DEMO: Simulating Realistic Mobility Patterns for Vehicular Networks with VanetMobiSim*

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***Abstract*— For this demonstration, we will present and describe VanetMobiSim, a generator of realistic vehicular movement traces for telecommunication networks simulators. VanetMobiSim mobility description has been validated by a comparison of its traces with TSIS-CORSIM, a benchmark traffic generator in the industry. VanetMobiSim is therefore one of the few vehicular-oriented mobility simulator fully validated and freely available to the vehicular networks research community.**

***Index Terms*— Vehicular mobility modeling, validation, vehicular ad hoc networks.**

I. Introduction

Vehicular Ad-hoc Networks (VANETs) represent a rapidly emerging, particularly challenging class of Mobile Ad Hoc Networks (MANETs). VANETs are distributed, self-organizing communication networks built up by moving vehicles, and are thus characterized by very high mobility of nodes and limited degrees of freedom in nodes movement patterns.

A critical aspect when studying VANETs, is the need for a mobility model which reflects, as close as possible, the real behavior of vehicular traffic. It would be desirable for a trustworthy VANETs simulation that both motion-constraints (road topology, street characterization, car class dependent constraints, traffic signs, etc.) and also traffic generator (car-to-car interactions, car-to-road interactions, acceleration and deceleration, overtaking, etc.) descriptions be jointly considered in modeling vehicular movements.

Nevertheless, many non-specific mobility models employed in VANETs simulations ignore these guidelines, and thus fail to reproduce peculiar aspects of vehicular motion, such as car acceleration and deceleration in presence of nearby vehicles, queuing at road intersections, clustering caused by semaphores, vehicular congestion and traffic jams.

II. VanetMobiSim

VanetMobiSim [2] is an extension to CanuMobiSim, a generic *user mobility* simulator. CanuMobiSim provides an efficient, easily extensible mobility architecture, but due to its general purpose nature, suffers from a reduced level of detail in specific scenarios. VanetMobiSim is therefore aimed at extending the vehicular mobility support of CanuMobiSim to a higher degree of realism. In the following, due to space restrictions, we only list the original additions introduced by VanetMobiSim, but the complete tool integrates all of the CanuMobiSim features, providing a very wide set of possibilities in simulating vehicular mobility. It is finally freely available on the project website [1].

A. Motion Constraints

In VanetMobisim, motion constraints takes into account the road topology, the road structure (unidirectional or bidirectional, single- or multi-lane), the road characteristics (speed limits, vehicle classes restrictions) and the presence of traffic signs (stop signs, traffic lights, etc.).

VanetMobiSim enhances CanuMobiSim allowing to define the road topology in the following novel ways:

- *User-defined graph*: the road topology is specified by listing the vertices of the graph and their interconnecting edges.
- *TIGER map*: the road topology is extracted from a map of the TIGER database.
- *Clustered Voronoi graph*: the road topology is randomly generated by creating a Voronoi tessellation on a set of non-uniformly distributed points. This creates fast and configurable random graphs, yet reflecting the non-uniform distribution of obstacles in an urban area.

The concept of vehicular motion constraints is not limited to the definition of the road topology, but also includes all aspects related to the characterization of the road structure. VanetMobiSim therefore also contains:

- Physical separation of opposite traffic flows on each road.
- Introduction of roads with multiple lanes.
- Speed constraints on each road segment.
- Implementation of traffic signs or lights at each road intersection.

B. Traffic Generator

The concept of vehicular traffic generator includes all aspects related to an individual car's speed and acceleration

*VanetMobiSim is freely available at http://vanet.eurecom.fr

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modeling. Moreover, it also includes the effects of the presence of points of interests, which influence vehicular movement patterns on the road topology.

First, VanetMobiSim contains a vehicular movement pattern selection based on points of interests and activity sequences. It is separated into a *Trip Generation* and the *Path Generation*.

The Trip generation lets the user define the trip's initial and destination points in two ways

- randomly chosen on the graph.
- chosen according to an activity sequence matrix based on a set of points of interests.

Independently from the trip generation method employed, the path generation, i.e. the selection of the best sequence of edges to reach a destination, is performed in three ways

- *Dijkstra*-based shortest path.
- Traffic Congestion-based path.
- Speed-based path.

Second, VanetMobiSim also adds two original microscopic mobility models in order to include the management of intersections regulated by traffic signs or lights, and roads with multiple lanes.

- *Intelligent Driver Model with Intersection Management* (IDM-IM) adds intersection handling capabilities to the behavior of vehicles driven by the IDM. In particular, IDM-IM models two different intersection scenarios: a crossroad regulated by stop signs, or a road junction ruled by traffic lights.
- *Intelligent Driver Model with Lane Changes* (IDM-LC) extends the IDM-IM model with the possibility for vehicles to change lane and overtake each others.

C. VanetMobiSim Validation

Several tests were run on the vehicular movement traces produced by VanetMobiSim and compared with other popular mobility models in order to show the increased realism obtained by the traces from VanetMobiSim (see [3]). It has also been rigorously validated by comparing its traces with TSIS-CORSIM, a benchmark traffic simulator that has already been calibrated and validated based on real traces. We managed to show that the mobility patterns generated by VanetMobiSim realistically reflect real vehicular motion patterns (see [2]).

D. Radio Propagation and Obstacles

Once realistic motion patterns are generated, it becomes possible to also benefit from the motion constraints description in order to model the radio propagation between vehicles. We are currently implementing a new module in VanetMobiSim which will reflect the quality of the radio link between two cars as they evolves in the VanetMobiSim's topology. Different propagation and fading models will be supported:

- Two-Rayground
- Shadow Fading
- Rician Fading

Based on VanetMobiSim's realistic topology description, it therefore becomes possible to know if two cars are in line of sight or not, and accordingly compute the propagation and fading on the radio link. The final objective is to make such information available to network simulators.

III. Demonstration

During this demonstration, we will show the movement and the connectivity of cars modeled by VanetMobiSim in various configuration such as a real map of downtown Baltimore, or based on a specific map showing particular motion patterns. First, we will show the effect of different motion constraints such as traffic lights or stop signs on the vehicular motion patterns, as well as radio obstacles acting on the LOS/NLOS connectivity. We will also show the effect of the traffic generator, including the influence of different configurations for the path generator, or the effect of overpassing in urban environment containing heterogenous vehicles (slow moving trucks, and fast moving cars).

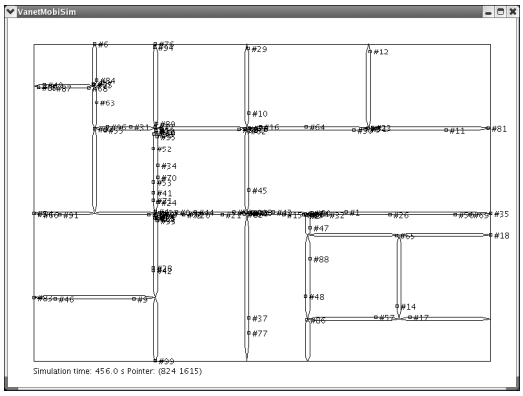

Fig. 1. Screen shot of VanetMobiSim GUI

Our objective is to convince the attendees of the level of realism obtained by VanetMobiSim considering its fast configuration and calibration compared to other commercial-based traffic generator such as CORSIM or VISSIM.

IV. Conclusions

In this demonstration, we will present VanetMobiSim, a freely available tool capable of producing realistic vehicular mobility traces for several network simulators. Our objective is to show that the features introduced by VanetMobiSim are necessary to reach a level of realism sufficient to confidently simulate VANETs mobility. Besides, VanetMobiSim is one of the few vehicular-oriented mobility simulator fully validated and freely available to the vehicular networks research community.

References

[1] VanetMobiSim Project, `http://vanet.eurecom.fr`

[2] J. Härri, M. Fiore, F. Filali, C. Bonnet, "VanetMobiSim: A Configurable Traffic Simulator for Generating Realistic Mobility Patterns for Vehicular Networks", submitted to *Elsevier Ad Hoc Networks*, preprint available on *Eurecom Technical Report RR_05_150*, March 2007.

[3] M. Fiore, J. Härri, F. Filali, C. Bonnet, "Understanding Vehicular Mobility for Network Simulation", in *Proc. of the 1st IEEE Workshop on Mobile Vehicular Networks (MoVeNet'07), part of MASS'07*, Pisa, Italy, October 2007.