. However, with a saturated channel (40 dbm), there exist a number of messages transmitted from nodes at close distances which can not be captured due to interferences.



(a) Average BDR vs.distance varying BGR

(b) Average BDR vs.distance varying transmission power

Figure 4: Simulation results

4. CONCLUSION

We have given an insight about simITS and we have presented both the new designed mobility model and the ITS stack. Our platform can be exploited by researchers working in the area of wireless vehicular communications to validate and evaluate the performances of communication protocols they propose for large scale wireless vehicular networks in realistic constraints. We plan to integrate additional features into ITS communication protocol stack in order to support other types of applications such as traffic efficiency and value-added services.

5. REFERENCES

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Digital Object Identifier: 10.4108/ICST.SIMUTOOLS2010.8697
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