Influences of TwoRayGround and Nakagami Propagation model for the Performance of Adhoc Routing Protocol in VANET

Pranav Kumar Singh
Assistant Professor, Department of Computer Science & Engineering
Central Institute of Technology (CIT), BTAD, Kokrajhar, Assam-783370, India

ABSTRACT
VANET is the emerging technology that is to be adopted worldwide. The studies and research for the adoption of this technology is still simulation based. VANET is a wireless adhoc networking techniques, whose feasibility and performance are usually tested by means of simulation. Routing protocols and their performances in all possible scenario of the traffic is key factor for the development of VANET. The main objective of this paper is to simulate the two adhoc routing protocol AODV and OLSR in realistic scenario of traffic under the two different radio propagation model Two Ray Ground and Nakagami. Through this paper I am wishing to highlight the use of radio propagation model for the adequate simulation. To carry out the whole simulation I used traffic simulator MOVE over SUMO and network simulator ns-2.

Keywords
TwoRayGround, Nakagami, MOVE, AODV, OLSR.

1. INTRODUCTION
Vehicular Adhoc Network (VANET) enables vehicles to communicate with each other via Inter-Vehicle Communication (IVC) as well as with roadside base stations via Roadside-to-Vehicle Communication (RVC). The main objective of VANET is to deliver the timely information to driver that enables them to foresee the accidental and hazardous situation to avoid the collision. It also helps for traffic enhancement to save fuel and time that in result causes less pollution. Vehicular Ad-Hoc Networks (VANET) is a subset of MANet (Mobile Adhoc Network) where ad hoc networks can be brought to their full potential. Vehicular adhoc network is one of the main steps towards the safety of human beings on road. VANET is a wireless ad-hoc network with vehicles as node on predicted road topology. It can be formed by equipping vehicles on road with short range wireless communication devices for the safety and more efficient driving.

Three main domains that VANET infrastructure consists are In-Vehicle, Adhoc domain and Infrastructure domain. The main components that can be used to form VANET are On-Board Unit (OBU), Application Unit (AU), Roadside Unit (RU), and Hot spots. The On-Board Unit (OBU) is responsible for vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communications. It also provides communication services to AUs and forwards data on behalf of other OBUs in the ad hoc domain. The OBU consists of Transceiver, Omni-directional antenna, Processor, GPS unit, Digital Maps, Sensors. OBU is used to send, receive and forward safety-related data in the ad-hoc domain. A Road-Side Unit (RSU) equipped with at least a network device for short range wireless communications using some radio technology is a physical device located at fixed positions along roads and highways, or at dedicated locations such as gas station, parking places, and restaurants [1, 2]. Roadside unit can be used to provide internet connectivity to OBU, as a source of information or some time it can help to extend the communication range of vehicles.

To implement better communication among the vehicles on road highly efficient protocol is required, that can perform well in various possible circumstances. In this paper, my objective is to evaluate AODV (Ad hoc On Demand Distance Vector) and OLSR (Optimized Link State Routing) in realistic urban traffic environment. This research study closely reflect the performances of routing protocols in realistic and adequate modeling of simulation in urban scenario. The two selected protocols are AODV and OLSR. AODV and OLSR are the best suited protocols for the MANET and got RFC (RFC [3561] and (RFC [3626] respectively. The two performance metrics end to end delay and Packet delivery Ratio are used in three different traffic densities low, medium and high.

To carry out the simulation well known and highly used road traffic simulation MOVE [4] (MObility model generator for VEhicular networks) built over SUMO [5] (Simulation of Urban Mobility and for network simulation for the traces open source, highly adopted by researchers NS-2 [6] (Network Simulator) is used.

2. RELATED WORK
Various research studies for the protocols performances in VANET used the three main mobility models, Random Way Point, Real world, and Road traffic Micro simulation [3]. The RWM model is imprecise and not suitable for VANET as vehicles has defined mobility pattern, Real world mobility model is very costly and time consuming process and also not feasible. Highly proffered mobility model by the researchers is Road traffic Micro Simulation, where mobility traces can be generated for real world road maps using road traffic simulator and then these traces can be used later on by network simulator for the protocols performances.
Most of the research studies have analyzed and perform the simulation using TwoRayGround radio propagation model that fails to reflect actual result. Buildings along side roads, trees, other structures, obstacles can cause fading of the signals and make it hard to communicate the vehicles as the signal strength gets low. TwoRayGround doesn’t deal fading model, so its quite interesting to see the performances in TwoRayGround and with the model that can help to implement fading scenario (Nakagami).

In this section of my research paper I am highlighting three main studies in the same area of research, these research studies [7, 8, 9] have focused their methods and results for the adhoc protocols performances in VANET scenario and these are good approach.

B. Ramakrishnan [7] and other members have analyzed the Performance of 802.11 and 802.11p in Cluster Based Simple Highway Model, this study is good approach but we know that the main problem of traffic congestion and accidents mainly occurs in City so this will be better to analyzed them in City scenario as well.

The next study by Arijit Khan [8] and other members have analyzed the same protocol in Urban and highway scenario by using Nakagami propagation model, this study is realistic approach but they perform their simulation for few vehicles on road.

Imran Khan [9] in his study has analyzed the performance of AODV and OLSR (OLSR-Default and OLSR-modified) in highly fading urban scenario. He used Nakagami radio propagation model. This study has clearly (theoretically) explains the drawbacks of using TwoRayGround radio propagation model and shows the performances in fading scenario.

3. RESEARCH METHODOLOGY

Before we set out to test such projects in reality it is important to perform a series of simulated tasks to cover all possible constraints since outdoor experiments are costly and they may or may not provide us with all the necessary stimuli. Software based simulations are designed to provide an alternative to obtain the required results. VANET hits the protocols strength due to its highly dynamic features, thus in testing a protocol suitable for VANET implementation the use of realistic mobility model should be considered [9]. For this purpose, the adopted methodology for the results of this research work is based on simulations near to the real time packages before any actual implementation.

After doing lot of studies and previously used methodology I finally decided to use two main simulator networks and traffic Simulator NS-2 (the most reliable and authenticated tools used and preferred by most of the for real looking simulations according to their parameter precisions) and MOVE (MObility model generator for VEhicular networks) over SUMO (Simulation of Urban Mobility). Simulation of Urban Mobility (SUMO) is an open source, highly portable, microscopic road traffic simulation package designed to handle large road networks.

Simulation is performed for two radio propagation models (TwoRayGround and Nakagami) on same traffic scenario of VANET.

In this section of my paper I have tried to cover all the details of simulation tools and methodology used: Radio Propagation models used, adhoc routing protocols used, working principle of simulation tools used, scenarios used for analysis, simulation setup, metrics used.

3.1 Radio Propagation Model

Two radio propagation models used to analyze their influences are TwoRayGround and Nakagami. These two models are now bundled in ns-2.33 and higher version.

Radio propagation is the behavior of radio waves when they are transmitted, or propagated from one point on the Earth to another, or into various parts of the atmosphere [10]. Like light waves, radio waves are affected by the phenomena of reflection, refraction, diffraction, absorption, polarization and scattering.

3.1.1 TwoRayGround

This radio propagation model is highly preferred in MANET and is also used in maximum research studies for protocols performances in VANET scenario. This model assumes that the received energy is the sum of the direct line of sight path and the reflected path from the ground. It takes no account for obstacles and sender and receiver have to be on the same height [11].

3.1.2 Nakagami

This radio propagation model [12] is a mathematical general modeling of a radio channel with fading. Compared to the existing models (shadowing and two-ray ground), Nakagami RF model has more configurable parameters to allow a closer representation of the wireless communication channel. It is able to model from a perfect free space channel, to a moderate fading channel on highway, even to a dramatically fading channel in urban communities.

3.2 Routing Protocols

Routing protocols are used to find, maintain, and form a route between sender and receiver for communication.

In VANET there are many challenges that protocols have to deal with: Node density, Node movement, short communication window due to high speed, movement patterns in different scenarios like urban, highway, rural, obstacles that can block the communication etc.

In this paper two adhoc routing protocols AODV and OLSR are used that are best suited in MANET and also got RFC. AODV is Reactive whereas OLSR is Proactive Routing Protocol.

3.2.1 Ad hoc On-Demand Distance Vector (AODV) Routing Protocol

The Ad hoc On-Demand Distance Vector (AODV) [13] algorithm enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication.

3.2.2 Optimized Link State Routing Protocol (OLSR)

The Optimized Link State Routing Protocol (OLSR) [14] is developed for mobile ad hoc networks. It operates as a table driven, proactive protocol, i.e., exchanges topology information with other nodes of the network regularly. Each node selects a set of its neighbor nodes as "multipoint relays" (MPR). In OLSR, only nodes, selected as such MPRs are responsible for forwarding control traffic, intended for diffusion into the entire network. MPRs provide an efficient mechanism for flooding control traffic by reducing the number of transmissions required.

3.3 Simulation Tools

In this literature three main open source tools are used to carry out the simulation, and are given as follows:

1. MOVE [4]
2. SUMO [5]
3. NS-2 [6]

3.3.1 MObility model generator for Vehicular networks (MOVE)

MOVE is a Java-based application built on SUMO (Simulation of Urban Mobility) with a facility of GUI [4].

MOVE allows users to rapidly generate realistic mobility models for VANET simulations. MOVE is built on top of an open source micro-traffic simulator SUMO(Simulation of Urban MObility).
The output of MOVE is a realistic mobility model and can be immediately used by popular network simulators such as ns-2 and qualnet.

3.3.2 Simulation of Urban MObility (SUMO)

SUMOis an open source, highly portable, microscopic road traffic simulation package designed to handle large road networks. It is mainly developed by employees of the Institute of Transportation Systems at the German Aerospace Center [5]. It allows the user to build a customized road topology, in addition to the import of different readymade map formats of many cities and towns of the world.

3.3.3 Network Simulator (NS-2)

NS is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks [6].

NS2 is an object oriented simulator, written in C++, with an OTcl interpreter as a frontend. This means that most of the simulation scripts are created in Tcl(Tool Command Language). If the components have to be developed for ns2, then both tcl and C++ have to be used.
Flow Chart [4] given in figure 1 explains the working of MOVE in integration with SUMO and NS-2
SUMO can convert real road map file downloaded from tiger shape line or open street map file into network file and then allow us to generate route for vehicles. Giving a road network map and the route file, which contains mobility-related information about all vehicles simulated in the road traffic simulator, the parser translates these files into a format acceptable by the network simulator.

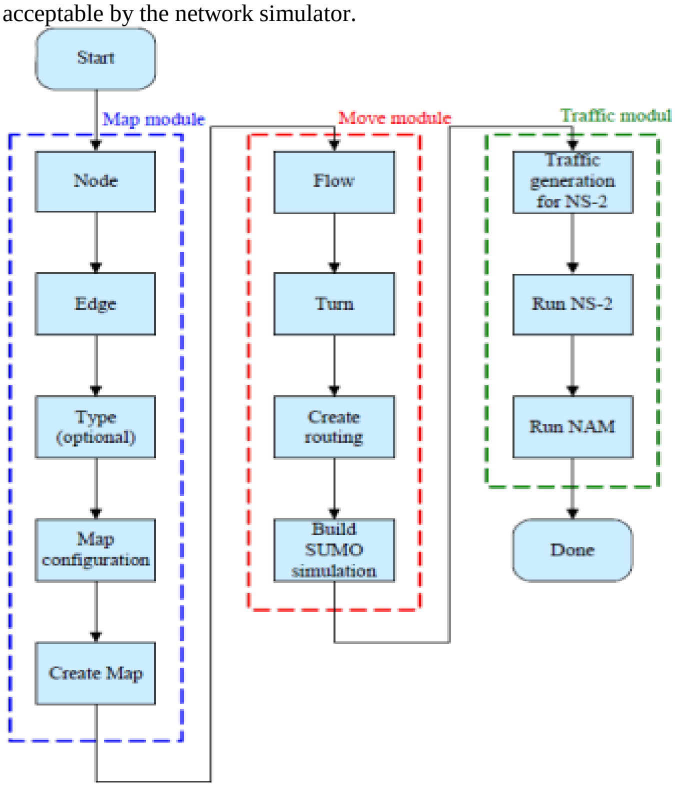

Fig 1: Flow Chart of MOVE [4]

3.4 Scenario Used

The scenario used for simulation is real world road traffic scenario in city [15] shown in figure 2. This map is tiger map file that is converted in network file by SUMO and is of area approximate 2.5 x 2.5 Kilometer.

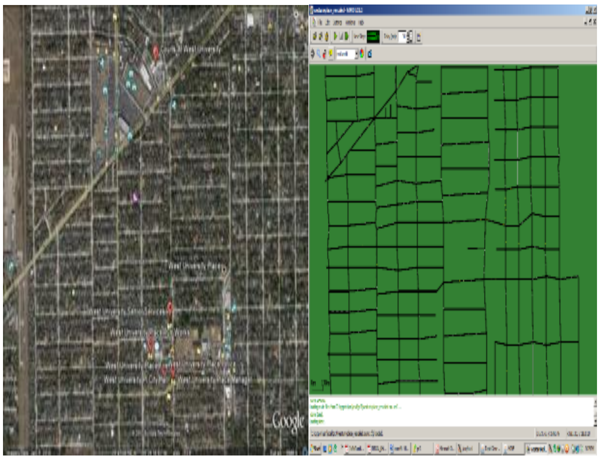

Fig 2 (a) Fig 2(b)
Fig 2: Real Map City Scenario (West University area, Houston, TX, USA.) (2.5 Km x 2.5 Km) (a) Map (b) SUMO generated Vehicles on MAP.

I have selected city scenario for simulation because this will reflect the result in above two different radio propagation model. In urban scenario where obstacles like tree, buildings will cause loss in radio signal strength, so we can see the influence of using TwoRayGround, that doesn't have fading constraints and Nakagami propagation that can model actual fading scenario (due to obstacles).

3.5 Simulation Setup and Code Fragment

The table1 given below is the detail of setup required to perform the simulation used in this paper.
Table 3 is the tcl fie and defines the parameters used for simulation. Table 4 defines the MAC and PHY definition of IEEE 802.11a used in simulation and Table 2[12] is the Nakagami radio propagation model definition shows the values of the Nakagami parameters set for an urban scenario to generate fading scenario.
Nakagami propagation model is an alternative to the TwoRayGround propagation model that can efficiently model the characteristics of different real world scenarios. By changing value of the Shaping Factor m, various scenarios from free space to moderate obstacles to high obstacles can be simulated [9].

Table1. Simulation Setup

Platform	Windows with Cygwin
NS version	ns-allinone-2.33
MOVE version	2.64
SUMO version	sumo-winbin-0.11.1
AODV	NS2 default
OLSR	UM OLSR patch[16]
Number of Nodes in City	45,223,400
Traffic Type	TCP
Scenario	City
Downloaded files	Tiger file (.dat format)
Speed	40 kmph

Data type	CBR
Data Packet Size	512 bytes
MAC protocol	IEEE 802.11
Radio Propagation	TwoRayGround and Nakagami
Simulation Time	200 seconds
Transmission Range	300 m
Road Traffic Direction for City	Multidirectional
No. of Road Lanes	2
Simulation Area	2.5km X 2.5km

Table2. Nakagami Urban model

```
Propagation/Nakagami set use_nakagami_dist_true
Propagation/Nakagami set gamma0_ 2.0
Propagation/Nakagami set gamma1_ 2.0
Propagation/Nakagami set gamma2_ 2.0
Propagation/Nakagami set d0_gamma_ 200
Propagation/Nakagami set d1_gamma_ 500
Propagation/Nakagami set m0_ 1.0
Propagation/Nakagami set m1_ 1.0
Propagation/Nakagami set m2_ 1.0
Propagation/Nakagami set d0_m_ 80
Propagation/Nakagami set d1_m_ 200
```

Table3. TCL script for different Parameters

```
======================================
# Define options#
======================================
================================
set val(chan)   Channel/WirelessChannel            ;# channel type
set val(prop)   Propagation/TwoRayGround         ;# radio-propagation model
#set val(prop)   Propagation/Nakagami  ;# radio-propagation model
set val(netif) Phy/WirelessPhy              ;# network interface type
set val(mac) Mac/802_11                  ;# MAC type
set val(ifq)    Queue/DropTail/PriQueue   ;# interface queue type
set val(ll)     LL                         ;# link layer type
set val(ant)    Antenna/OmniAntenna     ;# antenna model
set val(ifqlen) 50                         ;# max packet in ifq
set val(nn)     45           ;# number of mobilenodes
#set val(nn)     223        ;# number of mobilenodes
#set val(nn)     400        ;# number of mobilenodes
set val(rp)     AODV                              ;# routing protocol
#set val(rp)    OLSR                              ;# routing protocol
set opt(sc)             /usr/local/hr1/map.tcl
set opt(x)      2387   ;# x coordinate of topology
set opt(y)      2373       ;# y coordinate of topology
set opt(stop)   200   ;# time to stop simulation
#
======================================
================================
```

Table4. MAC and PHY definition for IEEE 802.11 used

```
#**************************************************
#          802.11a MAC and Phy definition
#**************************************************
Mac/802_11 set dataRate_          6.0e6
Mac/802_11 set basicRate_         6.0e6
Mac/802_11 set CCATime            0.000004
Mac/802_11 set CWMax_             1023
Mac/802_11 set CWMin_             15
Mac/802_11 set PLCPDataRate_       6.0e6
Mac/802_11 set PLCPHeaderLength_   50
Mac/802_11 set PreambleLength_     16
Mac/802_11 set SIFS_             0.000016
Mac/802_11 set SlotTime_          0.000009

# 300m, default power, freq, etc... These can be calculated with
Phy/WirelessPhy set RXThresh_  6.72923e-11     ;# 300m at 5.15e9 GHz
Phy/WirelessPhy set freq_      5.15e9
Phy/WirelessPhy set Pt_        0.281838       ;# value for the 300m case..
```

3.6 Simulation Metrics Used

Two simulation metrics used in this paper for the analysis are Packet Delivery Ratio and Average End to End delay. Both these metrics shows the performance of protocols in terms of successful packet delivery and latency.

4. RESULT

The Result is observed for both metrics in three different densities with varying no. of connections in each and is defined in Table5.

Table 5. Density and Connection pattern used

	Density	No of Nodes	Connections
Urban Scenario	LD	45	20
	MD	223	90
	HD	400	130

4.1 Performance in TwoRayGround (TRG) Radio Propagation model

Figure 3 and figure 4 given below represents the result observed in TwoRayGround Radio Propagation model for PDR and Avg. End to End Delay respectively.

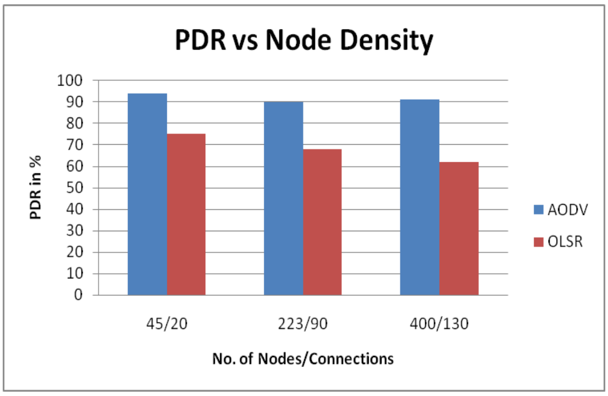

Fig 3: PDR vs. Node Density in Urban Scenario for TRG

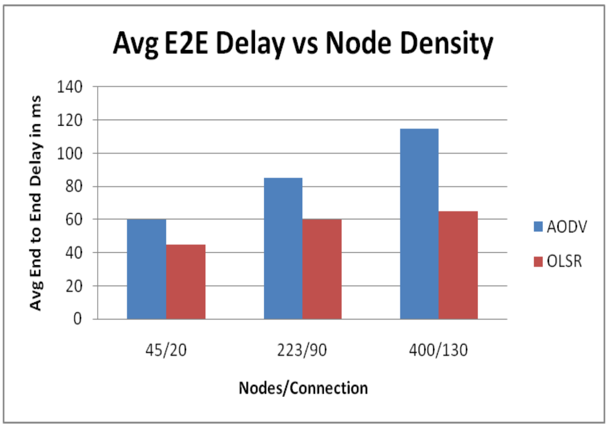

Fig 4: Average End to End Delay (ms) vs. Node Density in Urban Scenario for TRG

4.2 Performance in Nakagami Radio Propagation model

Figure 5 and figure 6 given below represents the result observed in Nakagami Radio Propagation model (defined in table 2 for fading scenario) for PDR and Avg. End to End Delay respectively.

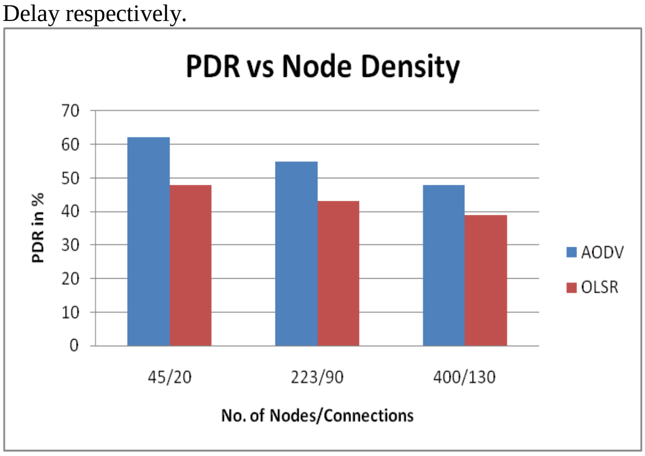

Fig 5: PDR vs. Node Density in Urban Scenario for Nakagami

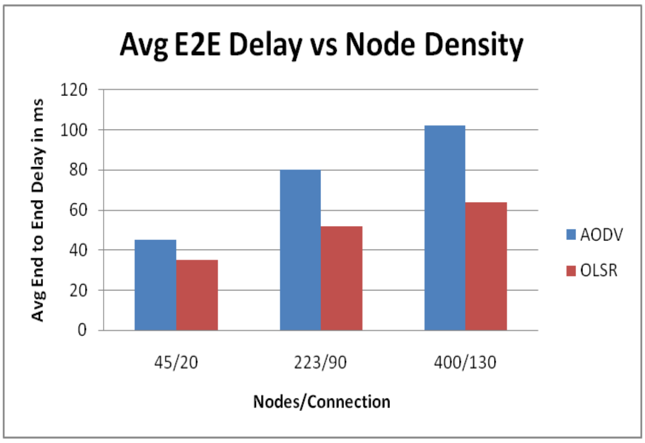

Fig 6: Average End to End Delay (ms) vs. Node Density in Urban Scenario for Nakagami

From fig3 and fig5 we can see that the PDR is low in case of Nakagami propagation model, approximate its half of PDR in TwoRayGround. In case of TwoRayGround AODV performs well and it reaches up to 92% PDR but if observed it in Nakagami maximum PDR is 62%. OLSR performance is also degraded in Nakagami in comparison to TwoRayGround.

From figure4 and figure 6 it is observed that Average End to End Delay is high for AODV in both models, and it reaches up to 110millisecond. It is also observed that in both models the performance in terms of Average E2E delay does not vary too much.

5. CONCLUSION

In this paper two radio propagation models are used to show their influences in urban scenario for protocols (AODV and OLSR) performances. TwoRayGround does not assume obstacles present in scenario. TwoRayGround relies on the Line of Sight (LoS) communications so signal strength fading is considered because of distance between sender and receiver .In obstacle environments strength fades also because of antenna position, transmission power, attenuation due to buildings etc. For better communication in wireless scenario signal strength must be strong but in obstacle presence signal strength gets low.

In TwoRayGround as there is no concept to model fading scenario for obstacle that in results leads to inaccurate modeling and we can see it from the figure3 and figure5.

Nakagami model is well suited model to analyze the performances in the urban scenario as it allows us to model real traffic scenario.

6. REFERENCES

[1] A. Festag, G. Noecker, M. Strassberger, A. Lübke, B. Bochow, M. Torrent-Moreno, S. Schnaufer, R. Eigner, C. Catrinescu, and J. Kunisch. “NoW - Network on Wheels”: In Proceedings of 6th International Workshop on Intelligent Transportation (WIT 2008), Hamburg, Germany, Mar 2008.

[2] CAR 2 CAR Communication Consortium Manifesto version 1.1. Technical report, CAR 2 CAR Communication Consortium (C2C-CC), Aug 2007.Available through www.car-to-car.org/fileadmin/.../C2C-CC_manifesto_v1.1.pdf

[3] Sommer, C.; Dressler, F.; Univ. of Erlangen Nuremberg, Erlangen, "Progressing Towards Realistic Mobility Models in VANET Simulations" appears in: Communications Magazine, IEEE Issue Date: November 2008, Volume: 46 Issue: 11 On page(s): 132 - 137

[4] F. Karnadi, Z. Mo, K.-C. Lan, "Rapid Generation of Realistic Mobility Models for VANET", in Proc. of the IEEE Wireless Communication and Networking Conference (WCNC"07), March 2007.

[5] SUMO: http://sourceforge.net/apps/mediawiki/sumo/index.php.

[6] NS: http://www.isi.edu/nsnam/ns/

[7] B. Ramakrishnan, Dr. R. S. Rajesh and R. S. Shaji "Performance Analysis of 802.11 and 802.11p in Cluster Based Simple Highway Model" International Journal of Computer Science and Information Technologies, Vol. 1 (5) , 2010, page no. 420-426.

[8] Arijit Khan, Shatrugna Sadhu, and Muralikrishna Yeleswarapu "A comparative analysis of DSRC and 802.11 over Vehicular Ad hoc Networks" Project Report, Department of Computer Science, University of of California, Santa Barbara, 2010.

[9] Khan, I. Qayyum, A. Center of Res. in Networks & Telecom (CoReNeT), M.A. Jinnah Univ., Islamabad, Pakistan, "Performance evaluation of AODV and OLSR in highly fading vehicular ad hoc network environments" appears in Multitopic Conference, 2009. INMIC 2009. IEEE 13th,International Issue Date: 14-15 Dec. 2009 On page(s): 1 – 5

[10] H. P. Westman et al., (ed), Reference Data for Radio Engineers, Fifth Edition, 1968, Howard W. Sams and Co., no ISBN, Library of Congress Card No. 43-14665 page 26-1

[11] Martinez, F.J.; Chai-Keong Toh; Cano, J.-C.; Calafate, C.T.; Manzoni, P.; Univ. of Zaragoza, Zaragoza "Realistic Radio Propagation Models (RPMs) for VANET Simulations" appears in: Wireless Communications and Networking Conference, 2009. WCNC 2009. IEEE Issue Date: 5-8 April 2009 On page(s): 1 – 6

[12] Documentation - CODE README, "Overhaul of IEEE 802.11 Modeling and Simulation in NS-2 (802.11Ext)" Available at: dsn.tm.uka.de/medien/.../Documentation-NS-2-80211Ext-2008-02-22.pdf

[13] Mobile Ad Hoc Networking Working Group – AODV, http://www.ietf.org/rfc/rfc3561.txt

[14] Mobile Ad Hoc Networking Working Group – OLSR, http://www.ietf.org/rfc/rfc3626.txt

[15] Rapid Generation of Realistic Simulation for VANET http://lens1.csie.ncku.edu.tw/wiki/doku.php?id=%E2%80%A7realistic_mobility_generator_for_vehicular_networks

[16] UM-OLSR, an implementation of the OLSR http://masimum.inf