JACET

J. ADV COMP ENG TECHNOL, 4(3) Summer 2018

Network Parameters Evaluation in Vehicular Ad-hoc Network (VANET) Routing Protocols for Efficient Message Delivery in City Environment

Ojo Jayeola Adaramola
Computer Engineering Department, The Federal Polytechnic Ilaro Ogun State, Nigeria.
(ojo.adaramola@federalpolyilaro.edu.ng)

Received (2018-08-21) Accepted (2018-10-13)

Abstract: *Efficient message delivery in city environment is required to ensure driver's safety and passenger's comfortability. In cities of developed nations, routing of data in vehicular Ad hoc Network (VANET) faces many challenges such as radio obstacles, mobility constraints and uneven nodes distribution. These factors primarily makes communication between vehicles complex. To overcome and transmit data traffic effectively in city environment in the presence of above-mentioned challenges, evaluation of some network parameters conducted. The selected metrics are packet delivery ratio (PDR), end-to-end delay and routing overhead. These are based on three performance of position-based routing protocols: Anchor–based Street and Traffic Awareness Routing (A-STAR), Greedy Perimeter Coordinator Routing (GPCR) and Contention Based Forwarding (CBF) with the help of Simulation of Urban Mobility (SUMO) to generates vehicle mobility in city environment and network simulator (OMNeT++) to creates and calculates needed components. The speed of the vehicles and node density were varied in this process, and the simulated results showed that CBF outperforms significantly than A-STAR and GPCR in terms of packet delivery ratio as the speed varied and with a better end-to-end delays and routing overhead at a lower speed. In addition, CBF performs better than A-STAR and GPCR in terms of packet delivery ratio as the node varied with a better end-to-end delay, and a better routing overhead at a lower node density.*

Keywords: *Node Density, OMNet++, Routing Overhead, Routing Protocols, SUMO*

How to cite this article:
Ojo Jayeola Adaramola. Network Parameters Evaluation in Vehicular Ad-hoc Network (VANET) Routing Protocols for Efficient Message Delivery in City Environment. J. ADV COMP ENG TECHNOL, 4(3) Summer 2018 : 185-192

I. INTRODUCTION

Ver the years, many research works had been carried-out on mobile ad-hoc networks (MANET) and many of these work revealed one of the unique classification of this MANET as vehicular ad hoc network (VANET) which is identified with many vehicles that have power to relay messages to each other in the absence of fixed infrastructure. The idea behind this innovation is to advance communication of vehicle to permit instant and profitable data transmission for passenger's comfort and safety benefits of driver [1]. The node in the network communicates with other nodes in their radio range using wireless means. [2]. tactically, the idea of strengthen wireless communication in vehicles has captivate many researchers. Several vehicles on the road are equipped with wireless transmitters and receivers (wireless transceivers) to exchange message information with other vehicles. Messages for diverse reasons need to get across to other vehicles through inter-vehicle communications to enhance drivers' safety and present comfortable driving environment for both drivers and passengers [3]. VANET is identified with some unique characteristics such as On-board sensors (like GPS device) which help to sense the present position and nodes movement for effective message delivery and routing decision [4]. It does not have constant topology (i.e. topology changes) because of dynamic nature of vehicle on the road which moves at high speed making frequent disconnection between vehicles when information is being exchanged [5]. Although this has been one of the major challenges facing VANET routing process which is mostly experienced in highway (sparse network) [4]. In VANET technology, vehicle mobility pattern depends on structure of roads, traffic environment, vehicle speed and behaviour of driver driving [4]. Technologically, VANET is motivated as to ensure increase in the safety of traveller, decrease in travelling time [6], and with experience of no power constrain [4] because it is battery powered, and in addition, having adequate computing power required for effective message delivery. Practically, VANET Deployment in intelligent transport system (ITS) plays important roles such as road information dissemination for traffic efficiency and passenger comfort improvement [7],[8] security distance warning for both driver and passengers, vehicle collision warning, automatic parking, cooperative driving, driverless vehicles, internet access [9],[10] and also providing vehicle to vehicle (V2V) communication and communication between vehicles and road side infrastructure (V2I) in order to obtain some service [9]. The platform for drivers to exchange data for sharing information and warning messages so as to increase driver assistance, environmental sensing, monitoring, and providing update of traffic for driver in a real time through vehicular ad-hoc network [11]. The architecture of VANET technology is classify into three. These include On board Unit, application Unit and Road Side Unit [12]. In city environment which is considered for this research work, obstacle such as tree, building and other objects are major factor affecting efficiency and routing of message in city scenario [13]. To fulfill the need of VANET in wireless communication for city scenario, execution of this research work realized with two simulators used together; network simulator to evaluate network protocol performance and application in a various conditions and traffic simulator to create realistic traffic traces as an input for network simulator [14].

The rest of this work is structure as follows: Section II briefly reviewed related works on analysis carried out on different routing protocols in VANET based on different networks metrics using different simulation software. Section III discussed simulation environment for the research work, the three routing protocols considered for comparison and various network parameters used for the simulation work. Section IV presents result analysis using tables and graphs in Microsoft Excel. Lastly, section V concludes the work with future direction of the needs to examine routing protocols in other scenario.

II. RELATED WORK

According to [15], many unique networking research challenges are pose in VANETs thereby making designing of efficient routing protocol for message delivery in this technology very significant. However, several works had been done by different researchers with different simulation tools to address these unique challenges to improve VANET technology for better implementation. [16], A-STAR, a position based routing protocol was proposed in a city environment and thus made a comparison of this routing protocol with other position based routing protocols such as Geographic Source Routing (GSR) and Greedy Perimeter Stateless Routing (GPSR) on selected metrics parameters. The selected parameters were end-to-end delay and packet delivery ration using network simulator (NS-2) and observed that A-STAR outperformed in packet delivery ratio with a better end-to- end delay than these other protocols. Also [17] offered a method that does not make use of beacons to carry out position-based unicast forwarding and created three suppression approaches having different suppression uniqueness and forwarding competency. They analyzed behavior of CBF using network simulator (ns-2) with all the three suppression approaches and compared these with greedy position- based routing approaches that are already in existence. Accordingly, the CBF results shows that to achieve a particular delivery rate, there is a significant reduction of load on the required wireless channel as compared to the load that will be generates by a beacon-based greedy forwarding strategy. In their effort [18], further investigate performance of some existing position-based routing protocols in city environment. And proposed and evaluated Junction-Based Routing (or JBR), a new position-based routing algorithm and compared it with existing position-based routing algorithm: Greedy Perimeter Coordinator Routing (GPCR) algorithm in real city scenario using network simulator (ns-2) and traffic mobility generator (VanetMobiSim) based on some selected network metrics such as Average end-to-end delay, Packet delay distribution, delivery ratio (PDR). The proposed JBR outperformed GPCR in terms of packet delivery ratio, delay distribution; end-to-end delay with a better performance at higher transmission range is higher. [19], researched and selected city of Cologne, German for realistic traffics simulation using Veins framework that joined Traffic generator (SUMO) and network simulator (OMNET++) to simulate this environment by determine the Probability of Beacon Delivery for each car sampled. He concluded that each car has different Probability of Beacon Delivery that can change as the number of cars or received beacons increases or decreases in each time.

Extra effort had also been made by other researchers to analyse different routing protocols available in VANET technology. [20], further emphases that routing protocols performance can be vary with several network parameters like node density, speed, traffic scenarios and pause time. They based their consideration and analysis on two on-demand routing protocols such as Dynamic Source Routing (DSR) and Ad hoc On Demand (AODV) based on loss packet ratio, packet delivery ratio, and end-to-end delay with varying node density and pause time under CBR and TCP connection. NS2 simulation techniques deployed to measure the routing protocols performance and observed that performance of both routing protocols relied heavily on the scenario used. [21] Analyzed three routing protocols namely: Dynamic Source Routing (DSR), Ad hoc On Demand (AODV) and Greedy Perimeter Stateless Routing (GPSR) routing protocols performance. Deployed Simulation of Urban Mobility (SUMO) and NS-2.33 based on their behavior with increase in network density for selected network metrics such as packet delivery ratio, packet loss, and throughput. They agreed that GPSR out performed in terms of packet delivery ratio, throughput, and with a lesser packet loss than AODV and DSR for the city map considered for the researched work. The previous effort made by various researchers on routing protocols had opened research opportunity for evaluation. Three network metrics like end-to-end- delay, packet delivery ratio and routing overhead selected to compare three position-based routing protocols: A-STAR, CBF, and GPCR in city environment in the presence of radio obstacles, mobility constraints and uneven nodes distribution with simulation techniques. Technically, Variation in node speed (m/s) and node density were the basic factors for the simulation.

III. SIMULATION ENVIRONMENT

The mobility of vehicle for City Environment was generated using Simulation of Urban Mobility (SUMO-0.19.0), a highly portable, open source, macroscopic and microscopic mobility model with ability to handle very large number of vehicle by importing and editing street maps from OpenStreetMap. A city in Sanfrancisco selected showing some vehicle mobility as simulated in Figure 1.

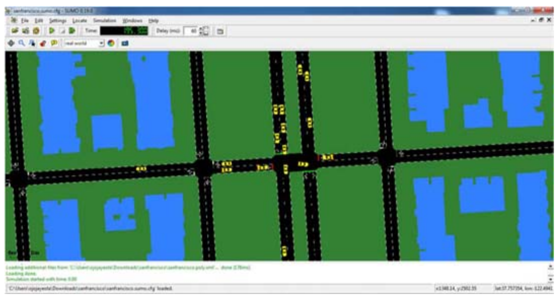

Fig. 1. Vehicle Traffic Generated During Simulation in SUMO-0.19.0 for City Environment in Sanfrancisco

Network parameters generated, simulated and evaluated using OMNet++, a C++ based discrete event simulator, an open source with the ability to simulate communication networks. The network parameters used were packet delivery ratio, routing overhead and end-to-end delay for the chosen position-based routing protocols. The protocols chosen were; A-STAR, which uses street map to determine the series of junctions (anchors) path for packet to reach it destination [13]. GPCR, that relies on transmission of packet of data continuously to the junction node rather than allowing the packet of data to be transmitted everywhere on the junction [13]. CBF, which avoid utilization of beacon messages to conserves bandwidth, and only allows data packet transmission to all direct neighbors and identifies the most suitable node to forward the packet using a distributed timer- based contention process by suppressing other prospective forwarders [13]. Two important elements were considered for the simulation; the speed of the vehicle and the node density. The speed of the vehicle varied in the city for 40m/s, 60m/s, 80m/s and the node density also varied by increasing the node from 100 to 120, and 150. The simulation area was set to 2.5km x 2km. Other parameters and their values used for the simulation such as mobility type, simulation time limit, maximum transmission power, carrier frequency, and channel bit rate shown in Table I

Table I: Parameters Used for the Simulation

Parameters	Value
Simulation Scenario	City Environment
Network Simulator	OMNet++ 4.4.1
Vehicle Mobility Generator Simulator	SUMO-0.19.0
Simulation Area	2500m x 2000m
Routing Protocols	GPCR, ASTAR, CBF
Simulation Time Limit	600s
Transmission Range	50m
Node Density in City	100, 120, 150, 180
Speed	40m/s, 60m/s, 80m/s
Mobility Type	TraCIMobility
Carrier Frequency	5.89GHz
Maximum Transmission Power	2mW
Mac	IEEE802.11p
Traffic Type	UDP
Channel Bitrate	2Mbps

IV. RESULTS

The results for this research work generated in OMNet ++. Table II shows varying speeds at 40m/s, 60m/s, and 80m/s. The transmission range of 50m and node density of 100 considered. Three position based routing protocols: A-STAR, GPCR and CBF investigated based on packet delivery ratio in percentage, end-to- end delay in second and routing overhead in percentage also considered. For routing protocols to deliver message efficient and effectively, it expected to operate at higher packed delivery ratio, lower end-to-end delay, and lower routing overhead. Observation from table II shows that routing protocol performance varied at various speeds which means that the performance of routing protocols in city environment depends on the speed at which the node operates. In all situation, the results obtained from OMNet++ were analyzed in excel and related graphs were obtained and represented in figures.

TableII: Simulation with Varying Speeds, Fixed Transmission Range, and Fixed Node Density.

Speed (m/s)	Routing Protocols	Packet Delivery Ratio (PDR)	End-to-End Delay (sec)	Routing Overhead
40	A-STAR	0.84	12.73	91.62
	GPCR	0.8	8.96	99.75
	CBF	0.94	7.9	55.31
60	A-STAR	0.84	12.73	64.2
	GPCR	0.8	10.86	88.89
	CBF	0.94	12.73	11.85
80	A-STAR	0.84	6.79	52.7
	GPCR	0.8	13.71	44.81
	CBF	0.94	8.81	87.64

Table III shows packet delivery ratio for the three routing protocols at various speeds. Observation from the table showed that packet delivery ratio for all the routing protocols remained constant all through the speed while Greedy Perimeter Coordinator Routing (GPCR) has lowest packet delivery ratio 0f 0.8*100%, Contention Based Forwarding (CBF) has highest packet delivery ratio of 0.94*100%. The graphical illustration of Table III were represented in Figure 2 below

Table III: Packet Delivery Ratio in Different Routing Protocols with Varying Speed

Speed (m/s)	A-STAR	GPCR	CBF
40m/s	0.84	0.8	0.94
60m/s	0.84	0.8	0.94
80m/s	0.84	0.8	0.94

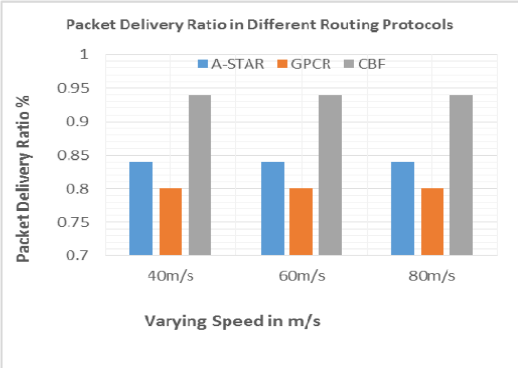

Fig. 2. Packet Delivery Ratio with varying speeds, fixed node density, and fixed transmission range

Table IV shows end-to-end delay for the three routing protocols at various speeds. Observation from the table shows that end-to-end delay is low in Contention Based Forwarding (CBF) with 7.90 second at 40m/s. Greedy Perimeter Coordinator Routing (GPCR) has lower end-to-end delay with 10.86 seconds at 60m/s while Anchor-Based Street and Traffic Routing (A-STAR) has lowest end-to-end delay with 6.79 at 80m/s. The graphical illustration of Table IV represented in Figure 3 below.

Table IV: End-to-End Delay in Different Routing Protocols with Varying Speed

Speed (m/s)	A-STAR	GPCR	CBF
40m/s	12.73	8.96	7.9
60m/s	12.73	10.86	12.73
80m/s	6.79	13.71	8.81

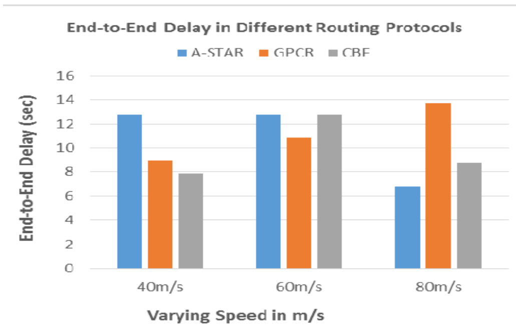

Fig. 3. End-to-End Delay with varying speeds, fixed node density, and fixed transmission range

Table V shows routing overhead for the three routing protocols at various speeds. Reflection from the table shows that Contention Based Forwarding (CBF) shows lowest routing overhead at both 40m/s and 60m/s with 55.31% and 11.85%. Greedy Perimeter Coordinator Routing (GPCR) has lowest routing overhead with 44.81% 80m/s while Anchor-Based Street and Traffic Routing (A-STAR) is averagely good at all speed in terms of routing overhead in city environment. The graphical illustration of Table V are shown in Figure 4 below

TableV: Routing Overhead in Different Routing Protocols with Varying Speed

Speed (m/s)	A-STAR	GPCR	CBF
40m/s	91.62	99.75	55.31
60m/s	64.2	88.89	11.85
80m/s	52.7	44.81	87.64

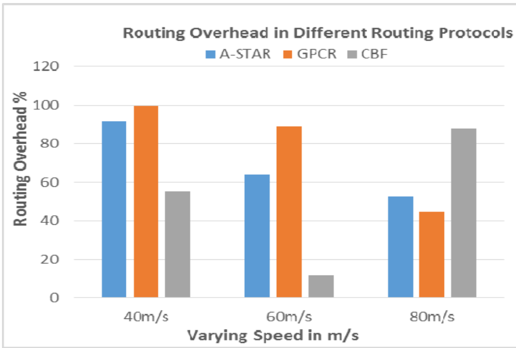

Fig. 4. Routing Overhead with varying speeds, fixed node density, and fixed transmission range

Table VI shows varying node density at 100, 120, and 150. Transmission range of 50m and speed of 40m/s also considered for the work. Three position based routing protocols A-STAR, GPCR and CBF were also examined based on packet delivery ration (%), end-to- end delay (seconds), and routing overhead (%). Remark from table V shows that routing protocol performance varied at various node densities. In all situation, the results obtained from OMNet++ were also analyzed in excel and related graphs were obtained and graphical illustration were represented in figures.

Table VI: Simulation with Varying Node Density, Fixed Transmission Range, and Fixed Speed.

Node Density	Routing Protocols	Packet Delivery Ratio (PDR)	End-to-End Delay (sec)	Routing Overhead
100	A-STAR	0.84	12.73	91.62
	GPCR	0.8	8.96	99.75
	CBF	0.94	7.9	55.31
120	A-STAR	0.84	12.05	29.38
	GPCR	0.8	5.88	33.58
	CBF	0.94	7.9	18.92
150	A-STAR	0.84	14.94	24.1
	GPCR	0.8	14.94	91.85
	CBF	0.94	10.95	31.18

Table VII shows packet delivery ratio for the three routing protocols at various node densities. Observation from the table showed that packet delivery ratio for all the routing protocols remained constant with varying node density, 50m transmission range and 40m/s node speed. Greedy Perimeter Coordinator Routing (GPCR) has lowest packet delivery ratio 0f 0.8*100%, Contention Based Forwarding (CBF) has highest packet delivery ratio of 0.94*100%. The graphical illustration of Table VII presented in Figure 5 below.

Table VII: Packet Delivery Ratio in Different Routing Protocols with Varying Node Density

Node Density	A-STAR	GPCR	CBF
100	0.84	0.8	0.94
120	0.84	0.8	0.94
150	0.84	0.8	0.94

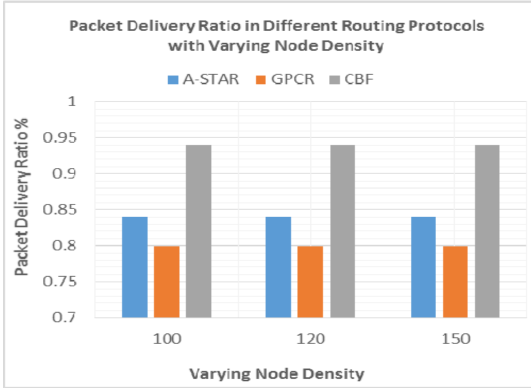

Fig. 5. Packet Delivery Ratio with varying node density, fixed speed, and fixed transmission range

Table VIII shows end-to-end delay for the three routing protocols at various node densities. Observation from the table shows that end-to-end delay is lowest in Contention Based Forwarding (CBF) with 7.90 second at 100 and 150 nodes. Greedy Perimeter Coordinator Routing (GPCR) has lowest end-to-end delay with 5.88 seconds at 120 nodes. The graphical illustration of Table VIII are represented in Figure 6 below

Table VIII: End-to-End Delay in Different Routing Protocols with Varying Node Density

Node Density	A-STAR	GPCR	CBF
100	12.73	8.96	7.9
120	12.05	5.88	7.9
150	14.94	14.94	10.95

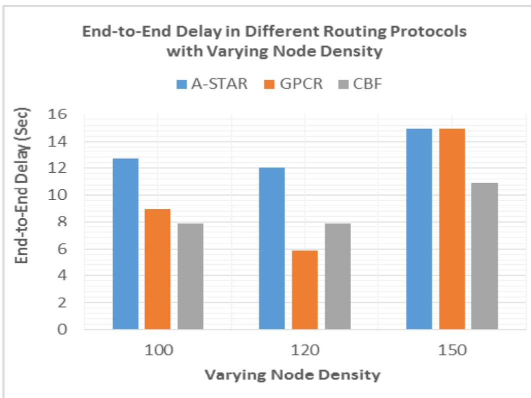

Fig. 6. End-to-End Delay with varying speeds, fixed node density, and fixed transmission range

Table IX shows routing overhead for the three routing protocols at various node densities. Observation from the table shows that Contention Based Forwarding (CBF) shows lowest routing overhead at both 100 and 120 node densities with 55.31% and 18.92%. Anchor-Based Street and Traffic Routing (A-STAR) has lowest routing overhead with 24.1% at 150 nodes density. The graphical illustration of Table IX are well presented in figure 7 below

Table IX: Routing Overhead in Different Routing Protocols with Varying Node Density

Node Density	A-STAR	GPCR	CBF
100	91.62	99.75	55.31
120	29.38	33.58	18.92
150	24.1	91.85	31.18

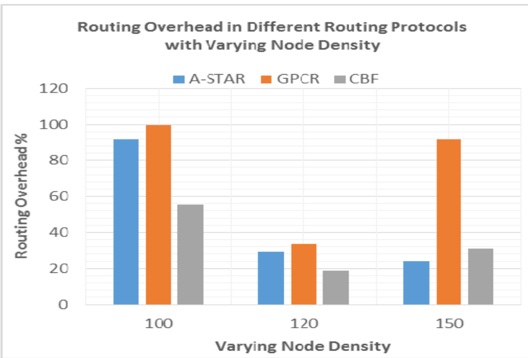

Fig. 7: Routing Overhead with varying nodes, fixed speed, and fixed transmission range

V. CONCLUSION

Performance evaluation of any network considered important in determining any issues that may exist. The most appreciable way used to achieve the evaluation is to deploy appropriate simulations that offered closest results to real world scenario. SUMO and OMNet++ give a better option for the evaluation and the analysis with the results based on the graph that show better data packets delivery with CBF routing protocols than A-STAR and GPCR routing protocols in city environment irrespective of speed and node density. Better routing overhead observed in CBF than A-STAR and GPCR and end-to-end delay for each routing protocol depends on speed and number of nodes at which it operates, CBF considered better at lower speed and low node density. These routing protocols needs further examination as a future work in highway environment.

REFERENCES

1. Nidhi, and Lobiyal, D., .K., 2012. Performance Evaluation of Realistic Vanet using Traffic Light Scenario, International Journal of Wireless and Mobile Networks (IJWMN) Vol. 4, No 1, pp. 237-249.

2. Prasan, U., D., and Murugappan, S., 2016. An Analysis on Vehicular Ad-Hoc Networks: Research Issues, Challenges and Applications, International Journal of Applied Engineering Research , Vol. 11, No. 6, pp. 4569-4575.

3. Lin, Y., Chen, Y., and Lee, S., 2010. Routing Protocols in Vehicular Ad Hoc Networks: A Survey and Future Perspectives, Journal of Information Science and Engineering , Vol. 26, pp. 913-932.

4. Paul, B., Ibrahim, M., and Bikas, M., A., N., 2011. VANET Routing Protocols: Pros and Cons, International Journal of Computer Applications, Vol. 20, No. 3, pp. 28-34.

5. Eiza, M., H., Owens, Q., Ni., T., and Min, G.., 2013. Investigation of Routing Reliability of Vehicular Ad hoc Networks, EURASIP Journal on Wireless Communications and Networking , Vol. 1, No. 179, pp. 1-15.

6. Singh, P., K., Lego, K., and Tuithung, T., 2011. Simulation based Analysis of Adhoc Routing Protocol in Urban and Highway Scenario of VANET, International Journal of Computer Applications, Vol 12, No 10, pp. 42-49.

7. Al-Sultan, S., Al-Doori, M., .M., Al-Bayatti, A.., H., and Zedan, H., 2013. A Comprehensive Survey on Vehicular AdHoc Network, Journal of Network and Computer Applications , Vol. 37, P. 380–392.

8. Paul, B., Ibrahim, M., and Bikas, M., A., N., 2012. Performance Evaluation of AODV & DSR with Varying Pause Time & Speed Time Over TCP & CBR Connections in VANET, International Journal of Computer Science Issues (IJCSI), Vol. 9, No. 1, pp. 493-504.

9. Nagara, U., and Dhamal, P., 2011. Broadcasting Routing Protocols in VANET, Network and Complex Systems, Vol. 1, No. 2, pp. 13-19.

10. Paul, B., Ibrahim, M., and Bikas, M., A., N., 2011. Performance Evaluation of AODV & DSR with Varying Pause Time & Node Density Over TCP & CBR Connections in Vanet, International Journal of Computer Science and Network Security (IJCSNS), Vol. 11, No. 7, pp. 119-127.

11. Braga, R., B., and Herve, M., 2011. Understanding Geographic Routing in Vehicular Ad Hoc Networks, The Third International Conference on Advanced Geographic Information Systems, Applications, and Services, pp. 17-22.

12. Barskar, R., and Chawla, M., 2015. Vehicular Ad hoc Networks and its Applications in Diversified Fields, International Journal of Computer Applications, Vol. 123, No .10, pp. 7-11.

13. Sharef, B., T., Alsaqour, R.,. A., and Ismail, M., 2013. Vehicular Communication Adhoc Routing Protocols: A Survey, Journal of Networkand Computer Applications , Vol. 40, No. 2014, p. 363–396.

14. Hussain, S., A., and Saeed, A., 2013. An Analysis of Simulators for Vehicular Ad hoc Networks, World Applied Sciences Journal , Vol. 23, No. 8, pp. 1044-1048.

15. Karande, N., D., and Kulkarni, K., K., 2013. Efficient Routing Protocols For Vehicular Adhoc Network, International Journal of Engineering Research & Technology (IJERT), Vol. 2, No. 1, pp. 1-8.

16. Seet, B., Liu, G., Lee, B., Foh, C., Wong, K., and Lee, K.,, 2004.. A-STAR: A Mobile Ad Hoc Routing Strategy for Metropolis Vehicular Communications, International Federation for Information Processing (IFIP), Vol. 3042, No. 0302-9743, pp. 989- 999

17. Füßler, H., Widmer, J., Käsemann, M., Mauve, M., and Hartenstein, H., 2003. Contention-Based Forwarding for Mobile Ad-Hoc Networks, Elsevier Science, Vol. 1, No. 4, pp. 1-29.

18. Tsiachris, S., Koltsidas, G., and Pavlidou, F., 2013. Junction-Based Geographic Routing Algorithm for Vehicular Ad-hoc Networks, Wireless Personal Communications: An International Journal, Vol. 7, No. 2, pp. 955-973.

19. Noori, H., 2012, November. Realistic Urban Traffic Simulation as Vehicular Ad-Hoc Network (VANET) via Veins Framework, Proceeding of the 12th Conference of Fruct Association, No. 2305-7254, (pp. 99-105)

20. Paul, B., Ibrahim, M., and Bikas, M., A., N., 2011. Experimental Analysis of AODV & DSR Over TCP & CBR Connections with Varying Speed and Node Density in VANET, International Journal of Computer Applications, Vol. 24, No. 4, pp. 30-37..

21. Pankaja, R., Shona, M., and Archana, M., 2014. Analysis of Routing Protocols for VANET using Real City Map Scenarios, International Journal of Computer Applications, pp. 19-22.

