Chapter 8
Creating Realistic Vehicular Network Simulations

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ABSTRACT

A key component for Vehicular Ad-Hoc Network (VANET) simulations is a realistic vehicular mobility model, as this ensures that the conclusions drawn from simulation experiments will carry through to the real deployments. Node mobility in a vehicular network is strongly affected by the driving behavior such as route choices. While route choice models have been extensively studied in the transportation community, the effects of preferred route and destination on vehicular network simulations have not been discussed much in the networking literature. In this chapter, the authors describe the effect of route choices on vehicular network simulation. They also discuss how different destination selection models affect two practical ITS application scenarios: traffic monitoring and event broadcasting. The chapter concludes that selecting a sufficient level of detail in the simulations, such as modeling of route choices, is critical for evaluating VANET protocol design.

INTRODUCTION

Vehicular Ad-Hoc Network (VANET) communication has recently become an increasingly popular research topic in the area of wireless networking, as well as in the automotive industry. The goal of VANET research is to develop a vehicular communication system to enable the quick and cost-efficient distribution of data for the benefit of passengers' safety and comfort.

While it is crucial to test and evaluate protocol implementations in a real world environment, simulations are still commonly used as a first step

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in the protocol development for VANET research. Several communication networking simulation tools already exist to provide a platform to test and evaluate network protocols, such as ns-2 (Breslau, 2000), OPNET (Chang, 1999) and Qualnet (http://www.scalable-networks.com/). However, these tools are designed to provide generic simulation scenarios, without being particularly tailored for applications in the transportation environment. In addition, simulations also play an important role in the field of transportation. A variety of simulation tools, such as PARAMICS (Cameron, 1996), CORSIM (Halati, 1997) and VISSIM (Fellendorf, 1994), have been developed to analyze transportation scenarios at the micro- and macro-scale levels. However, to date there have been only few attempts (Saha, 2004; Mahajan, 2006; Baumann, 2007; Dressler, 2010) to create communication scenarios in a realistic transportation simulation environment.

One of the most important parameters in simulating vehicular networks is the node mobility. It is important to use a realistic mobility model so that results from the simulation correctly reflect the real world performance of a VANET, as shown in some prior studies (Saha, 2004; Heidemann, 2001). Node mobility in a vehicular network is strongly affected by the drivers' behavior, which can change road traffic at different levels. Drivers' preferences in path and destination selection can further affect the overall network topology. It has been shown that drivers tend to use certain regular routes for their daily routines (Abdel-aty, 1994), and only 15.5% of commuters reported that they did not always choose the same exact route to work. Once a commuter has settled on a habitual route, the route choice strategies they deploy might possibly descend to a subconscious level, unless there are external factors (e.g., accidents or traffic jams) that bring the choice of route back to the conscious level (Tawfik, 2010). Furthermore, some commuters might select their routes based on the suggestions of some travel guidance system, such as variable message signs. Once a commuter has had a good experience with using a travel guidance system, they might increase their reliance on such advice the next time they travel (Zhao, 2010). While most current navigation systems use the shortest path to the destination for selecting routes, some commuters use faster paths instead of shorter ones to avoid congestion and reduce travel time. Some studies also show that path selection could possibly change on a temporal basis (Li, 2005; Chen, 1993). For example, when driving in the evening commuters usually have more flexibility in selecting alternate routes than when they drive to work in the morning.

In this chapter, we discuss the effect of path selection (for a particular destination) and destination selection on vehicular network simulations. We also consider two application scenarios in which we assume cars are equipped with sensors and can collect road information. In the first scenario, we consider the situation in which some road-side units (RSUs) are deployed so that cars can push their sensor data online via the help of such units, which we assume are connected to servers on the Internet. In other words, each car can upload its sensor data to the Internet when it encounters a RSU. We also assume that the sensor data can be sent to a RSU even when it is far away if there exists a multi-hop path between the source and the RSU. In the second scenario, we consider the case in which cars want to disseminate their sensor information over the vehicular network via vehicle-to-vehicle communication only.

RELATED WORK

Details in the mobility model may have a critical effect on the fidelity, and thus the usefulness, of the resulting network simulations. Zhang *et al*. (Zhang, 2007) used traces taken from the UMassDieselNet project (Burgess, 2006) to study the effect of mobility models on the performance of Delay-

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