Middle-East Journal of Scientific Research
24 (Special Issue on Innovations in Information, Embedded and Communication Systems): 113-119, 2016
ISSN 1990-9233; © IDOSI Publications, 2016
DOI: 10.5829/idosi.mejsr.2016.24.IIECS.23148

Vehicle Mobility and Realistic Channel Communication Model for VANET Simulation

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Abstract: Improving real-time safety and non safety application for vehicular ad hoc networks (VANETs) understanding network topology characteristics since the dynamic determine both the performance of routing protocol and efficient of feasibility of an application over VANETs. To evaluate a protocol the realistic mobility models are needed for the VANET simulation. "Simulation of Urban Mobility" (SUMO) is the one of the microscopic realistic mobility. SUMO is the open source software. The SUMO framework is used in Opnet Modeler simulation scenario and the input is net convert files and the feature of the Opnet Modeler. Using the key metrics of interest include simulation speed and memory usage that can provide by the realistic analysis of the VANET topology characteristic over both the time and space for real time urban traffic scenario. The output of Opnet modeler trajectory file is the input to the NS-2 and to perform the vehicle to vehicle communication using various key metric such as node degree, neighbor distribution, number of cluster, link duration ect. In the VANET topology characteristic both the key metric reveal that unit disk model and lognormal model is fail for long range of vehicle to vehicle communication. To avoid this using matching mechanism to tune the parameter of the lognormal model according to the vehicles density and a correlation model to take into account in which the evolution of the link characteristics over time.

Key words: Vehicular Ad Hoc Network(VANET) · Mobility Model · SUMO Simulation · Opnet

INTRODUCTION

A Vehicular Ad Hoc Network (VANrET) is a intelligent transportation system technology that occur for many applications such as safety message dissemination, dynamic route planning, content distribution and entertainment.The VANET research effort on protocol design on simulation due to the prohibitive cost of deploying real world road topology. Building a realistic simulation environment for VANETs model is essential in judging the performance of the protocol proposed at various layers in vehicular network.

To evaluate Protocol implementation in a real world environment simulation are commonly used as a first step in protocol development for VANET. Simulation plays an important role in the area of transportation. The various simulation tools is available such as SUMO [1], DIVERT [2], GLoMoSim [3] etc which have been developed to analyze the mobility transportation scenarios with the micro and macro-scale levels the important parameter in simulating ad-hoc network is the node mobility. It is mainly use in real world mobility model so the result from the simulation correctly reflects the real world road topology performance of a VANET. MOVE tool is built on the top of an open source microscopic mobility model traffic simulator SUMO. The output of the MOVE tool is a mobility trace file that contains the information of vehicle position and movement of vehicle.

A VANET simulation environment should be realistic, requiring an accurate representation of the vehicular mobility model and signal propagation model among the vehicles and the efficient of an reasonable amount of simulation time. Realistic representation of the vehicles mobility requires using real-world road topology from the open street map and the accurate microscopic mobility modeling using SUMO tool and real database traffic demand modeling whereas a realistic model represent the signal propagation model among the vehicles requires reproducing of the actual two ray radio propagation process for a given environment. On the other hand, an

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efficient vehicles mobility and signal propagation model would require to analyzing the closeness to the realistic representations in term of the key metrics, for summarizing the static and dynamics evolution of the VANET topology in both time and space, for runtime of the SUMO simulations. The survey on VANET topology characteristics focuses on the realistic channel models tested on simplistic vehicles mobility models, realistic mobility models without considering the realistic signal propagation models, or simplistic modes for both vehicle mobility and communication channel.

VANET topology characteristics on a highway, rural section by integrating realistic microscopic or macroscopic mobility to traces and generated using real-world road topology and real database vehicle traffic demand with realistic channel models, that taking into account for find the effect of vehicles on the received signal power.

The goal of this paper is to analyze VANET topology characteristics on the urban section by integrating realistic microscopic mobility trace generated using real-world road topology and traffic demand with realistic channel model taking into account the effect of vehicles on the received signal power.

Related Work: RuiMeireles *et al.*, Illustrate DIVERT framework which allows for micro-simulation allows thousand of vehicles with a high degree of realism. In this model, vehicles make adjustments to their speed as to keep a safe distance to the car in front, accelerating and braking as needed. In our urban scenario, this results in average speeds of around 35 Km/h after 300 seconds [4]. Line-of-sight (LOS) is a condition where a signal travels over the air directly from the transmitter vehicle to receiver vehicle through wireless without having an obstruction. LOS is an ideal condition for a wireless transmission through the propagation challenge only comes from weather condition or atmospheric parameters and the characteristic of its operating frequency signal. In LOS environment signal can reach longer distance with better signal strength and higher throughput range [4, 5].

Rui Meireles *et al.*, illustrate Non-line-of-sight (NLOS) is a condition where a signal from a wireless transmitter passes various obstructions before arriving at a wireless receiver. The signal may be reflected, refracted, diffracted and absorbed. These create more signals that will arrive transmitter to receiver at different times, from different paths and with different signal power strength. Consequently, wireless systems developed for NLOS environment have to incorporate a number of techniques to avoid those problem use the LOS propagation model [5].

SeyedA.Hosseini *et al.*, Illustrate GloMoSim simulates networks with up to thousand nodes of vehicles linked by a heterogeneous communications capability that includes unicast, multicast, asymmetric communications using satellite broadcasts, with single hop and multi hop wireless communications using ad-hoc networking and traditional Internet protocols [6]. In unit model, the vehicles can communicate with each other vehicle within a threshold value distance and cannot communicate other vehicle. In the Lognormal model calculating the additional attenuation (reducing signal strength) due to each obstacle between the transmitter and the receiver of vehicles, the probabilistic distribution of the additional attenuation model with a lognormal probability density function.

Nabeel Akhtar *et al.*, Illustrate SUMO is used to simulate the microscopic mobility of the vehicles. SUMO is an open-source space for continuous discrete time traffic simulator capable of modeling the behavior of individual driver. The path of each driver is determined based on the source/sink matrix provided as an input to the simulator [1]. In this channel model, algorithms to incorporate the effect of the surrounding obstacles for vehicles such as other vehicles, walls and buildings on the received signal strength have been evaluate [1, 3] rather than modeling the average additional attenuation due to these obstacles by a stochastic large-scale fading model. Usually, there are a few more buildings around the highway, mostly far from the vehicles and the surrounding vehicles as obstacles vehicles. Since the additional obstacles can only further reduce the probability of the line of sight (LOS) between the transmitter and receiver vehicles is evaluate and this approach gives a case analysis for the probability of LOS, as stated in [1, 3].Various performance metrics are node degree, neighbor distribution, number of cluster, link duration.

System Architecture: Vehicular mobility model are usually classified into two type are macroscopic and microscopic model. The macroscopic which determine movement pattern for different vehicles. The microscopic model determines the vehicular movement and position of vehicles. Using channel model for vehicle to vehicle communication and the channel model including unit disk and lognormal shadowing models that are commonly used in the analysis of the VANET topology and find the obstacle based on the received signal strength of the vehicles.

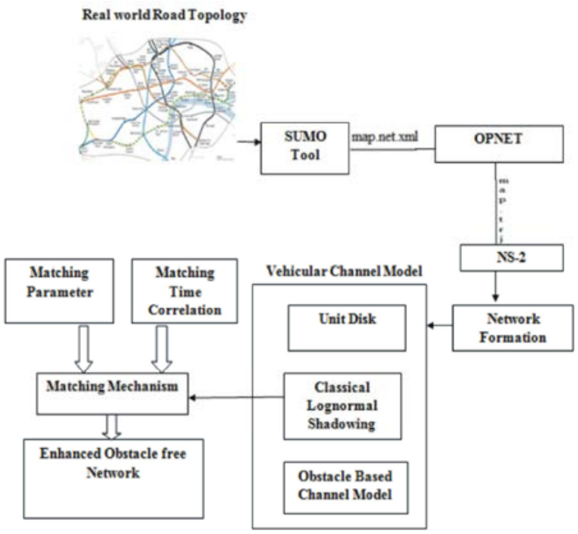

Fig. 1: System Architecture

SUMO Tool: SUMO is the microscopic mobility for simulate of the vehicles. The input of SUMO tool is osm(Open Street Map) file simulator is not support traditional map format. It only support NETMAP format map then using osm file then the osm files is convert into NETMAP format using sumo NETCONVERT tool. It is represented as an xml file.

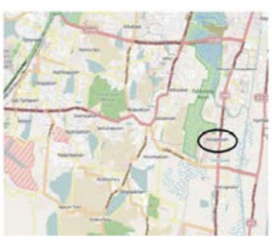

Fig. 2: map.osm

Fig. 3: map.net.xml

Opnet Modeler: Opnet Modeler [7] enables both random mobility and trajectory mobility. It allows elaborating complex node movement. The input for Opnet modeler is net.xml file. Convert xml file to Opnet Modeler to achieve our extension TRACEEXPORTER file. The input of xml files contain two parameter are node attribute and objects. The node attribute file contains the attribute of each vehicle node and the object file contains description of all objects.

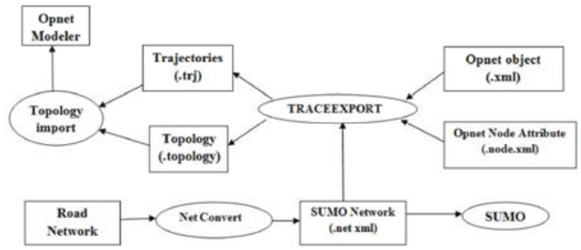

Fig. 4: Process to generate vehicle mobility with SUMO to Opnet

TRACEEXPORTER generate trajectories and topology Opnet file. One trajectories Opnet file for each vehicle that contain GUI of Modeler and one topology Opnet file contain initial vehicles position. Once trajectories file is generate and it copied to Opnet model directory.

Fig. 5: Opnet Modeler Traceexporter File

NS-2: The vehicle mobility output of Opnet Modeler TRACEEXPORTER [7] file is then input to NS-2.To provide vehicle to vehicle communication using vehicular channel model are unit disk, lognormal shadowing model and obstacle-based channel model where the channel models are implemented and the performance metrics are derived. Compare the channel model with various performances metric such as node degree, neighbor distribution, number of cluster and link duration.

Vehicular Channel Model: The simplistic channel model including unit disk and lognormal shadowing model that are fail to provide in the VANET topology characteristics. Proposed obstacle based channel model that incorporate the effect of the moving vehicles obstacle based on the received signal strength.

Unit Disk Model: In the unit disk model, the vehicles can communicate with each other vehicle within a threshold value distance and cannot communicate other vehicle. The threshold distance not only fails to capture the noise that can take unreachable node it does not take into account the effect of the obstacle on the received signal strength.

Lognormal Shadowing Model: In the lognormal shadowing model, rather than calculate the additional attenuation due to each obstacle between the transmitter and receiver such that surrounding vehicles as an obstacle. The probabilistic distribution of the additional attenuation is calculated based on the lognormal probability density function, formulation for the received signal power [1, 3]

$$P_{rx}(d) = P0 - 10n \log_{10} + N \quad (1)$$

where d is the distance between the transmitter and the receiver, d_0 is the reference distance, $P_{rx}(d)$ is the received signal power at distance d (in dBm), P_0 is the received signal power at the reference distance d_0 (in dBm), n is the path-loss exponent and N is a zero-mean Gaussian random variable with variance σ^2. A vehicle can communicate with another vehicle if P_{rx} is greater than a certain threshold value. The lognormal shadowing model reduces to the unit disk model.

Obstacle-Based Channel Model: In the obstacle-based channel models, algorithms to incorporate the effect surrounding obstacles such as other vehicles, walls and buildings on the received signal strength [1, 3] rather than modelling the average additional attenuation due to these obstacles by a large-scale fading model. Usually, there are a more buildings around the urban area, mostly far from the vehicles. Only consider the impact of the surrounding vehicles as obstacles. Since the additional obstacles can only further reduce the probability of the line of sight (LOS) between the transmitter and receiver vehicles, this approach gives a case analysis for the probability of LOS. The algorithm consists of three steps to calculate the additional attenuation due to the vehicles.

Algorithm 1 Obstacle-Based Model: Calculation of the Additional Attenuation Between vehicles i and j due to Surrounding Vehicles as obstacles.

```
1: [PotentialObs] = getPotentialObs(i, j)
2: if size ([PotentialObs])≠0 then
3:       [ObsVeh]=getLOSobs([PotentialObs])
4:       if size ([ObsVeh]) ≠0 then
5:          addAttenuation=calAttenuation([ObsVeh])
6:       else
7:          addAttenuation=0
8:       end if
9: else
10:         addAttenuation=0
11: end if
```

- First step is the vehicles potentially are obstructing the LOS between the transmitter vehicle i and the receiver vehicle j are determined (getPotentialObs (i, j)): the distance from the centre of the vehicle to the LOS line between vehicles i and j is less than half the width of the vehicle (see line 1 of Algorithm 1).
- Second step is the vehicles that obstruct the LOS between vehicles i and j chosen from the set of the potential obstructing vehicles that can be determine in the first step (getLOSobs([PotentialObs])):From the electromagnetic wave propagation perspective, the LOS is not guaranteed with the visual sight line between the transmitter and the receiver
- Third step is the calculate additional attenuation in the received signal strength is calculated for the LOS obstructing vehicles determined in the first step (calAttenuation ([ObsVehicles])). The existing models to calculate the attenuation [5, 8].

Matched Lognormal Shadowing Model: The classical lognormal shadowing model instead of calculating the attenuation calculate probabilistic distribution of additional attenuation due to the vehicles due to each vehicles from transmitter and receiver acting other vehicles as an obstacle [8]. Propose a matching mechanism to tune the parameter of the lognormal model such that the performance metric the link characteristics over space. Introduce a correlation model for timestamp to take into account the evolution of the link characteristic over time and the parameter is match to the performance metrics.

Algorithm 2 Matching Parameters of the Lognormal Shadowing Model

```
Input: nValues, σValues
Output: n_m, σ_m
NDObs=cdfND(ObsModel);
Error_min=0;
for all nValues do
   for all σValues do
      NDlog=cfdND(LogModel,n,σ);
      Error=Diff(NDObs,NDLog)
      if Error < Error_min then
         Error_min = Error;
         nm=n;
         σm=σ;
      end if
   end for
end for
```

Matching Parameter of the Lognormal Model: The parameter of link characteristic is matched for the spatial evolution include the path-loss exponent and the standard deviation The inputs of the algorithm are the set of possible values for the path-loss exponent and standard deviation denoted by nValues and Values, respectively. nValues and Values are chosen in the range of [1.5-5] and [1, 3-17], respectively, based on the channel measurement results reported in [5, 8]. The outputs of the algorithm are the values for the path-loss exponent and standard deviation that provide the best match to the obstacle-based model, which are denoted by n, respectively.

The algorithm extracting the cdf of the node degree metric for the obstacle-based model by using function cdf ND with the parameter of ObsModel and its representing in the obstacle-based model and storing the resulting cdf in the variable NDObs and initializing the minimum error to infinity by using variable $Error_{min}$ (lines 1 and 2). The algorithm then computes the cdf with the parameter of node degree metric of the lognormal model, which min is represented by LogModel and storing the result for every possible value of the path-loss exponent and standard deviation in cdf and variable NDLog, stored in the input variable n and respectively in each iteration (line 3-5).

Matching Time Correlation: Lognormal model are independently calculated at each time stamp of the simulation resulting in zero-correlation of the link characteristic over time.

Algorithm 3 Matching Correlation Factor for the Lognormal Shadowing Model

```
Input: n_m, σ_m, αValues
Output: α_m
  1: LDObs=cdf LD(ObsModel)
  2: Error_min=0;
  3: for all α Values do
  4:     LDLog=cdf LD (LogModel, n_m, σ_m, α)
  5:     Error=Diff(LDObs,LDLog)
  6:     if Error < Error_min then
  7:        Error_min = Error;
  8:        α_m=α;
  9:     end if
 10: end for
```

The matching algorithm to tune the value of the correlation factor is given in Algorithm 3. The inputs of the algorithm are the values of the path-loss exponent and standard deviation providing the best match with the spatial link characteristics of the obstacle-based model, i.e., n_m and $\square_m$, respectively and the set of possible values for the correlation factor, which is denoted by α Values. αValues are chosen in the range of [0–2] based on the correlation coefficient values used in [5] and [5, 8]. The output of the algorithm is the value of the correlation factor that provides the best match with the parameter link characteristics of the obstacle-based model, which is denoted by α_m.

Performance Metrics: The performance metrics are used in the comparison of different signal propagation.

Node Degree: The node degree of a vehicle is defined as the number of the neighboring vehicles it can communicate with each other. It is used to measure the density of the network.

Neighbor Distance Distribution: Neighbor distance distribution is defined as the distribution of the distance of the neighbor of the vehicle in the network. It is used to measure the distribution of the communicating vehicles over space.

Link Duration: Link duration is defined as the time span between the instance at which the communication link between two vehicles is established and lost. It is used to measure the stability of a connection over time.

Number of Cluster: Number of cluster is defined as the number of non connected group of vehicles at a given instant. Cluster as a connected group of vehicles within which there exists a path between any pair of nodes.

Simulation Result: The goal of the simulation is to compare the different urban scenarios based on traffic density. The topology of the VANET is obtained by using the accurate microscopic mobility modeling of SUMO while determining its input with contains vehicle position. The vehicle mobility output of SUMO is then input to the Opnet modeler, where the channel model is implemented and the performance metrics are derived and plotted the graph. The performance metrics parameter is simulation speed and memory usage of vehicle.

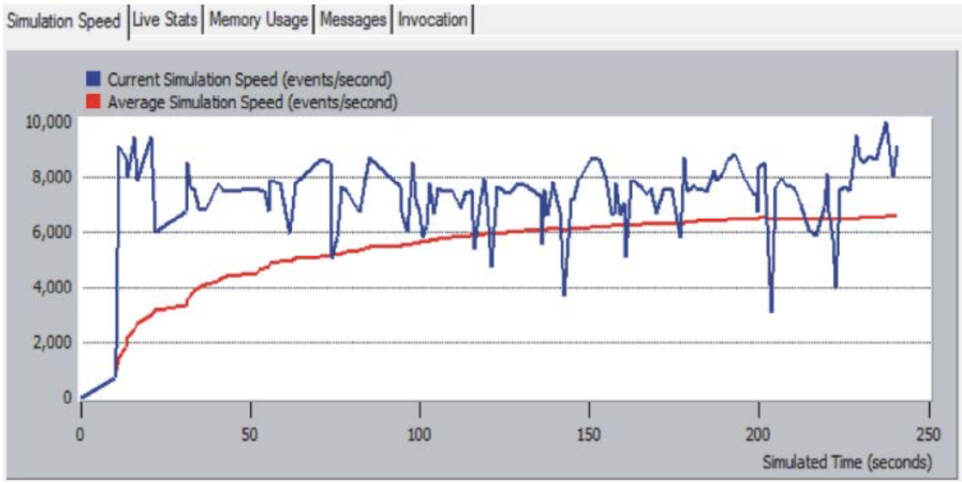

Fig. 5: Simulation Speed

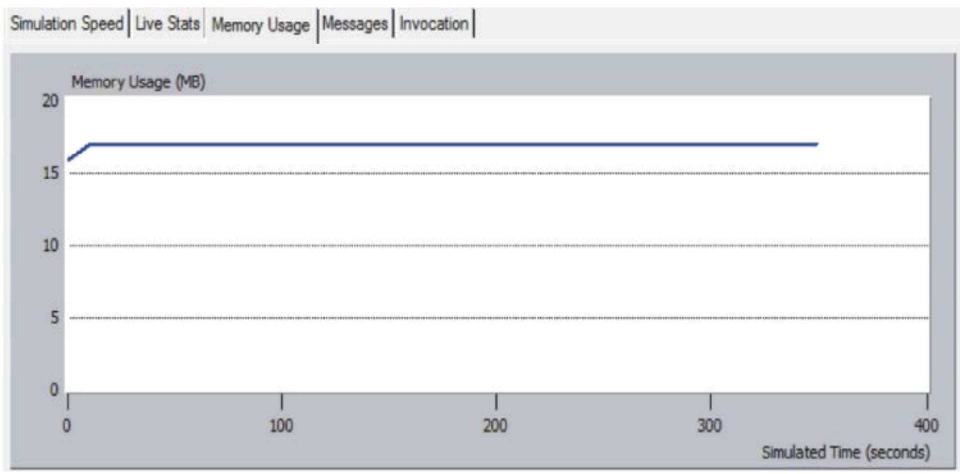

Fig. 6: Memory Usage

CONCLUSION

Analyze the time and space evolution of the VANET topology characteristics by using both realistic mobility model and channel model. The mobility model are obtained by using microscopic mobility model of SUMO, determine its input and the parameter are vehicle flow and speed of vehicle. The output of net convert file in SUMO is the input to the Opnet Modeler. Modeler will generate the trajectory (.trj) file that contains node and attribute of each vehicle. The trajectory file is the input to NS-2 and performs the channel model for vehicle to vehicle communication compare with various performances metric. The channel models are unit disk model, lognormal shadowing model and obstacle-based channel model. The obstacle-based channel model that takes all vehicles around the transmitter and receiver into the account in determine received signal strength. The performance is compared to the most commonly used channel model include unit disk and lognormal shadowing model. The link characteristic over both time and space including node degree, neighbor distribution, link duration and number of cluster introduce matching mechanism to provide the good match with the expensive obstacle-based channel model. Validate the dependence of the value of these parameter on the vehicle traffic density based on the real data of urban scenarios.

REFERENCES

1. Feliz Kristianto Karnadi Zhi Hai Mo Kun-chan Lan, 2007. “Rapid Generation of Realistic Mobility Models for VANET” IEEE Communications Society subject matter experts for publication in the WCNC.

2. Cheng, L., B.E. Henty, D.D. Stancil, F. Bai and P. Mudalige, 2007. “Mobile vehicle-to-vehicle narrow-band channel measurement and characterization of the 5.9 GHz dedicated short range communication (DSRC) frequency band,” IEEE J. Sel. Areas Commun., 25(8): 1501-1516.
3. Dhoutaut, D., A. Régis and F. Spies, 2006. “Impact of radio propagation models in vehicular ad hoc networks simulations,” in Proc. 3rd Int. Workshop VANET, pp: 40-49.
4. Nzouonta, J., N. Rajgure, G. Wang and C. Borcea, 2009. “VANET routing on city roads using real-time vehicular traffic information,” IEEE Trans. Veh. Technol., 58(7): 3609-3626.
5. Karedal, J., *et al.*, 2009. “A geometry-based stochastic MIMO model for vehicleto-vehicle communications,” IEEE Trans. Wireless Commun., 8(7): 3646-3657.
6. Gudmundson, M., 1991. “Correlation model for shadow fading in mobile radio systems, “Electron”, 27(23): 2145-2146.
7. Karedal, J., N. Czink, A. Paier and F. Tufvesson, 2011. “Path loss Modeling for Vehicle-to-Vehiclle communications” IEEE Transaction on Vehicular Technology, 60(1).
8. Liming Zhang, Feng Chen, 2013. “A Channel Model for VANET Simulation System” International Journal of Automation and Power Engineering, 2(4).
9. Florent Kaisser, Christophe Gransart, Mohamed Kassab and Marion Berbineau, “A framework to simulate VANET scenarios with SUMO” Universite Lille Nord de France IFSTTAR-LEOST.
10. Gozalvez, J., M. Sepulcre and R. Bauza, 2012. “Impact of the radio channel modelling on the performance of VANET communication protocols,” Telecommunication System, 50(3): 149-167.
11. Muhammad R. Muhaimin, “Realistic Urban Traffic Simulation” tool.
12. Nabeel Akhtar, Oznur Ozkasap and Sinem Coleri Ergeny, 2013. “VANET Topology characteristics under realistic mobility and channel models” IEEE Wireless Communication and Networking Conference in 2013
13. Nabeel Akhtar, Oznur Ozkasap and Sinem Coleri Ergeny, 2015. “Vehicles mobility and communication channel for Realistic and Efficient highway VANET Simulation IEEE Transaction On Vehicular Technology, 64(1).
14. Protzmann, R., B. Schunemann and I. Radusch, 2011. “The influences of communication models on the simulated effectiveness of V2X applications,” IEEE Commun. Mag., 49(11): 149-155.
15. Rui Meireles, Michel Ferreira, Joao Barros, 2009. “Vehicular Connectivity Models: From Single-Hop Link to Large-Scale Behaviour ” IEEE 70th Vehicular technology Conference Fall in.
16. Sepulcre, M. and J. Gozalvez, 2009. “Adaptive wireless vehicular communication techniques under correlated radio channels,” in Proc. IEEE VTC Spring, pp: 1-5.
17. Seyed A. Hosseini Tabatabaei, Martin Fleury, 2011. “Improving Propagation Modeling in Urban Environment for Vehicular Ad Hoc network” IEEE Transactions on Intelligent transportation System, pp: 12.