Chapter 20
Mobility Models of Vehicular Networks

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ABSTRACT

A key component for VANET simulations is a realistic vehicular mobility model that ensures conclusions drawn from simulation experiments will carry through to real deployments. However, VANET simulations raise many new questions about suitable levels of details in simulation models. To get accurate results, the mobility models of Vehicular Networks should be as realistic as possible, and involve road-maps with all constraints and facilities related to the vehicular movement. In this chapter, the authors provide an overview of some mobility models that are relevant to VANETs. The criteria of applicability they consider here is the employment of road maps, and thus limiting the nodes movements into the routes, instead of moving them in a wide open area. They compare different models based on the parameters they use. For instance, some models use traffic control mechanisms (stop signs or traffic lights) at route intersections, and some just assume continuous movement at these points. Some assume routes to be single-lane, some others support multi-lanes routes. Some define the security distance, while others just ignore this parameter.

INTRODUCTION

To get accurate results, the model should be as realistic as possible, and involve road-maps with all constraints and facilities related to the vehicular movement. In this chapter, we provide an overview of some mobility models that are relevant to VANETs. One of the realistic applications of mobile Ad hoc Networking (MANET) is Vehicular Ad hoc Networking (VANET). In VANET, communications between nodes do not rely on any dedicated infrastructure. Although it is self-organized and easy to deploy, the infrastructureless vehicular network introduces many challenges that should be tackled before real implementations. For instance, to allow communications between nodes (vehicles) which are

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out of the power range of each other, some other intermediaries should act as routers to remedy the lack of dedicated routers. Thus, a distributed routing protocol needs to be employed. It is mandatory before passing to the real deployment of a routing protocol as well as any other protocol or application) to evaluate it by simulation. The faithfulness of the simulation results depends on the realism of the parameters and the models used in the simulation, particularly on the mobility model. This can be defined as the pattern that establish the nodes movement within simulation area during a simulation. The earlier mobility models used in MANET simulation assume the terrain to be without obstacles, and nodes to be able to move freely in the whole rectangular stimulation area. For example, Random way-point (RWP) (David et al., 1996) is a typical example of such a kind of models, which is largely used in the literature, and available in many network simulators (ns2, GloMoSim, etc.). This model defines the pause-time parameter, so that each node has phases of movement and others of pause. At the beginning, the node selects randomly and uniformly a destination where it goes using a random and constant speed, which is also selected for each movement following a uniform distribution. Once it reaches this destination it stays there for the pause-time duration, then repeats the process. It has been illustrated that this model engenders, after a given simulation time, a spatial distribution of nodes concentrated around the center of the simulation area (Bettstetter et al., 2001 ; Bettstetter et al., 2003). Generally speaking, the assumption of an open terrain is realistic for some applications of pedestrians, but it is inappropriate for VANET. More recent studies propose new models constrained to routes and obstacles, and thus are more suitable for VANET. In (Camp et al., 2002) Camp et al. discuss a variety of mobility models used to evaluate ad hoc networks, and split them up into two categories: entity models and group models. The authors show by simulation how the choice of a mobility model can have a significant effect on the performance results. However, except city section (Zheng et al., 2004), all the other models presented in this survey are inappropriate for VANETs. In (Bettstetter et al., 2001; Zheng et al., 2004) the authors classify the models according to the randomness of speeds and directions, and divide them into i) trace-based (deterministic) models, ii) constrained topology based models and iii) statistical (fully random) models. Based on this classification, (Zheng et al., 2004) provides a more recent survey of MANET's mobility models, presenting some ones that consider obstacles in the simulation area. These models are suitable to simulate pedestrian movements, but not vehicles. In (Boudec et al., 2005), the authors provide a mathematical and simulation investigations into some of the statistical (random) models, and combine them in the so-called random trip. The most recent research works on mobility models focus on the vehicular ad hoc network application of MANET. (Luo et al., 2004) provides a general survey of VANET, and the existing challenges to overcome before the real deployment. In (Chisalita et al., 2004) the authors discuss the usefulness of VANET to ensure the vehicular traffic safety and facilities, as well as the advantages it provides compared to the other centralized technologies. Some specified applications have been proposed, such as the discovery of free parking places (Caliskan et al., 2006). Regarding the mobility models, some new ones have been specifically proposed for VANET, such as (Amit Kumar Saha et al., 2004 ; Choffnes et al., 2006 ; Mahajan et al., 2006; Gorgorin et al., 2006; Karnadi et al., 2007). In this manuscript, we first present and discuss these novel models, as well as those proposed for the general MANET that apply to VANET. We also present a new vehicular traffic simulator we implemented to generate movement trace files usable by some well-known network simulator, notably GloMoSim (Zeng et al., 1998) and ns2 (The Network Simulator, 2009), then we use this tool along with GloMoSim to conduct a simulation comparative study. Our main contribution here is