

Performance of VANET through Realistic Large Scale Fading Channels

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Abstract

Vehicular Ad Hoc Network (VANET) is a form of wireless Ad Hoc Network is a promising technology to enable the communication among vehicles and nearby RSU(roadside units). It is a special type of Mobile Ad Hoc Network (MANET) to provide various services to the drivers: such as safety warnings from traffic accidents, information about traffic jamming, entertainment etc. In VANETs there is rapid change in network topology because mobile nodes (vehicles) are of highly mobile and dynamic nature so VANETs are different from other wireless ad hoc networks Due to these characteristics there exists a no of research issues in VANET e.g. issues in routing, sharing of data, issues in security etc. In this paper, we develop appropriate scenarios for VANET in the realistic channel conditions e.g. Highway, RSU-OBU (On Board Unit) scenario. We studied the performance of VANET through different large scale realistic wireless channels e.g. free space and shadowing. We have selected NCTUns 6.0(National Chiao Tung University Network Simulator) to validate our findings that is a GUI based high-fidelity network and traffic simulator and emulator that uses the novel kernel-reentering methodology for simulation results.

Keywords: VANET, ITS, MANET, V2V.

1. INTRODUCTION

Every day, a lot of people die, and many more are injured in traffic accidents around the world. The desire to disseminate road safety information among vehicles to prevent accidents and improve road safety was the main motivation behind the development of VEHICULAR Ad Hoc Networks (VANETs). VANETs are a promising technology to enable communications among vehicles on roads [23]. It enables the connectivity of users on-the-move and also implement Intelligent Transportation Systems (ITS). The latter is a technology that refers to smart transportation information collection and dissemination, such as cooperative traffic monitoring, collision prevention and real-time detour computation [3]. The development covers both vehicular communications vehicle to vehicle communications (V2V) and vehicle to infrastructure (V2I). VANETs resemble classical Mobile Ad-hoc Networks (or MANETs), but they also have some unique characteristics. The most important one is the geographically constrained topology. In VANETs, nodes cannot freely move around an area or surface; their movements are restricted within the roads formed around obstacles such as buildings. These obstacles have also a great effect in the transmitted wireless signals, causing large distortions to them. A side-effect of this is the partial predictability of nodes' movements. Another interesting characteristic is the large scale of the network, as VANETs may comprise hundreds or thousands of nodes that may be too close together or too far away. Finally, in VANETs the nodes' power consumption is not a critical design parameter [4].

An ad hoc network, among which are the VANETs, makes no use of fixed network infrastructure, so that communication and organization of the network is in charge of each of the nodes (vehicles) within it. The messages in the network hop by hop and the decision of what is the next node in the path lies in each one of the vehicles are moving [1].

VANETs have attractive and unique features, distinguishing them from other types of MANETs, such as normally higher transmission power, higher computational capability, and some kind of predictable mobility, in comparison with general MANETs [15]. VANET suggests unlimited advantages to companies of any size. Vehicles access of fast speed internet which will change the automobile's on board system from an effective widget to necessary productivity equipment, making nearly any internet technology accessible in car. If a traveler download his email, he can transform jam traffic into a productive task and read on-board system and read it himself-if traffic stuck. One can browse the internet when someone is waiting in car for a relative or friend. If GPS System is integrated it can give us a benefit about traffic related to reports to support the fastest way to work.

The special behaviour and characteristics of VANETs raise important technical challenges that should be considered to deploy these networks effectively. The most challenging issue is potentially the high mobility and the frequent changes of the network topology [2], [5]. In VANETs, the network topology could vary when the vehicles change their velocities and/or lanes. These changes depend on the drivers and road situations and are normally not scheduled in advance.

In this paper, we studied the performance of VANET through large scale fading channels. The organization of the paper is as follows: In Section II Related Work about VANET is discussed. Section III Simulation Scenarios for VANET are created. Section IV provides the results and discussion. Finally, Section V concludes the paper.

2. RELATED WORK

Pratap Kumar Sahu et al. [6] proposed a hop greedy routing scheme that yields a routing path with the minimum number of intermediate intersection nodes while taking connectivity into consideration. Moreover, they introduce back-bone nodes that play a key role in providing connectivity status around an intersection. Apart from this, by tracking the movement of source as well as destination, the back-bone nodes enable a packet to be forwarded in the changed direction. Simulation results signify the benefits of the proposed routing strategy in terms of high packet delivery ratio and shorter end-to-end delay.

Pavlos Sermpezis et al. [7] presented a new routing technique designed exclusively for VANETs and present some initial performance results. The algorithm was named Junction-based Multipath Source Routing (JMSR). Its main characteristics comprise the multiple routes towards the destination, the junction-centric logic and the adoption of source routing mechanisms.

C. T. Barba et al. [8] presented the design and evaluation of GBSR-B, a routing protocol based on GPSR that seeks to improve the performance of VANETs over urban scenarios. Their proposal includes a novel algorithm to select the optimal next-hop forwarding node. This paper also presents an alternative to the perimeter mode used in GPSR. They compare the proposal GBSR-B to GPSR and AODV using the network simulator NCTUns 6.0, showing better results in terms of packet losses.

Shie-Yuan Wang et al. [9] they proposed a receiver-centric WBSS (Wave Basic Service Set)-creating scheme to support multi hop data forwarding in WBSS-based IEEE 802.11(p)/1609 networks and evaluate its performances using simulations. Their simulation results show that this scheme outperforms a typical sendercentric WBSS-creating scheme on end-to-end flow goodputs under different traffic loads.

Mohammad Al-Rabayah et al. [10] presented a new hybrid location-based routing protocol that is particularly designed to address the issue in Vehicular ad hoc networks (VANETs) that is a highly mobile wireless networks that are designed to support vehicular safety, traffic monitoring, and other commercial applications. This new protocol combines features of reactive routing with location-based geographic routing in a manner that efficiently uses all the location information available. They show through analysis and simulation that their protocol is scalable and has an optimal overhead, even in the presence of high location errors.

Nikoletta Sofra et al. [11] provide a metric to support the design of networks that can proactively adapt to a constantly changing topology. They present a method that produces a link lifetime- related metric capable of capturing the remaining time for which a link can be used for efficient communication. They propose a cross-layer approach, which utilizes physical layer information, and formulate the relevant parameter estimation problem. The proposed scheme outperforms existing affinity-based schemes, achieving to opt for links that last up to 35% longer under the presence of shadow fading.

Nawaporn Wisitpongphan et al. [12] presented a comprehensive analytical framework to study the disconnected network phenomenon and its network characteristics. Their results show that, depending on the sparsity of vehicles market penetration rate of cars using Dedicated Short Range Communication (DSRC) technology, the network re-healing time can vary from a few seconds to several minutes. This suggests that, for vehicular safety applications, a new ad hoc routing protocol will be needed as the conventional ad hoc routing protocols such as Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV) will not work with such long re-healing times. In addition, the developed analytical framework and its predictions provide valuable insights into the VANET routing performance in the disconnected network regime.

Josiane Nzouonta et al. [13] presented a class of routing protocols called road-based using vehicular traffic (RBVT) routing, which outperforms existing routing protocols in city-based vehicular ad hoc networks (VANETs). They designed and implemented a reactive protocol RBVT-R and a proactive protocol RBVT-P and compared them with protocols representative of mobile ad hoc networks and VANETs.

3. SIMULATION METHODOLOGY

The purpose of our study is to investigate the challenges in the realization of future VANETs and study the performance of VANET through large scale fading channels. Previous studies on VANET focused more on single ad hoc routing method. Thus single ad hoc routing method is not sufficient enough in meeting all the different types of ad hoc networks. Furthermore, most researchers focused on single environment of VANET i.e. either on highway or in city to evaluate the performance of different routing protocols. And they evaluated the performance of VANET only in free space without considering different realistic scenarios with different fading channels for the performance evaluation of VANET. Therefore in our study we consider different realistic scenarios consist of Urban Area/City Are, Rural Area / Highway, RSU –OBU scenario in order to develop appropriate scenarios to the performance evaluation of VANETs.

3.1 Selection of Simulation Tool

Tool selection is important to validate any finding. We have selected NCTUns 6.0(National Chiao Tung University Network Simulator) to validate our findings that is a GUI based high-fidelity network and traffic simulator and emulator that uses the novel kernel-reentering methodology for simulation results. NCTUns 6.0 is supported by RED-HAT LINUX

with the flavor fedora 12 and this simulator is purely written in C++. Several other simulation tools like NS-2, OPNET, OMNET++, TRANS etc are available in the market but we decided to choose NCTUns. The reason to choose NCTUns is that, it provides maximum support to VANET. NCTUns supports various VANET standards i.e. IEEE 802.11 (a), (b) and (p) to make communication better for V2V and V2I in the Intelligent Transportation System (ITS). Due to its highly GUI environment, network design for different scenarios in VANET are easy and less time consuming as compared to other network simulators and it provide less programming overhead.

3.2 Simulation Setup

The first step for simulation setup is to create Vehicular Ad Hoc Network. Network is created by using blank project workspace that is provided by NCTUns. For simulation setup for VANET we followed following mentioned steps:

3.2.1 Draw Topology

In this step we designed roads networks and select the total number of nodes. First we designed the roads by selecting the appropriate icons for road design that is provided by NCTUns. Total length of the roads network also defined in this step.

3.2.2 Edit properties

In this step we assigned different values in each parameter of vehicular nodes and configured each parameter that is provided by NCTUns. Besides these node settings other important settings for simulation and communication among various nodes such that defining the total simulation time, signal selection, communication type etc. In this simulation study for the RSU-OBU Scenario, we have selected the following network parameters and tools for vehicular nodes and communication among them as shown in Table1.

Table 1: Simulation Parameters for RSU-OBU Scenario

Parameters	Value
Packet Size	1400 bytes
Simulation Time	400 sec
RSU	4
Simulation Area Size	1600*1600 meter (upper bound)
OBU	1
ITS Car moving speed	20 m/sec
Data Rate	27 Mbps
Transmit Power	28.8dbm
Receiver Sensibility	-82.0 dbm
ITS Car	IEEE 802.11 (p) agent controlled

3.2.3 Simulation scenario

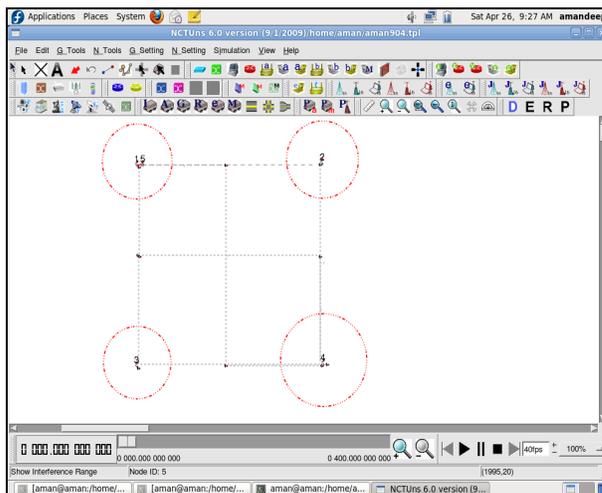


Figure 1 (a) RSU-OBU Scenario

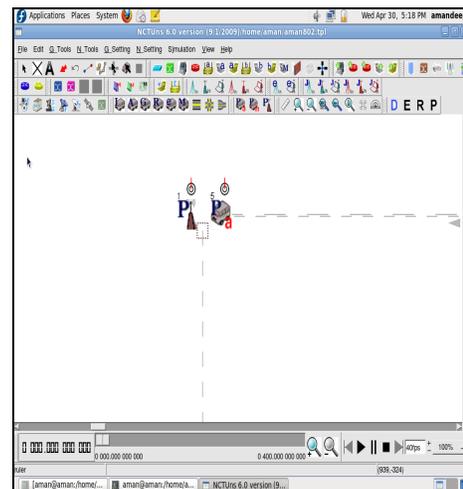


Figure 1 (b) RSU-OBU Scenario

We have created another scenario i.e. Highway scenario for evaluating the performance of VANET with varying values of path loss exponent. Table 2 shows the network parameters used for Highway Scenario.

Table 2: Simulation Parameters for Highway scenario

Parameters	Value
Packet Size	2000 bytes
Simulation Time	400 sec
Length of road segment	30 meter
Average distance between two cars on same lane	500 metres
Total no of deployed cars on roads	20
Data Rate	27 Mbps
ITS Car	IEEE 802.11 (p) agent controlled

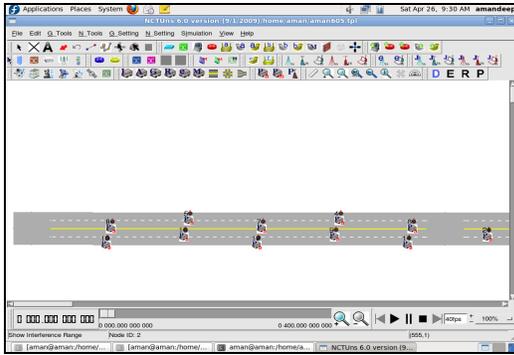


Figure 2 (a) Highway Scenario

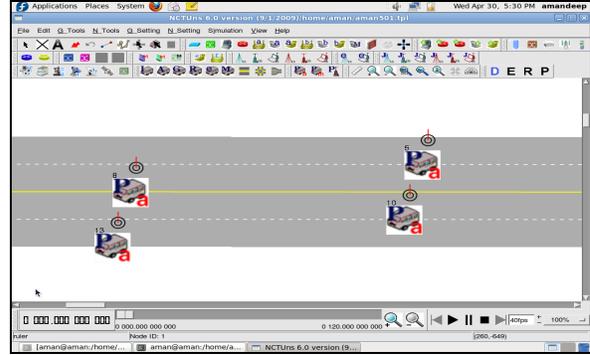


Figure 2 (b) Highway Scenario

4. RESULTS AND DISCUSSION

4.1 Scenario1

In this, we have selected free space and shadowing as path loss model and varied the values of Shadowing Standard Deviation from 2 to 6dB. Based on extensive literature survey it was found that for realistic scenarios the value of standard deviation is up to 7 dB for shadowed fading channels and when no LOS exists, large scale signal variation exactly fit long normal distribution and that standard deviation is about 4dB [16]. So, the value of shadowing standard deviation factor is different depending upon the different realistic scenario. Here, we have chosen three values of shadowing standard deviation i.e. n=2, 4, 6 (where n represents Shadowing Standard Deviation value) for evaluating the performance of VANET and studied the throughput and effect of packet loss on the performance of VANET in RSU-OBU Scenario as shown in figure 3, 4.

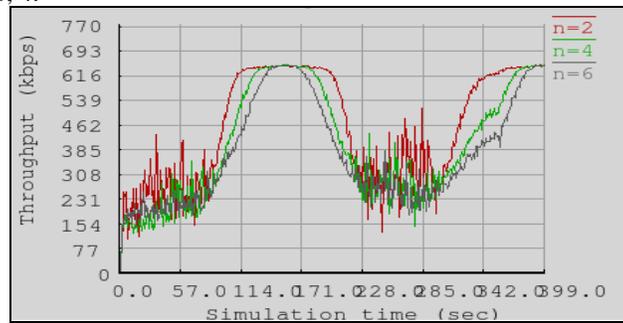


Figure 3 Throughput in large scale shadowed fading scenario

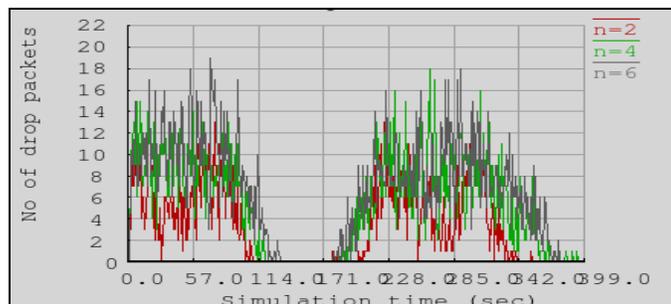


Figure 4 Packet loss in large scale shadowed fading scenario

Table 3: Graph Analysis of large scale shadowed fading scenario at time=114 sec

Shadowing Standard Deviation(n)	Simulation Time (sec)	Throughput (kbps)	No of drop packets
2	114	616	2
4	114	539	4
6	114	462	10

Table 4: Graph Analysis of large scale shadowed fading scenario at time=285 sec

Shadowing Standard Deviation(n)	Simulation Time (sec)	Throughput (kbps)	No of drop packets
2	285	528	2
4	285	308	10
6	285	231	17

4.2 Scenario 2

In this, we have selected free space as path loss model and by varying the values of Path Loss Exponent factor from 2 to 4, we studied the effect of path loss on the performance of VANET in Highway Scenario as shown in figure 5, 6 where n represents Path Loss Exponent value. For free space the value of Path Loss Exponent is 2. And as we move towards more realistic scenarios e.g. Highway or City environment the value of Path Loss Exponent increases. Because in City environment due to increase in obstacles like buildings, trees, railway crossing path loss increases.

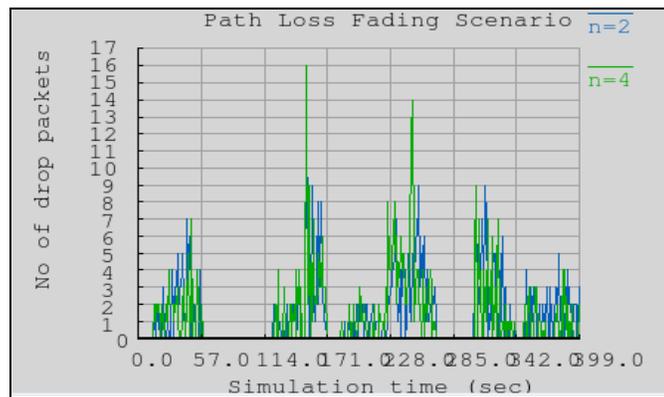


Figure 5 Path loss in Highway Scenario with n= 2, 4

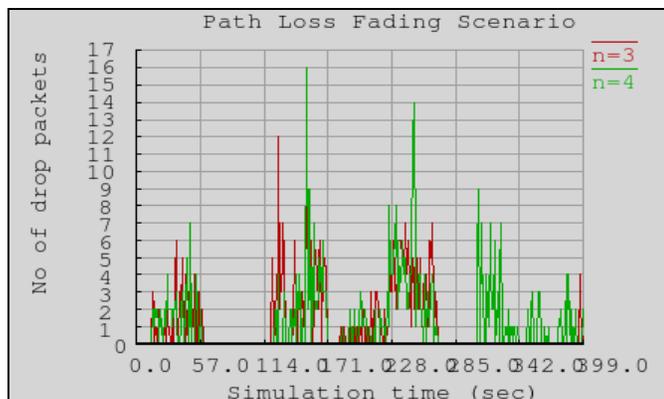


Figure 6 Path loss in Highway Scenario with n= 3, 4

Table 5: Graph Analysis of Path loss in Highway Scenario with n= 2, 4

Path Loss Exponent (n)	Simulation Time (sec)	No of drop packets
2	154	2
4	154	16

Table 6: Graph Analysis of Path loss in Highway Scenario with n= 3, 4

Path Loss Exponent (n)	Simulation Time (sec)	No of drop packets
3	247	5
4	247	14

5. CONCLUSION

The purpose of our study is to investigate the challenges in the realization of future VANETs. In this paper, we studied the performance of VANET through different large scale wireless fading channels. For this, we have created two scenarios RSU-OBU Scenario and Highway Scenario. In RSU-OBU Scenario, we have selected Free Space and Shadowing as a Path Loss Model and varied the values of Shadowing Standard Deviation factor from $n=2$ to 6. We analyzed from the Throughput and Packet loss graphs that the performance of VANET in RSU-OBU gradually decreases with the increase in Shadowing Standard Deviation factor as throughput decreases and no of drop packet increases with increase in Standard Shadowing Deviation factor. In Second Scenario i.e. Highway Scenario we have selected Free Space as Path Loss Model and varied the values of Path Loss Exponent factor from $n=2$ to 4 and plotted the graph between drop packets versus Simulation time. We analyzed that in Highway Scenario path loss increases as increase in values of Path Loss Exponent resulting in degrade in performance of VANET.

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