

# Methodology to perform simulation experiments for realistic VANET scenarios using open source software tools

<sup>1</sup>G.D.SINGH\*, <sup>2</sup>M. PRATEEK, <sup>3</sup>G.H. SASTRY

**ABSTRACT-** *Simulation software has made testing and training much cost effective and result oriented. Many fields are now depending on simulation results for their real-time product deployments. Vehicular Ad hoc Network is one of the recent emerging domain where simulation has played a very significant role. In this research paper, we have discussed our methodology that has used during our various research experiments to analyze VANET performance results. The most difficult aspect of simulation tests is deciding the software tools to perform the experiments. We have also presented features of our opted open source software tools that can used with ease by the research communities for their VANET simulations. Hence, this paper is a contribution that enables to decide which software tools are beneficial for realistic VANET scenario simulations.*

**Keywords:** *simulation, real-time, VANET, methodology, open source software*

## I. INTRODUCTION

Vehicular Ad hoc Network (VANET) is one of the fastest evolving research in the domain of Intelligent Traffic System (ITS). When we closely looks on the taxonomy of ITS, it can be seen that major concern is VANET routing and security. However, many international consortiums are already working on it with their own agendas and products. As high cost involved in real-time testing hence simulation software used to get proposed results. So, none of the research consortiums are directly testing their hypothesis on the field. They first create the real-time scenarios using various software tools and then test them using simulation experiments. Only after getting the desired results, they test that with actual hardware in fields [1]. Presently due to the emergence of cloud services and Internet of Things, we will see revolutionary change in the architecture of today's traffic and transportation system in near future [2]. VANET performance depends on various routing protocols and wireless standard. Otherwise timely communication and delay in data packets may cause accidental disasters in real-time ITS implementation [3]. To testing various routing protocols, simulation tools also used to verify the analysis of the results. Many open source and proprietary tools are already available but till yet none of the standard simulation software is available and able to fulfill all our simulation needs [4].

Hence, in this paper authors have presented their methodology that has verified for experiment tests during result their analysis. The paper is divided into five sections. First as introduction and in second methodology was presented to perform simulation tests. Then some major VANET simulation are discussed followed with simulation

---

<sup>1</sup> School of Computer Science, University of Petroleum and Energy Studies, Dehradun

<sup>2</sup> School of Computer Science, University of Petroleum and Energy Studies, Dehradun

<sup>3</sup> School of Computer Science, University of Petroleum and Energy Studies, Dehradun

experiment performed to show the validity of our proposed methodology. At last conclusion and a message given for our research community.

## II. METHODOLOGY

In this section, we will present our methodology that has been used and verified during our various research projects. This approach helps in performing our test in much simpler and faster way [5]. The result analysis is also instant as data can saved in csv formatted viewed as per our need. From our experience, we wish to state that the computing resource must be robust enough so that during execution of any simulation task no lagging or outages come. For all our experimental setups we have deployed the computing machine with Corei7-8700 3.2 Ghz. of processor and minimum of 4GB RAM is required. Previously we tried it on our Corei3 Laptop but results were not satisfactory and takes too long to run. You need to repeat the simulation tests multiple time to verify the results as some times, reading may varies due to machine's performance.

Figure 1 below illustrates the methodology of process followed for all our simulation tests.

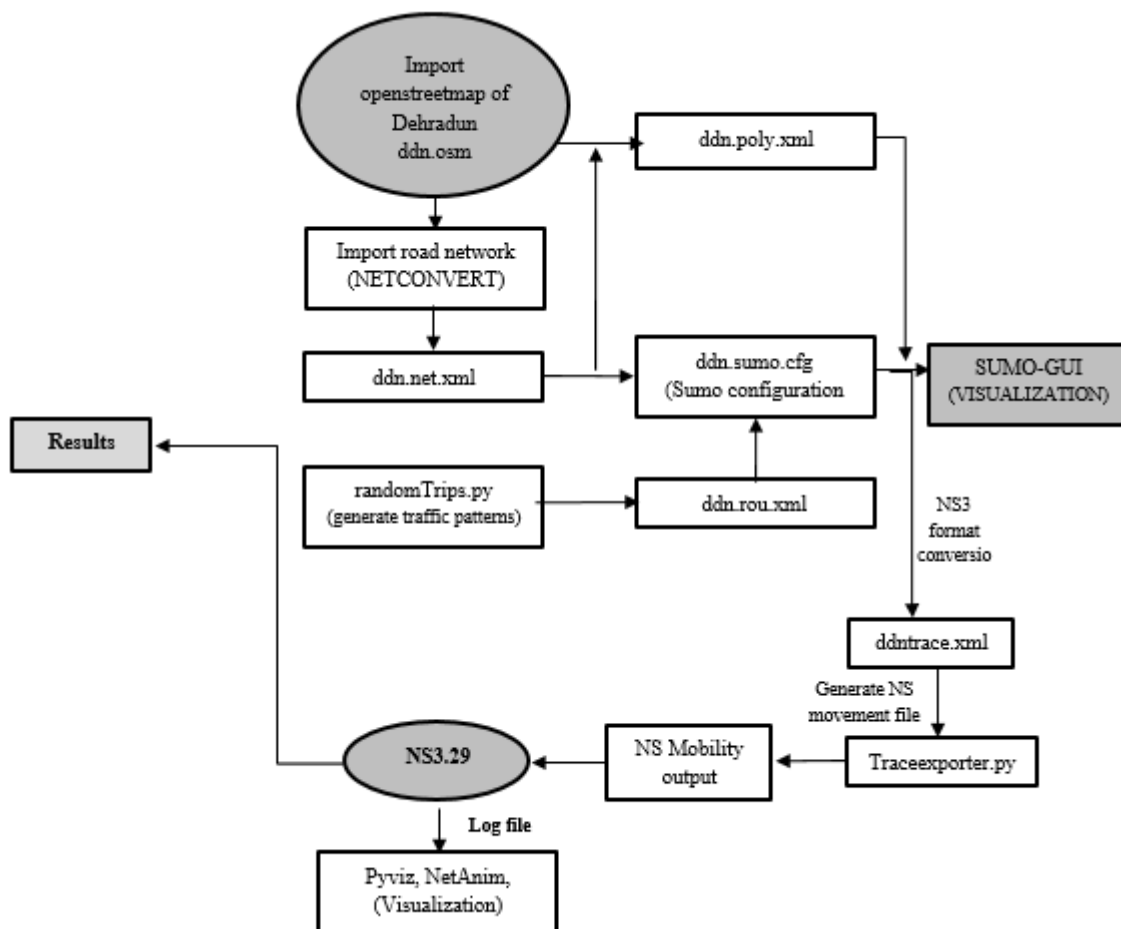


Figure 1: Methodology of simulation process

The above-mentioned methodology processed for repetitive simulation tests on a HP workstation machine in open source operating system Ubuntu 16.04 release [6]. The traffic simulator used is Simulation of Urban Mobility (SUMO 0.32) [7] and Network Simulator NS-3.29 [8] for all our tests. The simulation that carried by importing the real city scenario map of Dehradun city from openstreetmap as per the url given here <https://www.openstreetmap.org/search?query=dehradun#map=15/30.3257/78.0602> [9] for realistic approach and then converted for SUMO network. The region from Clock Tower to Mussoorie diversion Rajpur Road is selected as it is most congested route because of the heavy traffic going to Mussoorie from various regions.

Now we have converted our imported OSM map through netconvert command: “*netconvert --osm-ddn.osm -o ddn.net.xml*”. Then randomTrips.py used for adding the desired trip and routing in the network through the python scripts. This random trip script randomTrips.py applied through the command: “*py randomTrips.py -n ddn.net.xml -r ddn.rou.xml -e 50 -l -e*” to generate the route and this generates automatic file with extension .rou that was named as *ddn.rou.xml*. This completes our simulation at this stage. The route of the vehicle is defined as a set of edges. The separate file for the trip is also generated with departure and end node. Next, we run the network using SUMO configuration file *ddn.sumo.cfg*. This generates the traffic flow and road map for the real city scenario imported from *openstreetmap.org*. The road map generated is shown in figure 2. At last we run python script through “*./waf --run ddn.py --visualize*” command at NS3 shell prompt and *netanim-module.h* is included as header file for network animator in NS3.



Figure 2: Generated Road Map of Dehradun

The same methodology is used in our many research works to predict the routing issues in VANET using swarm intelligence techniques [10]. However, we have tried other methods also but found it more fast and feasible as compared to others.

### III. MAJOR VANET SIMULATORS

Many network simulators are already available to implement VANET research experiments. There are some of the proprietary VANET simulators such as QualNet, Carisma, Daimler-Chrysler, OPENT, TSIS-CORSIM, Paramics and VISSIM [11]. These closed source tools are not available to those who are not associated with these projects. Hence, researchers like us are dependent on only open source software tools for all our experimental works. The VANET simulation software can be classified into three distinguished categories such as Standard Network simulator, VANET Simulator and Mobility Generator.

Vehicular mobility generators provide real city road network traces as input for network simulator. It includes vehicle speed, road model and increase/decrease of vehicle counts. Some of the most popular open source mobility generator tools, are MOVE, STRAW CityMob, SUMO, FreeSim, VanetMobiSim and NETstream [12].

Standard network simulators basically, used for Mobile Ad hoc Network simulations but with VANET's mobility generator extension, it can be used for VANET simulations also. These are GTNetS, SNS, GloMoSim and NS2 [13]. Network simulation along with traffic simulation can be performed using VANET simulators such as VENTOS, VANETsim, GrooveNet, TraNS, MobiREAL and NCTUns. Now Veins is also getting popularity. It is an open source simulator designed for VANET. It is integration of SUMO and OMNET++ [14]. But none of the VANET simulator is best suited for all type of simulation test. VANET simulation depends on various scenario that cannot be verified through any of the above discussed tool. So our proposed methodology used to perform the simulation test on real city scenario. We did performance analysis and measured the average throughput using AODV routing protocol.

### IV. Simulation TEST PERFORMED USING ABOVE MENTIONED METHODOLOGY

This section illustrates the result of our simulation tests. Below mentioned details in the figure 3 shows the characteristics of our simulation parameters.

Parameters	Specification
Operating System	Ubuntu 16.04
Network Simulator	NS 3.26
Traffic Simulator	Simulation of Urban Mobility (SUMO-0.32)
Open Street Map for Dehradun vehicle traces	<a href="http://www.openstreetmap.org">www.openstreetmap.org</a>
Model	Manhattan mobility model
Velocity	20 to 80 km/h (more than 80 not permitted in DDN)
Transmission range	1500 to 250 m
Size of data packets	200 bytes
Interval	0.02 s
Data rate	2 mbps
Protocol	Mac Layer 802.11p
Model	Manhattan Mobility Model

Figure 3: Parameter with specification

We already analyzed and compared many of the major performance metrics during our research but in this section, we will be discussing the result obtained only by one performance metrics i.e. average throughput. The simulation was performed for three VANET scenarios. The first is parse network, second is dense network and the third is for real city scenario route network taken from osm. We followed above methodology and only tested Ad hoc On-demand Distance Vector (AODV) routing protocol [15] just to verify the performance of AODV as comparing of protocols is not our scope of research in this paper. This proves that methodology we developed is easier to perform simulation of VANET using open source tools. The data that we considered to calculate average throughput in kbps for AODV protocol is as per table 1 and performance analysis shown in figure 4.

Table 1: Data for simulation

Number of Vehicles	Parse Network	Dense Network	DDN Network
100	200	140	90
200	160	125	100
300	140	115	110
400	130	100	90
500	125	110	95

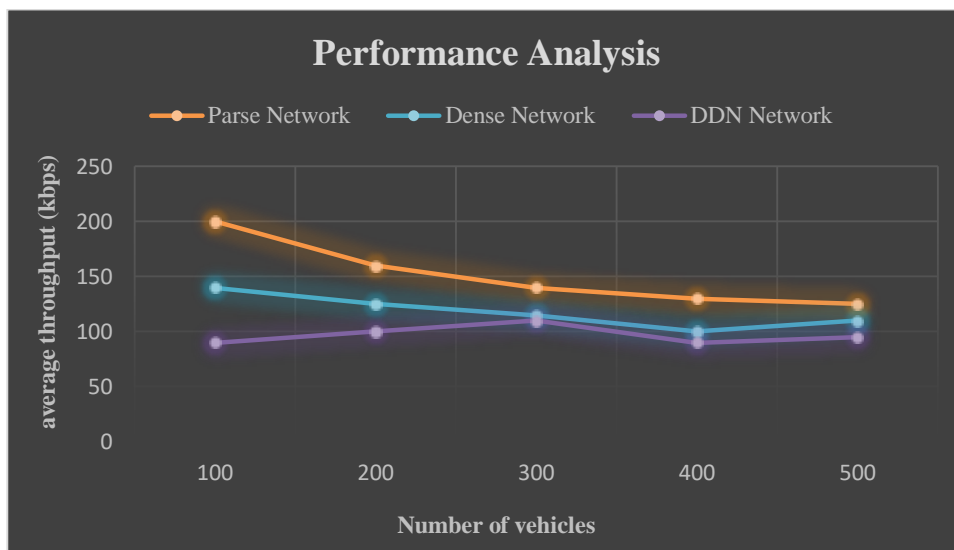


Figure 4: Performance analysis of average throughput for three VANET networks

This paper is not focusing on the performance issues of routing protocol. We just presented here our methodology to perform simulation in VANET using open source tools like Ubuntu, SUMO, NS3, OSM and python. However, we can predict from the above analysis that AODV performed superior in parse network and the performance is least in real city scenario.

## V. Conclusion of the research and future scope

In this paper, we have discussed some of the major open source software tools that are widely accepted by the research community for realistic simulation. The VANET has emerged as a dynamic platform to perform simulation tests and to verify the results based on various parameters including routing protocols. We have developed our own methodology for testing VANET simulations and presented in this paper. We concluded that by opting our advised methodology research community would be able to get results faster and in much easier way. The same as been demonstrated by us showing AODV routing protocol performance analysis of average throughput. In our future research works, we will use the same methodology to verify the simulation performance analysis of Swarm Intelligence based routing algorithms. Hence, we can confidently states that open source VANET simulation tools are the boon to our research community.

## REFERENCES

- [1] <https://hal.inria.fr/hal-01024271/document>
- [2] K. L. K. Sudheera, M. Ma, G. G. M. N. Ali, and P. H. J. Chong, "Delay efficient software defined networking based architecture for vehicular networks," in 2016 IEEE International Conference on Communication Systems (ICCS), 2016, pp. 1–6.
- [3] G.D.Singh, R.Tomar, G.H. Sastry, M.Prateek, "A Review on VANET routing protocols and Wireless Sensors", Springer, SSIT, Vol78, PP329-340, 2018. <https://www.springerprofessional.de/en/a-review-on-vanet-routing-protocols-and-wireless-standards/15174836>.
- [4] Mohammad Jan Haidari ; Zeki Yetgin, Veins based studies for vehicular ad hoc networks, International Artificial Intelligence and Data Processing Symposium (IDAP), IEEE Trans., 2019 DOI: 10.1109/IDAP.2019.8875954
- [5] G. D..Singh, M..Prateek, G.H. Sastry "Swarm Intelligence based efficient routing algorithm for platooning in VANET through Ant Colony Optimization", International Journal of Innovative Technology and Exploring Engineering(TM), Vol. 8, Issue 9, July2019, ISSN: 2278-3075
- [6] <https://ubuntu.com/tutorials/tutorial-install-ubuntu-desktop-1604>
- [7] <http://sumo.sourceforge.net/>
- [8] <https://www.nsnam.org/releases/ns-3-29/download/>
- [9] <https://www.openstreetmap.org/search?query=dehradun#map=15/30.3257/78.0602>
- [10] G.D. Singh, M. Prateek, G. H. Sastry, Swarm Intelligence Based Algorithm for Efficient Routing in VANET, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-5, March 2020
- [11] T.K. Bhatia, R.K. Ramachandran, R. Doss, L. Pan, A review of simulators used for VANETs: The case-study of vehicular mobility generators, 7th International Conference on Signal Processing and Integrated Networks (SPIN), IEEEExplore, 2020
- [12] Francisco J. Martinez, Chai Keong Toh, Juan-Carlos Cano, Carlos T. Calafate, and Pietro Manzoni, A survey and comparative study of simulators for vehicular ad hoc networks (VANETs), WIRELESS COMMUNICATIONS AND MOBILE COMPUTING. Wirel. Commun. Mob. Comput. (2009), Published online in Wiley InterScience ([www.interscience.wiley.com](http://www.interscience.wiley.com)) DOI: 10.1002/wcm.859
- [13] V. Nampally, M. R. Sharma, Simulators for VANET, International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; Volume 5 Issue IX, September 2017
- [14] M. J. Haidari, Z. Yetgin, Veins based studies for vehicular ad hoc networks, 2019 International Artificial Intelligence and Data Processing Symposium (IDAP), IEEE Xplore: 21 October 2019, DOI: 10.1109/IDAP.2019.8875954
- [15] Pooja Rani, Nitin Sharma, Pariniyojit Kumar Singh, Performance Comparison of VANET Routing Protocols, 7th International Conference on Wireless Communications, Networking and Mobile Computing, 2011, IEEEExplore, DOI: 10.1109/wicom.2011.6040428.