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Performance Evaluation of Topology based Routing Protocols in a VANET Highway Scenario

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ABSTRACT

Vehicular Ad-Hoc Network (VANET) has been derived from the well-established Mobile Ad-hoc Network (MANET). It facilitates wireless communication among vehicles to roadside equipment. Such kind of communication is utilized for different purposes such as safety, comfort, or even entertainment. The performance of VANET applications are highly determined by its underlying routing protocols. In this paper, the authors investigate the performance of topology based MANET routing protocols (AODV, DSDV and DSR) in a VANET highway design using NCTUNS 6.0 simulator. Different parameters are varied including speed, node density, propagation loss model, fading effects, data rate and payload. The selected routing protocols are then evaluated in terms of performance metrics throughput, packet drop and packet collision. Results shows that the performance of routing protocols depends on the application requirements in terms of throughput, delay and percentage of packet drops.

KEYWORDS

Ad-Hoc Network, IEEE 802.11p, NCTUNS 6.0, Routing Protocols, VANET's

INTRODUCTION

Intelligent transportation system (ITS) enhances the deficiency of the transportation system through the usage of the modern wireless communication technologies. The benefits experienced are reduced accidents, less traffic congestion and more comfort travel (Dimitrakopoulos & Demestichas, 2010). Nowadays, vehicles can communicate among themselves and with the infrastructure as human or smartphones and this is made it possible with the technology of VANET's.

Vehicular Ad hoc Networks (VANET) is a subclass of Mobile Ad Hoc Network (MANET) that uses moving vehicles as nodes to form a wireless network that helps vehicles to communicate and exchange information during their movement on roads (Xing & Cai, 2012). It is an influencing area for the improvement of ITS in order to provide safety and comfort to road users.

The communication that takes place in VANET is Vehicle-to-Vehicle (V2V) using On-Board Units (OBUs) and Vehicle to Infrastructure (V2I) using OBUs and Road Side Units (RSUs). As a result of the cost associated in prototyping and deploying real-world VANET, most current research work in VANET relies on the use of simulation studies to evaluate system behavior and performance (Guo, Ammar, & Zegura, 2005).

Despite of the similarities with MANET's, VANET's have some distinct characteristics and features. These unique features includes: fast movement of vehicles on road, frequent connect/

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disconnect of network topology, unrestricted power supply, more processing capability and poses more delay constraint challenges for many applications (Mittal, 2010).

The Federal Communications Commission (FCC) realized the requirements of inter-vehicle communication and has allocated a frequency of 75MHz around 5.9GHz (5.850 to 5.925 GHz) range known as Dedicated Short Range Communication (DSRC) (Hartenstein & Laberteaux, 2010). Wireless Access in Vehicular Environment (WAVE) is considered as a core component of DSRC. IEEE 802.11p standards are oriented towards PHY and MAC layers. Figure 1, shows the WAVE protocol stack along with the frequency spectrum.

Some vehicles manufacturers already incorporated this technology in their products. We expect that passengers will soon ask for utilizing all their favorite wireless networking applications, including real time applications (Tonguz & Boban, 2010).

VANET CHARACTERISTICS

VANET is a new evolving technology that recently attracted the attention of researchers, automobile industry and academic institutions. It uses moving vehicles equipped with the latest wireless technology to form an Ad hoc network for exchange of information (Jakubiak & Koucheryavy, 2008). The main purpose of this technology is to support wide range of applications such as road safety, traffic management, comfort and entertainment as well.

VANET communications are classified into three forms, namely: Vehicle to Infrastructure (V2I), Vehicle-to-Vehicle (V2V) and V2X or Hybrid (V2I and V2V). V2I deals with the data transfer between On Board Unit (OBU) equipped in each vehicle and Road Side Units (RSUs) positioned along road sides with some predetermined distances between them. In V2V, data is transferred between OBUs of the vehicle peers. As shown in Figure 2, Infrastructure-to-Infrastructure (I2I) uses different wireless technology standard other than IEEE 802.11p and thus not categorized under VANETs. The VANET

Figure 1. WAVE protocol stack and DSRC channel allocation