Chapter 11
Mobility and Traffic Model Analysis for Vehicular Ad-Hoc Networks

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ABSTRACT

Vehicular Ad Hoc Networks represent a specialized application of Mobile Ad Hoc Networks. Here the mobile nodes move in lanes and their mobility can be modeled based on realistic traffic scenarios. To meet the above challenge the goal of defining the mobility model for vehicular ad hoc network along with a realistic traffic pattern is an important research area. Vehicular mobility is characterized by acceleration, deceleration, possibility of different lanes and intelligent driving patterns. Also a modeling of traffic is necessary to evaluate a vehicular ad hoc network in a highway environment. The traffic model has to take into account the driver behavior in order to take decisions of when to overtake, change lanes, accelerate and decelerate. To overcome the limitation of traditional mobility models and mimic traffic models, many traffic model based simulators like CORSIM, PARAMICS and MOVE have been proposed. In this chapter we provide taxonomy of mobility models and analyze their implications. To study the impact of mobility model on routing protocol for vehicular motion of nodes we analyze the performance of mobility models with suitable metrics and study their correlation with routing protocol. We also discuss the fundamentals of traffic engineering and provide an insight into traffic dynamics with the Intelligent Driver Model along with its lane changing behavior.

INTRODUCTION

Traffic Management is a huge problem in large cities. Absence of technological support to complement road safety measures results in loss of precious human lives and severe implications to our environment. According to National Highway Traffic Safety administration (Fatal Car Accidents, 2005), around 43,000 people were killed in accidents, millions of people were injured and the economic consequences of these accidents were $230 billion. The traditional safety measures like seat belts, airbags alone cannot
eliminate the problem. It is also required that the driver has the ability to foresee the developing situation on highways ahead of time (Ebner & Rohling, 2001). The usage of sensors, computer and wireless communication leads to the prediction of speed and generate warning messages frequently (Glathe, Karlsson, Brusaglino & Calandrino, 1990). Thus the wireless communication in ubiquitous fashion is achievable through Mobile Ad-Hoc Networks (MANETs). Vehicular Ad-Hoc Networks (VANETs) is one of a rapidly emerging and challenging class of MANETs (Fiore, Harri, Filali & Bonnet, 2007). In VANET nodes represent vehicles moving at a high speed and vehicle traffic determined by regularity (Takano, Okada & Mase, 2007). VANET allows for communication between vehicles and nearby road-side infrastructure (Csilla & Yuliya). With the inception of VANET, the commercial and research based interests in intelligent transport systems, accident control, traffic jams and weather updates have increased. VANETS are being studied for applications where nodes or vehicles can communicate with each other in urban streets and highways (Mahajan, Potinis, Gopalan and Wang An I-A, 2005). The cost of testing VANETs in realistic scenarios is very high and time consuming. Also the complexities involved in theoretical analysis of these dynamic vehicles with ever changing topologies are not feasible. An automated simulation tool can imitate VANETs and yields a similar result to that of real world (Hassan, 2009). To support the goal of realistic VANET simulation it is important to generate a realistic mobility model. The usage of mobility models will have a direct reflection on the protocol being used by VANETs. To explore the area of mobility models further we classify them and analyze their performance. Traffic Engineering provides a lot of useful insights into vehicular distribution and traffic jams. We discuss the basics of traffic engineering and also the traffic based motivation for mobility models. Finally we analyze the Intelligent Driver Model and future research in the area of mobility models and traffic engineering for VANETs.

**MOBILITY MODELS FOR VANET: A BACKGROUND**

Mobility models attempt to mimic the movements of real mobile nodes. The mobility scenario thus generated can then be integrated into a network simulator to perform tasks between the nodes. A mobility model for VANET poses challenges in terms of visualizing its separation at Macroscopic and Microscopic level (Fiore M et al. 2007). The node mobility that considers streets lights, roads, building, etc. are classified as Macroscopic. The movement of vehicles and their behavior is called as Microscopic. Another way to visualize mobility model for VANET is to consider it as a constituent of two blocks: Motion Constraints and Traffic Generator. (Harri, Filali & Bonnet, 2005). Motion constraints describe how each vehicle moves and which is obtained from a topological map. Traffic generator, generates different kinds of cars and deals with interactions with cars. Traffic regulations and traffic sign considerations.

If we consider globally, the development of modern vehicular mobility models can be clustered into four different classes like the synthetic model, traffic simulator based model, survey based models and finally trace-based model (Harri J, Filali F & Bonnet C, 2007). This is illustrated in Figure 1.

The above classification is as described in the following sections

**Synthetic Models**

The basic mobility models were the first to evolve from the synthetic class models. The classification of Synthetic models according to Fiore (Fiore M 2006, 2009) is divided into five classes. Stochastic Models, Traffic Stream Models, Car following Models, Queue Models and Behavioral Models.