

MobiCom Poster Abstract: Studying Vehicle Movements on Highways and their Impact on Ad-Hoc Connectivity*

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I. Introduction

The mobility of the nodes in a Mobile Ad-Hoc Network (MANET) is a crucial factor in the performance studies of communication protocols for these kind of networks. For this reason, researchers usually use a randomized node movement model, such as the Random Way-Point Model [6], in the process of designing or analyzing the behavior of their protocols. Since movement is not very predictable in these scenarios, they generally serve as a “worst case assumption” of node mobility concerning communication protocol performance in the sense that a positive correlation between performance in an RWP scenario and an arbitrary scenario exists. Additionally, RWP is an analytically well-understood mobility scheme and the movements can be generated very easily with tools complementary to most of the common network simulators.

Vehicular Ad-Hoc Networks (VANETs) are one type of MANETs that is recently attracting the attention of both industry and academia. VANETs are characterized by the—usually—street-bound scenarios due to the special kind of their nodes, i.e., vehicles. Recent research [3] though, shows that protocol performance in VANETs is quite different from performance in RWP scenarios and specializing protocols in these scenarios can be both challenging but also beneficial.

In this work, we present a set of real scenarios of one of the common situations in vehicular environments, i.e., highways. Additionally, an analysis from a connectivity perspective has been performed intending to support the design and/or study of communication protocols tailored to this specific environments.

Starting from reality-audited highway movement data generated for the FleetNet project [5], we have created a set of node movement traces especially for the use with network simulators like ns-2 [7]. In addition, we provide a tool, called *HWGui*, for the visualization and computation of the set of statistics dealing

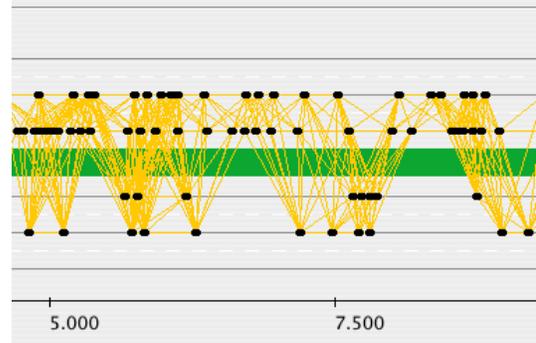


Figure 1: Partial screen shot of *HWGui*

(a) with the movements itself and (b) with the implications on communication assuming a Unit Disk Graph (UDG) [2] radio connectivity model. A screen shot of *HWGui* can be found in Fig. 1. It shows a 2×2 lane highway scenario with cars traveling in both directions. The yellow lines depict the connectivity according to UDG.

For further information on the software and for downloading the movement traces and the software, please refer to [1, 4]. The next section will briefly outline some statistical examples.

II. Statistic Examples

The available scenarios have a different number of lanes and different node densities representing varying road traffic conditions. In the following, we will shortly outline some statistical values we have computed for one example scenario with two lanes per direction and a density setting of 6 nodes per km in one direction and 2 nodes per km in the other (see [4]). Applying a unit disk graph model with an assumed radio range of 500m, Fig. 2(a) shows the distribution of nodes with n radio neighbors, e.g., about 20 nodes have 16 neighbors, which is a useful information for the designers of routing or application protocols.

Extending this single-hop value to the transitive closure of the “network”, Fig. 2(b) shows the number of communication partners available at a certain distance, e.g., in the given scenario, approximately 360 communication partners are available at $6km$ distance.

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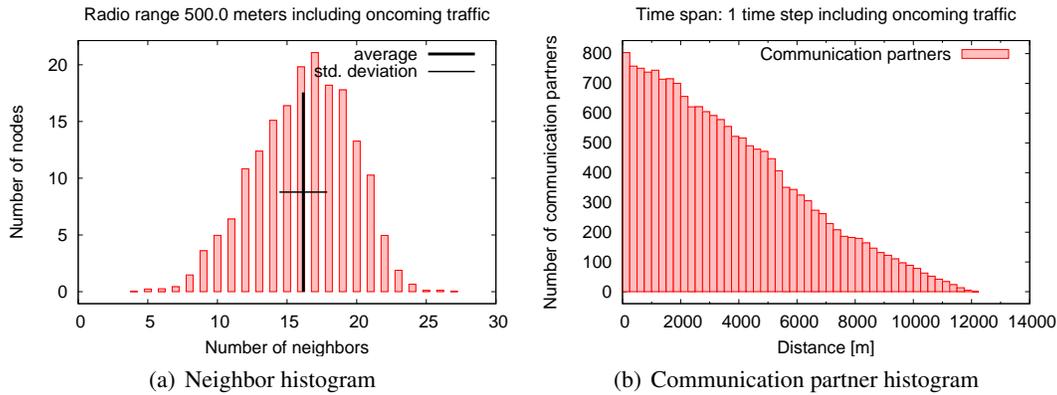


Figure 2: Connectivity statistics

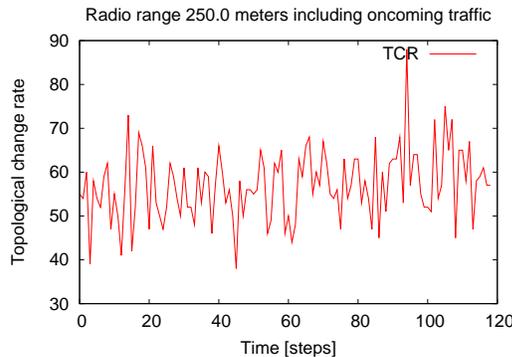


Figure 3: Topology change rate

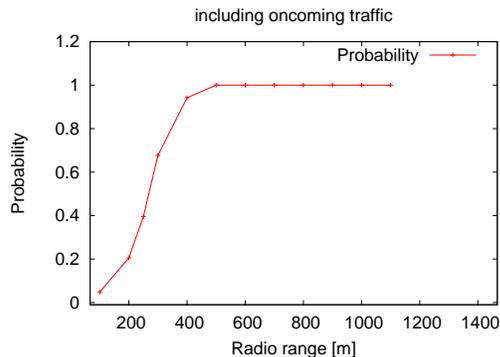


Figure 4: Probability of two nodes to be able to communicate w.r.t. radio range

While these parameter distribution are averaged over all nodes and the simulation time, it is also interesting to express the dynamics of the mobile network. Fig. 3 shows the number of topological changes occurring per time step (500ms) if nodes would have a radio range of 250m, i.e., the number of unit disk graph “links” appearing and disappearing between two neighboring position samples.

Another interesting property examined by the statistics set is the critical transmission range, i.e., the minimal radio range at which the network is transitively connected. Fig. 4 shows the average probability of two arbitrary node pairs to be able to communicate with a given radio range. Thus, in the given scenario, the critical transmission range is approximately 470m.

[4] gives a complete description of the whole set of statistics. We strongly believe that the statistics assist a network developer in understanding his simulation results and understanding the upper boundaries the unit disk graph model implies on a MANET defined by the highway movements. Thus, complemented by the visualization tool, the presented work should be useful for research dealing with this kind of networks.

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