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Effect of Realistic Vehicular Traces on the Performance of Broadcasting Techniques in Vehicular Ad Hoc Networks

Sanjoy Das and D.K. Lobiyal
School of Computer and Systems Sciences, Jawaharlal Nehru University, New Delhi, India

Abstract: In this study, performance analysis of different broadcasting methods i.e., flooding and probabilistic broadcasting inside the geocast region has been done. We have considered an urban scenario where radio transmission is obstructed due to presence of high rise buildings, trees and other objects. Our objective is to provide a comparative analysis between flooding and probabilistic methods with varying traffic density and nodes speed in VANET. Different values of probability for probabilistic broadcast method have been considered to investigate an appropriate value that may give best results. To generate real traces of vehicles movement VanetMobiSim is used. The mobility model considered is Intelligent Driver Model with Intersection Management. We have considered different types of traffic conditions based on number of vehicles present in the network in a particular time period are Sparse, Intermediate and Dense. The results obtained shows that in dense traffic scenario probabilistic broadcasting method achieves maximum packet delivery ratio is 83.9412% when p = 0.1. In sparsely populated network the PDR are low as compared to other traffic conditions. The minimum value of PDR obtained is 21.0455% when number of node is 50 and p = 0.8. Simulations have been conducted using the NS-2 simulator and for result analysis used awk programming, Matlab is used.

Keywords: Ad hoc networks, flooding, IDM_IM, mobility model, packet delivery ratio, probabilistic broadcast, urban area

INTRODUCTION

VANET is a special class of Mobile Ad hoc Network (MANET), where nodes movements are confined to the road structure. In this network a node behaves like a router to relay a message from one node to another. In VANET mobility of vehicles depends on the structure of the geographical areas. VANET uses two types of communication methods one form is Vehicle to Vehicle (V2V) and the other is Vehicle to fixed Road side infrastructure (V2R). In both the methods vehicles can communicate to other vehicles or road side unit either directly or through multiple hops. It depends on the position of the vehicles. Further, the Road Side Units (RSU) can also communicate with other RSU via single or multi hop. The RSU supports numerous applications like road safety, message delivery; maintaining connectivity by sending, receiving or forwarding data in the network. The main focus of the VANET is to provide real-time and safety applications for drivers and passengers. There are various types of safety features and services supported by VANET that are needed to be timely disseminated to a driver for appropriate actions. Some of the applications are collision warnings, road sign alarms, blind turn warning, congested road notification, free flow tolling, parking availability notification, parking spot locator, internet connections facility, electronic toll collection and a variety of multimedia services etc., (Hassnaa and Zhang, 2009; Marc *et al*., 2010). By delivering these messages on time can minimize road accidents and save total journey time. The RSU can improve traffic management system by providing drivers and passengers with the above vital information. It is desirable that protocols should maintain the low end-to-end delay and, high delivery ratio, low overheads and minimum numbers of hops.

LITERATURE REVIEW

Many studies have been carried out by researchers, academicians and industries for successfully routing of messages in VANET. There are several research projects on VANET being carried out by researchers and various consortiums. Some of them are Car Talk, Fleet Net-Internet on the Road, NoW (Network on Wheel), (Hassnaa and Zhang, 2009; Marc *et al*., 2010) with the emphasis on deployment in the real world. The main focus of all these projects is to provide better safety, comfort and timely dissemination of message from one location to another location. Some of the message delivery protocols proposed for

Corresponding Author: Sanjoy Das School of Computer and Systems Sciences, Jawaharlal Nehru University, New Delhi, India

VANET attempt to deliver a message to a geographic region rather than to a node. These protocols are called geocast routing. LAR (Young-Bae and Vaidya, 1998), LBM (Young-Bae and Vaidya, 1999) and GeoTORA (Young-Bae and Vaidya, 2000) is modified TORA, GRID protocol is modified to GeoGRID (Wen-Hwa *et al*., 2000), DREAM (Stefano *et al*., 1998), GRUV (Guoqing *et al*., 2009) are few geocasting protocols. In (Young-Bae and Vaidya, 1999) authors use flooding method but it limits the flooding to a small geographic region called forwarding zone instead of whole network area. The forwarding zone is computed based on the position of sender and geocast region. In (Young-Bae and Vaidya, 2000) authors have improved the method proposed in (Young-Bae and Vaidya, 1999) and incorporate it with TORA. Through simulation study, they have shown that this method reduces the overhead of geocast delivery and maintain high accuracy in data delivery. All these protocols use simple flooding technique inside the geocast region for message delivery. The flooding technique is the simplest broadcasting method to deliver message to a particular geographical region i.e., geocast region. Further, in simple flooding technique (Young-Bae and Vaidya, 2002; Jun and Jamalipour, 2009) any vehicle receives a broadcast message for the first time has the responsibility to rebroadcast the message for its onward transmission. In this method, number of transmissions increases with increasing number of nodes in the network. In (Christian *et al*., 2003) authors show a wide analysis of their proposed protocol Geographic Source Routing (GSR) with DSR, AODV for VANET in city scenarios. They have done simulation analysis of these protocols on realistic vehicular traffic for a particular city scenario. The real city map is considered and converted to graph for the analysis. Their result shows that GSR performs better than DSR and AODV in terms of end-to-end delivery and latency. In (Sidi-Mohammed and Rasheed, 2007; Floriano *et al*., 2003) the authors proposed different modified LAR algorithms. They have modified the request zone. Through simulation, the authors have established that their proposed algorithms reduces route request overhead as compared to original LAR. The performance analysis shows that their method outperforms original LAR especially, in a dense and highly dynamic ad hoc network. In (Dukhyun *et al*., 2012) a Probabilistic and Opportunistic Flooding Algorithm (POFA) proposed to controls rebroadcasts and retransmissions opportunistically in a sensor network. In this protocol every node only selects its one hop neighbours to rebroadcast the message. The criterion for rebroadcasting the message depends on link error rate among neighbour nodes. The sender of the message controls the retransmission the message opportunistically by checking the reception of the message by its neighbours. The simulation results show that the protocol perform better than flooding and increases the lifetime of the network. In (Young-Bae and Vaidya, 2002) authors have considered various factors like frequent link breakages, high mobility and signal attenuation in urban areas. In this method different forwarding zones are defined and for data delivery these forwarding zones are dynamically switches. The vehicles are classified based on their current location into two groups known as crossroads nodes and inroad node. The forwarding zones are BOX, Extended Box (E-Box) and FLOOD is used. Whatever method is successful to find a path between sources to geocast region that forwarding zone will continue till it does not encounter failure. According to the category of nodes it apply different next hop node selection algorithms i.e., crossroads node selection algorithm and in road node selection algorithm. It is able to find robust a path for data delivery due to next hops selection algorithms according to category of nodes. In (Khaled *et al*., 2009) addressed the spatial broadcast problem occur when many vehicles are try to rebroadcast message at the same time in a dense traffic scenario. In such circumstances introduce channel contention and collisions. The probabilistic Inter Vehicle Geocast (p-IVG) is a solution to the above problem. In this protocol rebroadcasting of messages follows a probabilistic approach which is depends on the traffic density surrounding the vehicles. The protocol improves the receptions rate, lower channel contention and faster dissemination of message to distant vehicles. In (Ehsan and Fathy, 2007) authors have only considered the energy consumption parameter for performance analysis of LAR1 protocol with DSR and AODV in highly dense ad hoc networks. The results reported show that LAR1 perform better than DSR and AODV protocol in highly dense network. But in low density DSR performs better than others in term of energy consumption. In (Sanjoy and Lobiyal, 2011) the authors analyzed the performance of LAR1 protocol in city scenario. Through extensive simulation they have shown the end-to-end delay is high in sparsely populated network, but in densely populated network end-to-end delay is low. Most of these protocols use random waypoint mobility model for the performance analysis of network models. None of above protocols considered the physical obstruction in delivery of message in urban scenario.

METHODOLOGY

Proposed model: We have considered an Urban Scenario. In this scenario, it's very rare that source and destination node fall in each other transmission range.

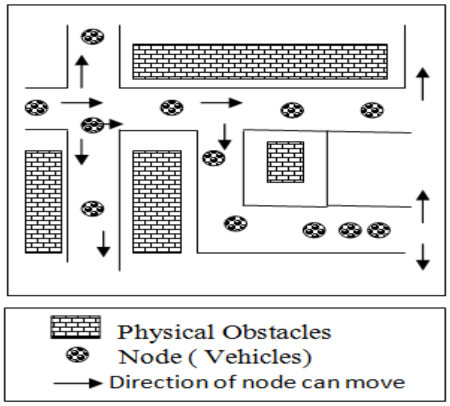


Fig. 1: Simple scenario of urban areas

Table 1: Different types of traffic

Type of traffic	No. of nodes
Sparse	50
Intermediate	100, 150
Dense	200

So, we have considered the multi-hop environment (Sanjoy and Lobiyal, 2012). As there is no direct connectivity between source and destination node because of the terrains structure. To route the message intermediate nodes play a vital role. The intermediate nodes act as relay node. The presence of physical obstacle to deliver message with in the geocast region shown in Fig. 1. The physical obstacles can affect radio signal propagation. In the urban areas presence of high rise building and other objects are provide limited connectivity and poor visibility among nodes. Further, the vehicles movements in urban area are confined by traffic lights and obstacles present over the area.

To deliver message to all the nodes inside the region we have considered flooding and probabilistic techniques. We have considered different types of traffic scenarios listed in the Table 1.

Overview of broadcasting techniques and mobility model: The flooding (Jun and Jamalipour, 2009) is the simplest method to deliver a message to all nodes present in a specific area. This is the most guaranteed geocasting mechanism. Here, a node that receives a message for the first time; will retransmit the message to all its neighbours. This method only guarantees that, a message will be definitely delivered to the destination in a connected network. Here, the packet delivery ratio is high, but the overhead is also very high. Suppose n nodes are participating in message dissemination in the geocast region. As the number of nodes n increases, no. of packet to be transmitted also increases. It causes redundant data transmission and inefficient use of network resources. This method ensure that, node present in the geocast region receives a copy of a geocast packet. Sometimes it leads to broadcast storm problem (Sze-Yao *et al*., 1999) due to high contention, collisions and redundant rebroadcast of messages. To mitigate the broadcast storm problem some solutions related to VANET is proposed in (Nawaporn *et al*., 2007).

Flooding algorithm: (Jun and Jamalipour, 2009; Yoav *et al*. 2003; Yoav *et al*. 2002):

```
Pseudo code:
Source (S) node send packet (Pkt)
IF node n_i received Pkt for first time // i = 1, 2, 3…
{
IF (neighbour of n_i! = NULL)
{
broadcast (Pkt) to its neighbour node
}
}
ELSE
DISCARD Pkt
EXIT
```

The Probabilistic technique of broadcast (Jun and Jamalipour, 2009) is a type of restricted flooding. To mitigate the shortcoming of flooding this method was introduced. In this method, upon receiving a non duplicate packet nodes further rebroadcast with probability p. where ($0<p\leq 1$).

Probabilistic broadcast algorithm: (Jun and Jamalipour, 2009; Yoav *et al*. 2002):

```
Pseudo code:
Source node (S) sends packet (pkt)
IF node n_i received Pkt for first time // i = 1, 2, 3…
{
IF (neighbour n_i! = NULL)
   {
Choose value probability of P // 0<p≤1
Broadcast (pkt) to its neighbour node with P
   }
}
ELSE
DISCARD Pkt
EXIT
```

Description of mobility model: VanetMobiSim is an extension for the CANU Mobility Simulation Environment (CanuMobiSim) [VanetMobiSim], a flexible framework for user mobility modeling. The VanetMobiSim [VanetMobiSim] extension focuses on

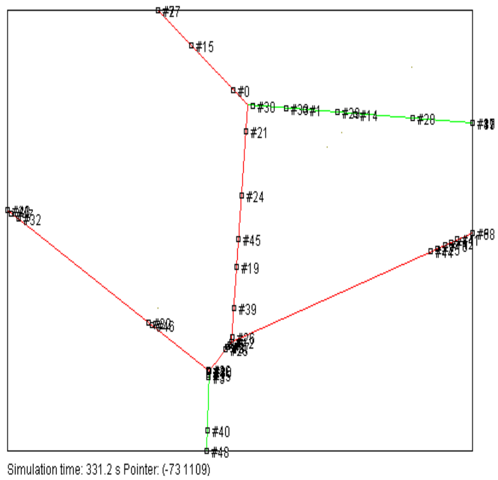


Fig. 2: Snapshot node movements in vanetmobisim no of nodes 50 at speed 30

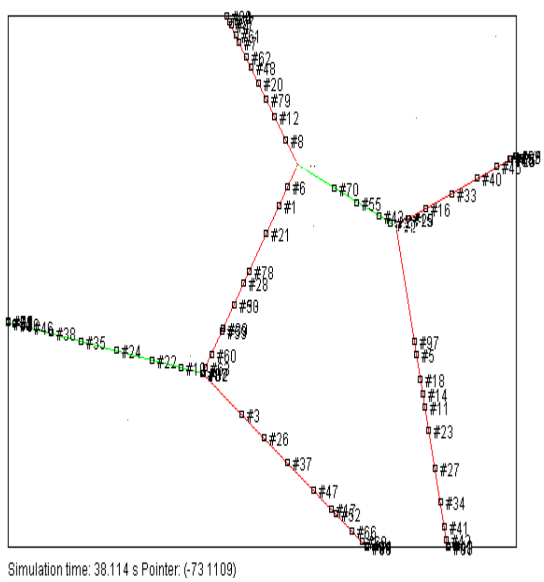


Fig. 3: Snapshot node movements in vanetmobisim no of nodes 100 at speed 50

vehicular mobility and features new realistic automotive motion models at both macroscopic and microscopic levels. The random movements of vehicles generate using Voronoi tessellation on a set of non-uniformly distributed points (Marco *et al*., 2007). The most important features supported are multi-lane roads, separate directional flows, differentiated speed constraints and traffic signs at intersections. At macroscopic level, it implements new mobility models, providing realistic communication between Vehicle-to-Vehicle (V2V) and Vehicle to Roadside (V2R) infrastructure. There are various factors which regula

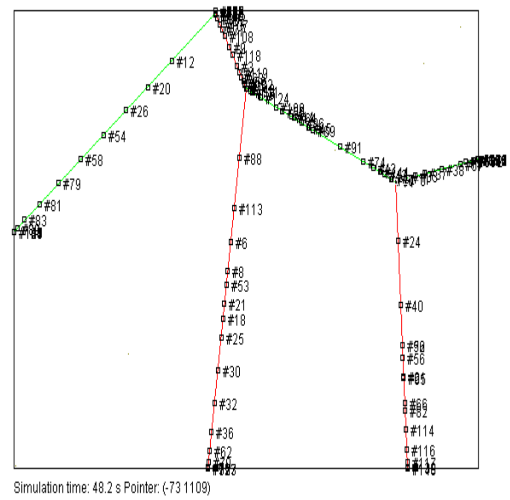


Fig. 4: Snapshot node movements in vanetmobisim no of nodes 150 at speed 50

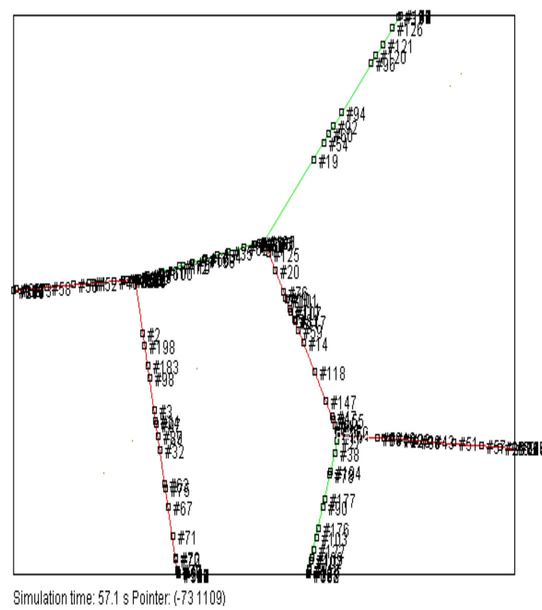


Fig. 5: Snapshot node movements in vanetmobisim no of nodes 200 at speed 40

vehicle speed, speed of nearby vehicles, overtake each other and traffic signs and stop signs on road intersections.

Intelligent Driver Model with Intersection Management (IDM_IM): In this mobility model (Jerome and Fiore, 2006; Marco *et al*., 2007) nodes movement is depends on the neighboring nodes movement. Suppose the front vehicle is slow down than vehicles following will also slow down their speed. The vehicles movement is controlled by smart intersection management. The vehicles stop according to traffic lights and slow down their speed and stop at

Table 2: Simulation parameters

Parameter	Specifications
MAC protocol	IEEE 802.11
Radio propagation model	two-ray ground reflection model
Channel type	wireless channel
Antenna model	omni-directional
Mobility model	intelligent driver model with intersection management (idm_im)

Table 3: Values of simulation parameters

Parameter	Values
Simulation time (Ns-2)	1000 s
Vehicular movement generation time (VanetMobiSim)	1000 s
Simulation area (X*Y)	1000x1000 m
Number of traffic lights	10
Transmission range	250 m
No of nodes (vehicles)	50, 100, 150, 200
Bandwidth	2 Mbps
Speed of nodes (m/s)	10, 20, 30, 40, 50

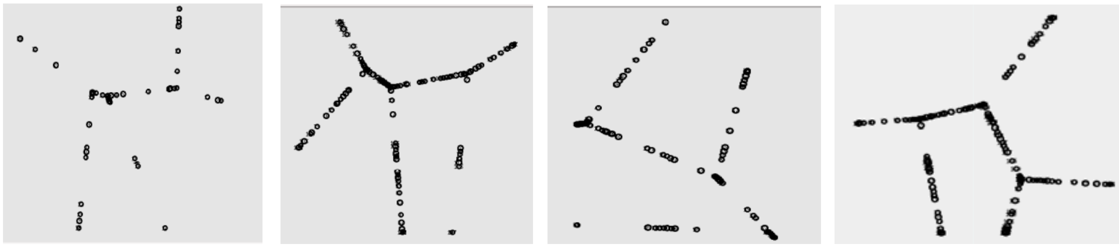
intersections point. Any vehicle stop at stop sign will cross the road if no vehicles present in front of the vehicle, otherwise it will wait for its turn on first arrived first served basis and right hand rule (Marco *et al*., 2007). In Fig. 2, 3, 4 and 5 shows various snapshots of nodes movements generated through VanetMobiSim during simulation.

SIMULATION ENVIRONMENTS AND RESULT ANALYSIS

The simulation has been carried out to evaluate the performance of simple flooding and probabilistic broadcast protocols for VANETs by using the Network Simulator NS-2 [NS-2]. The Table 2 and 3 shows different simulation parameters and parameters values

Table 4: Value of PDR for probabilistic broadcast and flooding

		Speed (m/s)				
Probability	No. of node	10	20	30	40	50
0.1	50	27.2120	23.8333	27.9310	24.3793	33.6875
	100	49.8857	48.4845	54.6129	26.1471	40.3333
	150	65.3878	70.4167	56.1026	68.3023	76.5366
	200	83.9412	81.5271	60.1026	68.0000	75.5000
0.2	50	26.2188	24.3333	27.4839	24.4706	32.7188
	100	36.7831	37.7647	39.1765	29.9405	31.2558
	150	55.6709	54.5584	45.2088	51.1264	63.0390
	200	60.4727	55.5273	49.2088	53.4831	60.6944
0.3	50	25.9737	25.5581	27.6923	23.7500	32.0000
	100	44.3585	46.4615	42.4091	31.1250	37.6667
	150	62.3968	56.9403	47.8986	57.5541	62.4306
	200	72.0556	60.5732	51.8986	66.6905	76.1282
0.4	50	27.6800	23.7647	27.5686	23.0536	30.1957
	100	41.1333	45.0923	43.4833	31.5970	36.1594
	150	55.6709	54.5584	45.2088	51.1264	63.0390
	200	60.4727	55.5273	49.2088	53.4831	60.6944
0.5	50	27.6800	23.7647	27.5686	23.0536	30.1957
	100	39.6582	39.8400	40.7297	30.7183	33.3889
	150	54.3400	45.8878	42.6038	48.5960	52.7692
	200	60.8720	48.2707	46.6038	55.6905	58.0752
0.6	50	24.3667	24.1569	26.4386	23.6415	28.2931
	100	36.7831	37.7647	39.1765	29.9405	31.2558
	150	50.0806	45.2393	44.5750	45.4630	47.4083
	200	55.8239	55.6644	48.5750	51.5974	50.8214
0.7	50	25.4194	23.0175	25.6724	23.3898	27.5968
	100	36.9885	37.0680	37.1250	29.5900	31.4000
	150	49.5748	41.8120	41.6894	43.9362	45.2463
	200	52.7358	51.7725	45.6894	45.1366	55.2303
0.8	50	22.0149	24.8939	23.7910	21.0455	25.6269
	100	35.9320	37.2718	36.5872	29.7524	30.8519
	150	46.3885	42.2847	41.7842	41.3867	44.4490
	200	51.2056	45.4734	45.7842	47.7784	54.6940
0.9	50	22.2027	24.5942	23.0139	21.3030	27.2535
	100	34.1466	37.4211	33.2479	30.9304	30.8000
	150	45.4545	41.4872	37.2590	39.9390	43.0061
	200	50.9423	48.3350	41.2590	46.7085	48.8889
Flooding	50	21.4211	24.6579	21.4079	21.4342	26.0526
	100	33.1270	33.5635	32.3730	29.1825	29.0873
	150	25.0795	44.8409	39.1477	39.7841	40.2273
	200	28.2478	46.3650	43.4071	43.7841	44.9381



(a) (b) (c) (d)

Fig. 6: Snapshot of node movements during simulation in NS-2 (a) no of nodes 50 at speed 20, (b) no of nodes 100 at speed 50, (c) no of nodes 150 at speed 20, (d) no of nodes 200 at speed 40

considered for simulation. The real vehicular traces are generated through Vanet MobiSim mobility generator widely used for VANET. The Mobility model is considered for the evaluation is IDM_IM with traffic lights. The results for probabilistic broadcast and flooding have been presented in Table 4. In the results we have computed the packet delivery ratio for both the protocols. We have used awk programming and Matlab [Matlab] for analyzing the simulation results and plotting the graphs. According to Fig. 1 the geocast region we have considered is 1000x1000 m. In Fig. 6a, b, c and d we have shown various snapshots of node movements during simulation in NS-2.

Packet delivery ratio: Packet delivery ratio is a very important metric to measure the performance of routing protocol. The performance of a protocol depends on various parameters chosen for the simulation. The major factors are packet size, no of nodes, transmission range and the structure of the network. The PDR can be obtained using Eq. (1) from the total number of data packets arrived at destinations divided by the total data packets sent from sources:

Packet Delivery Ratio =

$$\frac{\sum(Totalpacketsreceivedbyalldestinationnode)}{\sum(Totalpacketsendbyallsourcenode)} \quad (1)$$

Figure 7 shows the packet delivery ratio of flooding and probabilistic broadcasting techniques for 50 nodes with varying node speed. At node speed 50 m/s the maximum achievable PDR is 33.6875 when message is broadcast with probability 0.1. In the flooding method maximum value of PDR is 26.0526 when nodes are moving at 50 m/s in this sparse traffic scenario. When nodes are moving at speed 40 m/s PDR is gradually decreases from its previous value at 30 m/s for all value of p but in flooding there is minor

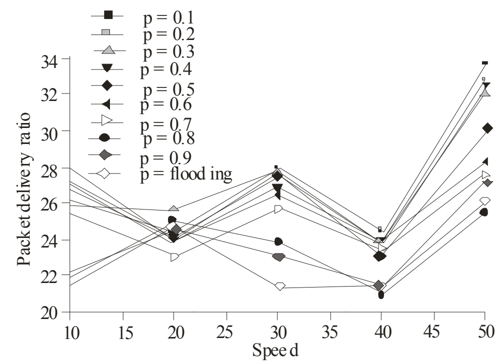


Fig. 7: Packet delivery ratio for node 50

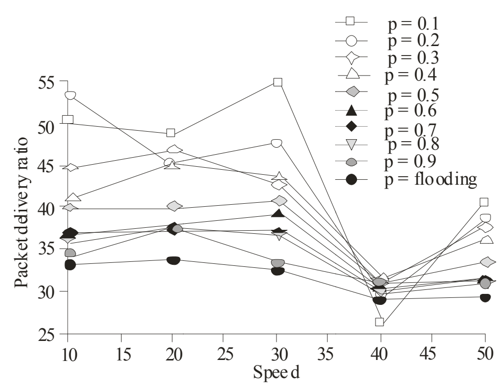


Fig. 8: Packet delivery ratio for node 100

improvement. Here, flooding method is perform better than in p = 0.8.

Figure 8 shows the PDR of flooding and probabilistic broadcasting techniques for 100 nodes with varying node speed. Initially at node speed 10 m/s p = 0.2 is perform better than p = 0.1. at node speed 20 m/s p = 0.3 and 0.4 is perform better than p = 0.2 In node speed 30 m/s the maximum achievable PDR is 54.6129 when message broadcast with probability 0.1. In the flooding method maximum value of PDR is

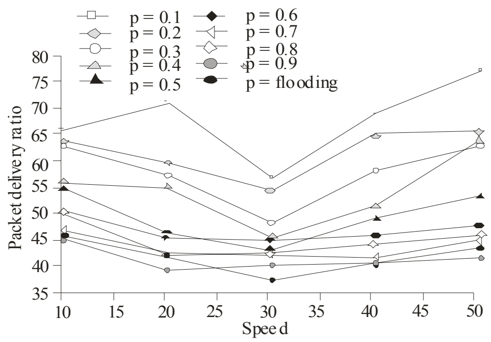


Fig. 9: Packet delivery ratio for node 150

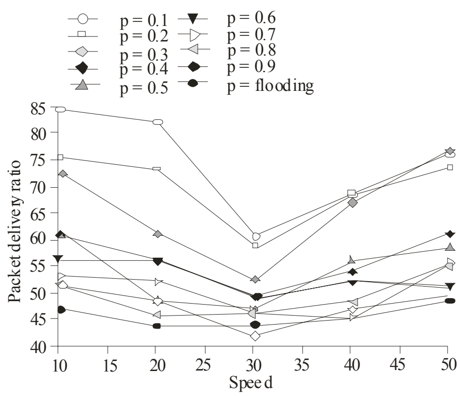


Fig. 10: Packet delivery ratio for node 200

33.5635 when nodes are moving at 20 m/s. When nodes are moving at speed 40 m/s PDR is gradually decreases for all value of p and flooding. Further, at node speed 50 m/s PDR value slightly increased from its previous values.

Figure 9 shows the PDR for both broadcasting techniques. In flooding maximum PDR is 44.8409 and the value fall down at speed 20 m/s to 39.1477. After 20 m/s the PDR is gradually increases with increasing speed. In probabilistic method when p = 0.1 and nodes are moving at speed 50 m/s achieved highest PDR 76.5366. In probabilistic broadcasting p = 0.6 performs better than p = 0.5 when nodes are moving at speed 30 m/s. The flooding method performs better at speed 30 and 40 m/s than p = 0.9. For other values of p and speeds initially at speed 20 and 30 m/s PDR is decreases and further at speed 40 ms/s onwards PDR is gradually increases.

Figure 10 shows the PDR for flooding and probabilistic broadcasting techniques. Here the different value of probability is considered. When nodes are moving at speed 10 m/s maximum achieved PDR is 83.9412 when p = 0.1. The performance of flooding protocol achieved better PDR is 46.365 at 10 m/s and maximum PDR is 44.9381 at speed 50 m/s in this densely populated network. Almost for all values of p the PDR is decreases when nodes are moving at speed 30 m/s for all different traffic scenarios.

CONCLUSION

In this study we have analyzed the performance of flooding and probabilistic broadcast protocols to deliver messages inside a geocast region in Vehicular Ad hoc Networks. The performances of these protocols are analyzed with varying node density, speed and different value of p for probabilistic broadcast. From the result analysis it is clearly evident that when the network is sparsely populated the packet delivery ratio is low as compared to other two scenarios. In densely populated network the highest value of PDR achieved is 83.9412 when nodes are moving at speed 10 m/s and p = 0.1. Further, we have concluded that probabilistic broadcast protocol outperforms flooding in all the cases. It is also observed that for better delivery ratio, message broadcasting should be done with minimum value of p. Further the performance of these protocols may be evaluated with other mobility models fit to VANET. The overall studies indicate that the performance of both the methods is better when traffic moves from sparse to dense traffic.

REFERENCES

Christian, L., H. Hartenstein, J. Tian, H. Füßler, D. Hermann and M. Mauve, 2003. A routing Strategy For vehicular Ad hoc networks In city environments. Proceeding of IEEE Intelligent Vehicles Symposium, pp: 156-161.

Dukhyun, C., K. Cho, N. Choi, Ted "Taekyoung'' Kwon and Y. Choi, 2012. A probabilistic and opportunistic flooding algorithm in wireless sensor networks, Comput. Commun. 35(4): 500-506.

Ehsan, A. and M. Fathy, 2007. Performance evaluation of routing protocols for high density ad hoc networks based on energy consumption by GlomoSim simulator. Proceeding of WASET International Conference, 23: 97-100.

Floriano, D.R., A. Iera, A. Molinaro and S. Marano, 2003. A modified Location Aided Routing protocol for the reduction of control overhead in Ad-hoc wireless networks. International Conference on Telecommunications (ICT2003), Tahiti, Papeete-French Polynesia, 2: 1033-1037.

Guoqing, Z., W. Chen, Z. Xu, H. Liang, L. Gao and D. Mu, 2009. Geocast routing in urban Vehicular Ad Hoc Networks. In R. Lee, G. Hu and H. Miao, Eds., Computer and Information Science 2009, SCI 208, Springer: 23-31.

Hassnaa, M. and Y. Zhang, 2009. Vehicular Networks: Techniques, Standards and Applications. CRC Press, Taylor and Francis Group, Boca Raton London, New York, pp: 1-28.

Jerome, H. and M. Fiore, 2006. VanetMobiSim-Vehicular Ad Hoc Network Mobility Extension to the CanuMobiSim Framework, Manual. Institute Eurecom/Politecnico di Torino, Italy, pp: 1-19.

Jun, Z. and A. Jamalipour, 2009. Wireless Sensor Networks A Networking Perspective. John Wiley and Sons, Inc., Hoboken, New Jersey, pp: 166-167.

Khaled, I., M.C. Weigle and M. Abuelela, 2009. P-IVG: Probabilistic inter-vehicle geocast for dense vehicular networks. In proceeding of the IEEE Vehicular Technology Conference, Barcelona, Spain, pp: 1-5.

Marco, F., J. Härri, F. Filali and C. Bonnet, 2007. Vehicular mobility simulation for VANETs. 40th IEEE/SCS Annual Simulation Symposium (ANSS-40 2007), Norfolk, VA, pp: 301-309

Marc, E., B. Bochow and C. Kellum, 2010. Vehicular networking automotive applications and beyond. A John Wiley and Sons, Ltd., Publication, United Kingdom, pp: 2-25.

MATLAB: The Math Works: Retrieved form: http://www. mathworks. Com.

Nawaporn, W., O.K. Tonguz, J.S. Parikh, P. Mudalige, F. Bai and V. Sadekar, 2007. Broadcast storm Mitigation Techniques in Vehicular Ad Hoc Networks. IEEE Wirel. Commun., NS-2: The Network Simulator. Retrieved from: http://www.isi. edu/nsnam/ns/. 14: 84-94.

Sidi-Mohammed, S. and T.M. Rasheed, 2007. Modified Location aided routing protocols for control overhead reduction in Mobile Ad Hoc Networks. IFIP International Federation for Information Processing, Network Control and Engineering for QoS, Security and Mobility, IV, Eds. Gaiti, D., 299, pp: 137-146.

Sanjoy, D. and D.K. Lobiyal, 2012. Intersection Area Based Geocasting Protocol (IBGP) for Vehicular Ad hoc Networks, In: N. Meghanathan *et al*., (Eds.): CCSIT 2012, Part III, LNICST, 86: 387-396.

Sanjoy, D. and D.K. Lobiyal, 2011. A Performance analysis of LAR protocol for Vehicular Ad Hoc Networks in city scenarios. Proceeding of International Conference on Advances in Computer Engineering, pp: 162-166.

Stefano, B., I. Chlamtac, V.R. Syrotiuk and B.A. Woodward, 1998. A Distance Routing Effect Algorithm for Mobility (DREAM). Proceeding of the 4th annual ACM/IEEE international conference on Mobile Computing and Networking, pp: 76-84.

Sze-Yao, N., T. Yu-Chee, Y. Chen and J. Sheu, 1999. The broadcast storm problem in a Mobile Ad Hoc Network. Proceeding. of ACM MOBICOM'99, Seattle,WA, Retrieved from: http://vanet. eurecom.fr/ VanetMobiSim, pp: 151-162.

Wen-Hwa, L., Y.C. Tseng, K.L. Lo and J.P. Sheu, 2000. GeoGRID: A Geocasting protocol for Mobile Ad Hoc Networks based on GRID, J. Int. Technol., 1(2): 23-32.

Young-Bae, K. and N. Vaidya, 1998.Location-Aided Routing (LAR) in mobile ad hoc networks, In the Proceedings of the ACM/IEEE International Conference on Mobile Computing and Networking, pp: 66-75.

Young-Bae, K. and N. Vaidya, 1999. Geocasting in mobile Ad-hoc Networks: location-based multicast algorithms, In 2nd IEEE Workshop on Mobile Computing Systems and Applications, New Orleans, 101-110.

Young-Bae, K. and N. Vaidya, 2000. GeoTORA: A protocol for geocasting in Mobile Ad Hoc Network, In IEEE International Conference on Network Protocols, Osaka, Japan, pp: 240-250.

Young-Bae, K. and N. Vaidya, 2002. Flooding-based geocasting protocols for Mobile Ad Hoc Networks, J. Mob. Net. Appl., 7(6): 471-480.

Yoav, S., D. Cavin and A. Schiper, 2002. Probabilistic broadcast for flooding in wireless mobile ad hoc networks, EPFL Technical Report IC/2002/54, Swiss Federal Institute of Technology (EPFL).

Yoav, S., D. Cavin and A. Schiper, 2003. Probabilistic broadcast for flooding in wireless mobile ad hoc networks, In the Proceeding of IEEE Wireless Communications and Networking Conference, pp: 1124-1130.