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RESEARCH ARTICLE

Simulative Investigation of VANET through Small Scale LOS-NLOS Channel Conditions

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Abstract— VANET that stands for Vehicular Ad Hoc Network is a powerful technology to provide the communication between vehicles and nearby RSUs (roadside units). It is a type of Mobile Ad Hoc Network (MANET) to provide the drivers with following services: such as safety warnings to protect them from traffic accidents, jammed traffic information, entertainment etc. In VANETs network topology changes because mobile nodes that are vehicles here move very rapidly and cause fast change in topology. Vehicle's nature is dynamic and highly mobile. Due to this nature, VANETs are different from other available wireless 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. City, RSU (Road Side Unit)-OBU (On Board Unit) scenario. We studied the performance of VANET through different small scale realistic LOS-NLOS channels conditions e.g. Rayleigh Fading Model and Rician Fading Model. 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; V2I; NCTUns; RSU; OBU

I. INTRODUCTION

VANET that stands for Vehicular Ad Hoc Network is a powerful technology to provide the communications between vehicles that are of mobile nature [23]. Users can be connected with each other while moving on the road with the help of VANET and Intelligent Transportation Systems (ITS) can also be implemented in this. VANET is a technology that provides the transportation information about traffic monitoring, prevention from collisions and real-time detour computation [10]. Both type of communications vehicle to vehicle communications and vehicle to infrastructure are covered in VANET. VANETs have almost similar features like Mobile Ad-hoc Networks (or MANETs), but they also have some unique characteristics that distinguished it from other wireless networks. The best one is the geographically constrained topology. In VANETs, nodes means vehicles cannot freely move within an area; they can move only within the roads that are formed around obstacles such as buildings, trees etc. 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 consumptions not a critical design parameter [15]. The idea of Inter-vehicle Communications (IVC) or Vehicle-to-Vehicle (V2V) communications has been proposed and studied for several decades. One of the earliest studies on IVC was started by JSK (Association of Electronic Technology for Automobile Traffic and Driving) of Japan in the early 1980s. Later, California PATH [18] and Chauffeur of EU [25] have also demonstrated the technique of coupling two or more vehicles together electronically to form a train. The intention of DRIVE is to improve traffic efficiency.

It focuses on the infrastructure requirements, traffic operations, and technologies of interest to public agencies responsible for the European road transport systems. Recently, the CarTALK 2000 [9] tries to investigate the problems related to safe and comfortable driving based on inter-vehicle communications. Since 2002, with the rapid development of wireless ad hoc networking technologies, VANETs have drawn a significant research interests from both academia and industry. The number of papers on VANETs has been dramatically increased. On the other hand, several major automobile manufacturers have already begun to invest real inter-vehicle networks. Audi, BMW, DaimlerChrysler, Fiat, Renault, and Volkswagen have united to create a non-profit organization called Car2Car Communication Consortium (C2CCC) that provides the road safety with the help of inter-vehicle communications.

In this paper, we studied the performance of VANET through small scale LOS-NLOS Channel conditions. 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.

II. RELATED WORK

MoezJerbi et al. [7] presented an improved greedy traffic-aware routing protocol (GyTAR), which is an intersection-based geographical routing protocol that is capable of finding robust and optimal routes within urban environments. The main principle behind GyTAR is the dynamic and in-sequence selection of intersections through which data packets are forwarded to the destinations. The intersections are chosen considering parameters such as the remaining distance to the destination and the variation in vehicular traffic.

Wenjing Wang et al. [8] presented vehicular mobility model that reflects real-world vehicle movement and study the performance of packet-routing protocols. First, they study the routing in small-scale VANETs and propose two routing schemes: 1) connection-based restricted forwarding (CBRF) and 2) connectionless geographic forwarding (CLGF). They introduce a two-phase routing protocol (TOPO) that incorporates road map information. To validate their design philosophy and the routing protocol, they use different areas in the city of Orlando, FL, and generate vehicular mobility traces, following their mobility models. They feed the traces to network simulators and study the routing behavior.

Wantanee Viriyasitavat et al. [9] presented a new broadcast routing protocol, Urban Vehicular BroadCAST (UVCAST), which addresses both the broadcast storm and disconnected network problems in urban VANET.

Khaleel Mershad et al. [10] exploited the infrastructure of roadside units (RSUs) to efficiently and reliably route packets in VANETs. The system operates by using vehicles to carry and forward messages from a source vehicle to a nearby RSU and, if needed, route these messages through the RSU network and, finally send them from an RSU to the destination vehicle. They evaluated the performance of their system using the ns2 simulation platform and compare their scheme to existing solutions.

M. T. Barros et al. [11] presented a routing architecture for VANETs . Their produced protocol is the Generic Vehicular Dynamic Source Routing (GVDSR). Simulations of the GVDSR protocol have been made on the Malaga city showing the contributions and advantages for routing performance. Their proposed architecture and protocol were simulated in the Network Simulator 2 featuring better performance than the compared protocols

III. 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 small scale fading channels. 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.

A. 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.

B. Simulation Setup

1) *Draw Topology*: In this step we designed roads networks and select total no of nodes. First we designed the roads by selecting appropriate icons for road design that is provided by NCTUns. Total length of the road network also defined in this step.

2) *Edit Properties:* In this simulation study for RSU-OBU Scenario, we have selected following network parameters and tools for vehicular nodes and communication among them as shown in table I.

TABLE I Simulation Parameters for RSU-OBU Scenario

Parameters	**Value**
Packet Size	1400 bytes
Simulation Time	400 sec
RSU	4
Simulation Area Size	1450*1450 meter (upper bound)
OBU	1
ITS Car moving speed	20 m/sec
ITS Car	IEEE 802.11 (p) agent controlled

3) Simulation Scenario

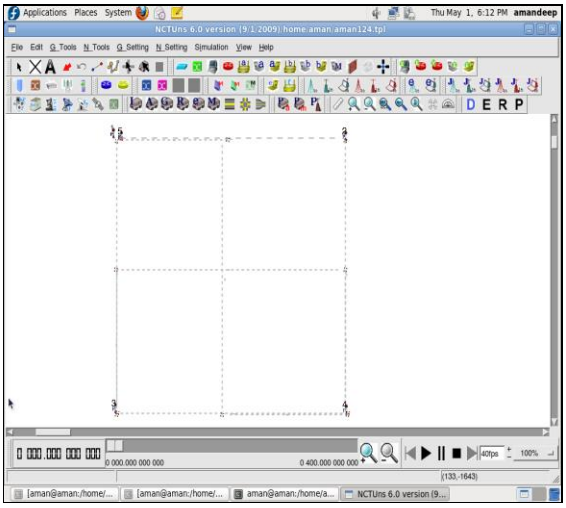

Fig. 1 (a) RSU-OBU Scenario

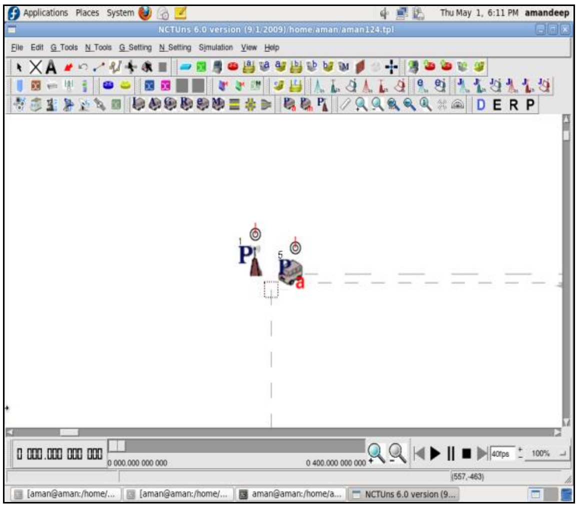

Fig. 1 (b) RSU-OBU Scenario

We have created another City Scenario for Small scale LOS-NLOS channel, and selected the following network parameters and tools for vehicular nodes and communication among them as shown in Table II.

TABLE II Simulation Parameters for City Scenario

Parameters	**Value**
Packet Size	1400 bytes
Simulation Time	400 sec
Length of Road Segment	30 meter
Simulation Area Size	850*850 meter (upper bound)
MAC Specification	IEEE 802.11 (p)
Average distance between two cars on same lane	400 meter
Total no of deployed cars on roads	30
Data Rate	27 Mbps
ITS Car	IEEE 802.11 (p) agent controlled

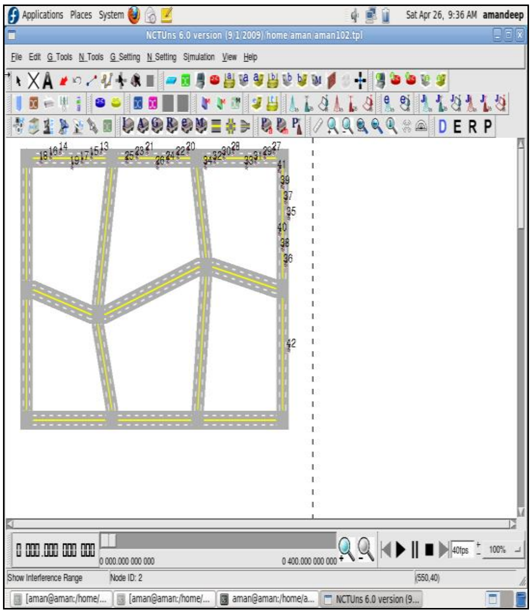

Fig. 2 (a) City Scenario

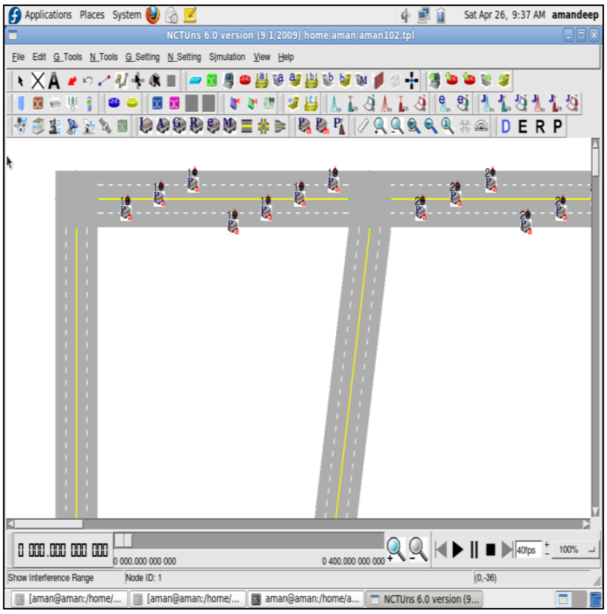

Fig. 2 (b) City Scenario

IV. RESULTS AND DISCUSSION

A. Scenario1- RSU-OBU Scenario

In this, we considered two different cases for evaluating the performance of VANET. In first case, we selected Free Space as Path Loss Model and Rician as Fading model where Rician Fading Model represents Line of Sight (LOS) Condition. In second case, we selected Free Space as Path Loss Model and Rayleigh as Fading model where Rayleigh Fading Model represents Non Line of Sight (NLOS) Condition and investigated the performance of VANET through small scale LOS –NLOS Channel Conditions in terms of throughput variations and packet loss for RSU-OBU Scenario as shown in fig 3,4.

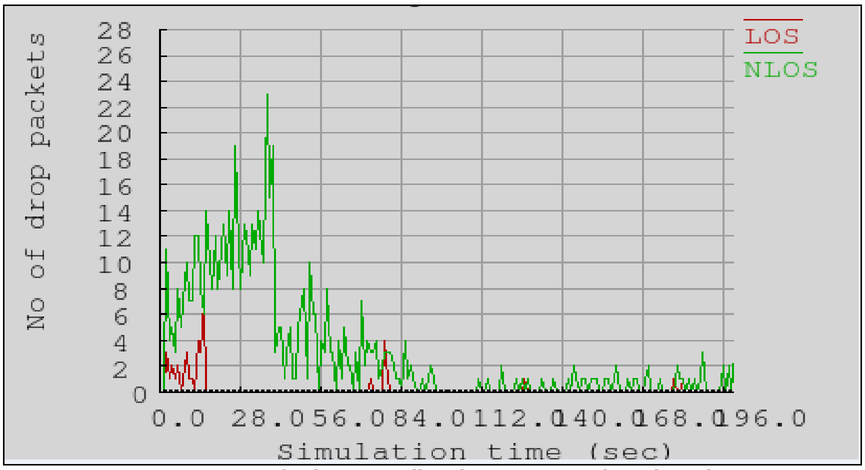

Fig. 3 Packet loss in Small Scale LOS-NLOS Channel Conditions

Here LOS represents Rician channel condition and NLOS represents Rayleigh channel condition.

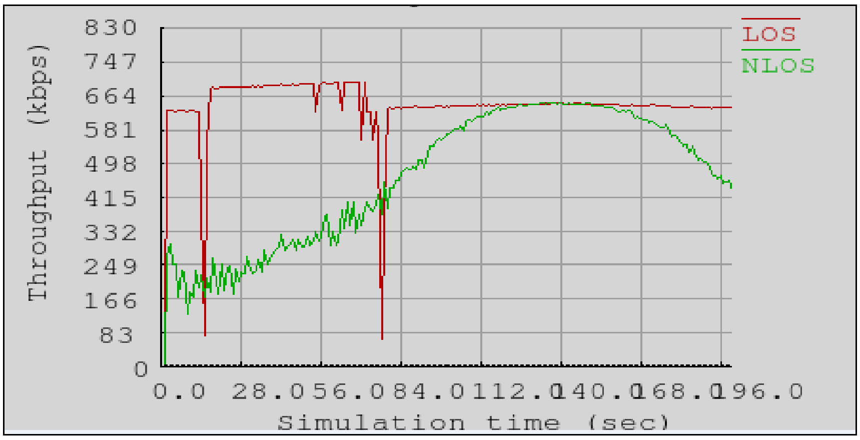

Fig. 4 Throughput variations in Small Scale LOS-NLOS Channel Conditions

TABLE III Packet Loss Graph Analysis of Small Scale LOS-NLOS Channel Conditions at time=14sec

Fading Model	Simulation Time (sec)	No of drop packets
LOS (Rician Fading)	14	4
NLOS (Rayleigh Fading)	14	12

TABLE IV Packet Loss Graph Analysis of Small Scale LOS-NLOS Channel Conditions at time=38sec

Fading Model	Simulation Time (sec)	No of drop packets
LOS (Rician Fading)	38	0
NLOS (Rayleigh Fading)	38	23

TABLE V Throughput Graph Analysis of Small Scale LOS-NLOS Channel Conditions at time=28sec

Fading Model	Simulation Time (sec)	Throughput (kbps)
LOS (Rician Fading)	28	689
NLOS (Rayleigh Fading)	28	237

TABLE VI Throughput Graph Analysis of Small Scale LOS-NLOS Channel Conditions at time=196sec

Fading Model	Simulation Time (sec)	Throughput (kbps)
LOS (Rician Fading)	196	639
NLOS (Rayleigh Fading)	196	457

B. Scenario II- City Scenario

In this, we created another scenario i.e. City Scenario for evaluating the performance of VANET with considering two cases for the same. In first case, we selected Free Space as Path Loss Model and Rician as Fading model for City Scenario where Rician Fading Model represents Line of Sight (LOS) Condition. In second case, we selected Rayleigh as Fading Model for City Scenario where Rayleigh represents Non Line of Sight (NLOS) Condition and investigated the performance of VANET for City Scenario through small scale LOS –NLOS Channel Conditions in terms of throughput variations and packet loss as shown in fig 5, 6.

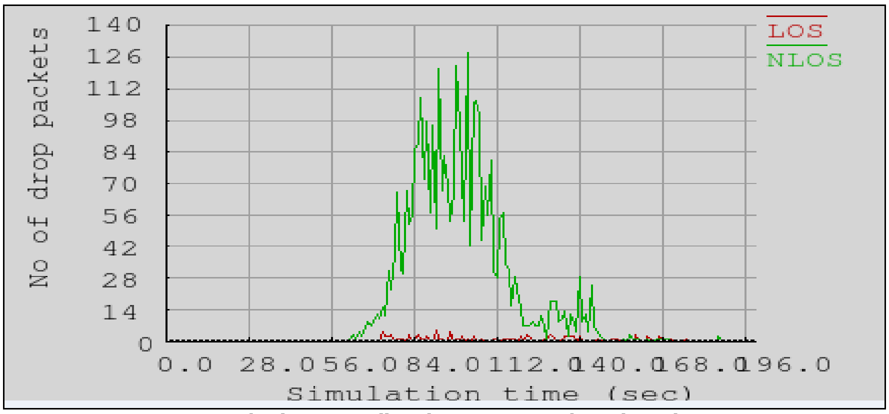

Fig. 5 Packet loss in Small Scale LOS-NLOS Channel Conditions

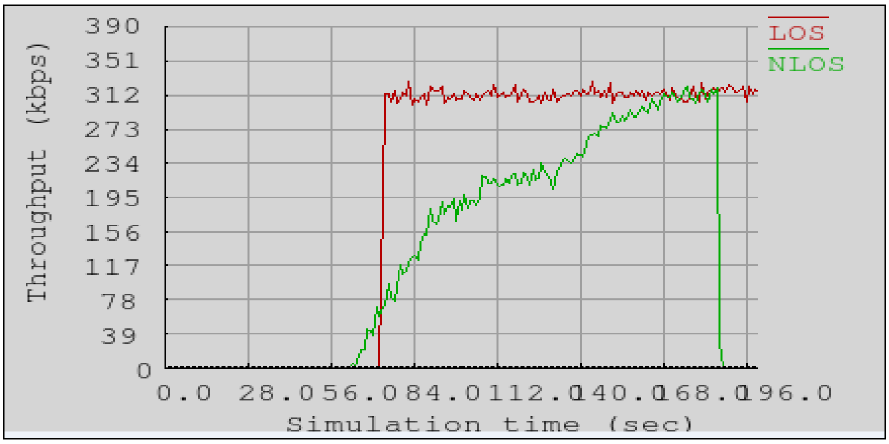

Fig. 6 Throughput variations in Small Scale LOS-NLOS Channel Conditions

TABLE VII Graph Analysis of Small Scale LOS-NLOS Channel Conditions at time=84sec

Fading Model	Simulation Time (sec)	Throughput (kbps)	No of drop packets
LOS (Rician Fading)	84	312	2
NLOS (Rayleigh Fading)	84	123	98

TABLE VIII Graph Analysis of Small Scale LOS-NLOS Channel Conditions at time=112sec

Fading Model	Simulation Time (sec)	Throughput (kbps)	No of drop packets
LOS (Rician Fading)	112	312	1
NLOS (Rayleigh Fading)	112	215	56

V. CONCLUSIONS

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 small scale wireless fading channels. For this, we have created two scenarios RSU-OBU Scenario and City Scenario. In both Scenarios, we considered two different fading models for evaluating the performance of VANET. Firstly, we selected Free Space as Path Loss Model and Rician as Fading model where Rician Fading Model represents Line of Sight (LOS) Condition.

Secondly, we selected Free Space as Path Loss Model and Rayleigh as Fading model where Rayleigh Fading Model represents Non Line of Sight (NLOS) Condition and investigated the performance of VANET through small scale LOS –NLOS Channel Conditions in terms of throughput variations and packet loss. We analysed from the Throughput and Packet loss graphs that the performance of VANET gradually degrades when we move from Rician to Rayleigh Model. In Rayleigh Model throughput decreases and packet loss increases as compare to Rician Model. So, Rician Model means LOS fading channel condition is better than Rayleigh Model NLOS condition for VANET.

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