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Performance Analysis of Broadcasting Methods in Geocast Region for Vehicular Ad Hoc Networks

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Abstract— In this paper, performance analysis of different broadcasting methods i.e. flooding or blind broadcast and probabilistic broadcasting inside the geocast region has been done. Our objective is to provide a comparative analysis between flooding and probabilistic methods with varying number of nodes in Vehicular Ad hoc Networks. Simulations have been conducted using the NS-2 simulator. For result analysis, we have used awk programming and Matlab. Different values of probability for probabilistic broadcast method have been considered to investigate an appropriate value that may give best results. The results show that probabilistic broadcasting method achieves maximum packet delivery ratio is 83.5 % when number of node is 196. In, sparsely populated network the packet delivery ratio for all cases is low. The minimum value of PDR obtained for sparsely populated network is 14.95%. From the result, it has also been observed that for better delivery ratio, message broadcasting should be done with minimum value of p for both the sparse and dense network.

Index Terms— Flooding, Probabilistic Broadcast, Ad hoc Networks, Vehicular Ad Hoc Network, Mobility Model, Packet Delivery Ratio.

1 Introduction

VANET is a special class of Mobile Ad hoc Network (MANET), where every node is a vehicle moving on the road. 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 from 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. Some of the applications are collision warnings, road sign alarms, blind turn warning, congested road notification, free flow tolling, parking availability notifi-

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-cation, parking spot locator, internet connections facility, electronic toll collection, and a variety of multimedia services etc [1, 2].

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.

The rest of paper is organized as follows. Section 2 presents work related to the geocast protocols. In section 3 proposed model and an overview of flooding or blind broadcast and probabilistic broadcasting techniques is presented. In section 4 simulation environment and result analysis is discussed. Finally, the work presented in this paper is concluded in section 5.

2 Related Work

Extensive works 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. Some of them are [CarTalk, FleetNet–Internet on the Road, NoW (Network on Wheel)] [1, 2] with the emphasis on deployment in the real world. The main focus of all these projects is to provide safety, comfort and timely dissemination of message from one location to another location. Some of the message delivery protocols proposed for VANET attempt to deliver a message to a geographic region rather than to a node. These protocols are called geocast routing. LAR [4], LBM [5], and GeoTORA [6] is modified TORA, GRID protocol is modified to GeoGRID [7], DREAM [8], GRUV [9], are few geocasting protocols. In [5] authors use flooding method but it limits the flooding to a small region called forwarding zone instead of whole area. The forwarding is computed based on the position of sender and geocast region. In [6] authors have improved the method proposed in [5] 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 inside a geographical region i.e. geocast region. Further, in simple flooding technique [3, 17], any vehicle receive a broadcast message for the first time, has the responsible to rebroadcast the message. In this method, number of transmissions increases with increasing number of nodes in the network. In [13] 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. 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 [11] and [14] 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 [12] the authors have proposed a greedy version of LAR protocol known as GLAR (Greedy Location-Aided Routing Protocol). This scheme improved the performance of LAR. In GLAR method, to find a route between source and destination, a baseline is drawn between them. The route request packets are broadcast within the request zone. The neighbouring node which has shortest distance towards baseline is selected as next broadcasting node. The authors considered various network performance parameters to compare LAR with GLAR. Their results revealed that GLAR reduces the number of route discovery packets and increases the average network route lifetime. In [10] 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 [18] the authors analysed 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 performance analysis. None of above protocol considered the grid structure for node deployment.

3 Proposed Model

We have considered the multi-hop environment, because it's very rare that source and destination node fall in each other transmission range. As there is no direct connectivity between source and destination node, to route the message intermediate nodes plays a vital role. The intermediate nodes are act as relay node. We have considered highway scenario to deliver message from source to geocast region shown in fig-1. To deliver data to all the nodes inside the geocast region we have considered flooding and probabilistic techniques.

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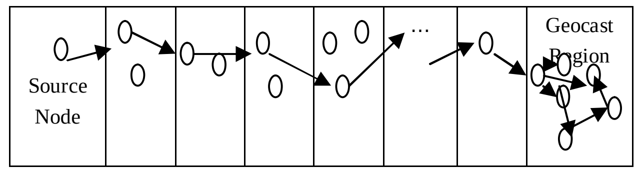

Fig 1. Simple Scenario of Geocast on Highway

3.1 Overview of Flooding and Probabilistic Techniques

The flooding or blind broadcast [17] 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 it 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* numbers of node are participated in message dissemination in the geocast region. As the number of nodes *n* increases no of packet to transmitted 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 [16] due to high contention, collisions and redundant rebroadcast of messages. To mitigate the broadcast storm problem some solutions related to VANET is proposed in [15].

3.1.1 Flooding Algorithm [17,19,20]

source node send packet (pkt) received at node n_i
if n_i received P for first time
{
if (neighbour n_i !=NULL)
broadcast (pkt) to its neighbour node
}
else
discard packet (pkt).
End.

The Probabilistic technique of broadcast [17] is a type of restricted flooding. To mitigate the shortcoming of flooding this method was introduced. In this method, upon receiving a non

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duplicate packet nodes further rebroadcast with probability *p. where* ($0 < p \leq 1$).

3.1.2 Probabilistic Broadcast Algorithm [17,19,20]

Source node send packet (pkt) received at node n_i
if n_i received pkt for first time
{
if (neighbour n_i !=NULL)
choose value probability of P // $0 \leq p \leq 1$
broadcast (pkt) to its neighbour node with P
}
End.

4 Simulation Environments and Result Analysis

The simulation has been carried out to evaluate the performances of simple flooding or blind broadcast and probabilistic broadcast protocols for VANETs by using the network simulator NS-2 [21]. The table 1 shows different simulation parameters and table 2 shows the different parameters values considered for simulation. The results for probabilistic broadcast have been presented in Table 3(a) and Table 3(b). In the results we have computed the packet delivery ratio for both the protocols. We have uses the awk programming and Matlab [22] for analyzing the simulation results. According to Fig.1 the geocast region we have considered is 500 m x 500 m. All the results presented are obtained as an average of 10 different simulation runs.

We have deployed the nodes in the simulation area on the basis of GRID structure. Where, the node placement starts at (0, 0). In this method each node is one GRID-UNIT away from its neighbors node. It is essential that the number of nodes must be square of an integer to support the GRID structure. The Grid Unit can be computed as:

$$Grid\ Unit = \frac{val\ (X)}{\sqrt{(no\ of\ nodes)}} \quad (1)$$

TABLE 1

Simulation Parameters

Parameter	Specifications
MAC Protocol	IEEE 802.11 DCF
Radio Propagation Model	Two-ray ground reflection model
Channel type	Wireless channel
Antenna model	Omni-directional

TABLE 2

Values of Simulation Parameters

Parameter	Values
Simulation Time	1000s
Simulation Area (X *Y)	500 m x500 m
Transmission Range	250 m
Bandwidth	2 Mbps

4.1 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 packet delivery ratio can be obtained from the total number of data packets arrived at destinations divided by the total data packets sent from sources.

Packet Delivery Ratio = Σ (Total Packets send by all Source node) / Σ (Total packet send by all source node)

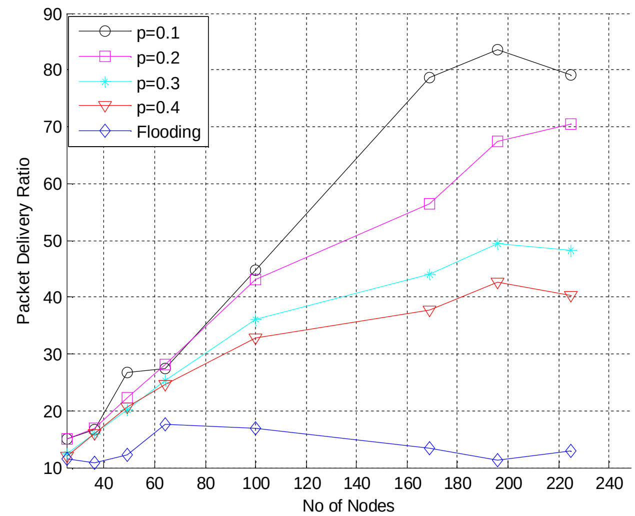

Fig 2. Packet Delivery Ratio of flooding and Probabilistic broadcast with p=0.1, 0.2, 0.3, 0.4.

Fig.2 shows the packet delivery ratio of flooding and probabilistic broadcasting techniques. We have shown PDR for flooding and probabilistic broadcasting with p=.1, 0.2, 0.3, 0.4. In the flooding method maximum value of PDR is 17.5231 when number of node is 64. For p=0.1, 0.2, 0.3, 0.4 packet delivery ratio gradually increases as the number of nodes increases. The maximum achievable PDR is 83.56629 when p=0.1 and number of node is 196.

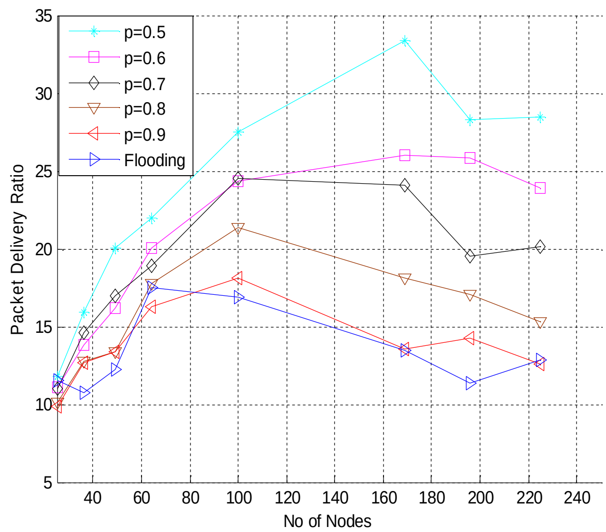

Fig 3. Packet Delivery Ratio of flooding and Probabilistic broadcast with p=0.5, 0.6, 0.7, 0.8, 0.9.

Fig.3 shows the packet delivery ratio of flooding and probabilistic broadcasting techniques. We have shown PDR for flooding and probabilistic broadcasting with p=0.5, 0.6, 0.7, 0.8, 0.9. For p=0.5, 0.6, 0.7, 0.8, 0.9 packet delivery ratio gradually increases as the number of nodes increases. When the number of nodes increases from 169 to onwards the PDR value starts decreasing for all values of p. The maximum achievable PDR value is 33.36514 when p=0.5 and number of node is 169.

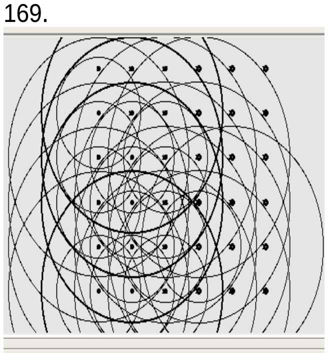

Fig 4. Shows the snapshot of simulation when n=36 and p=0.1.

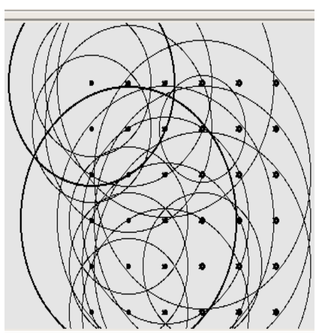

Fig 5. Shows the snapshot of flooding for n=36.

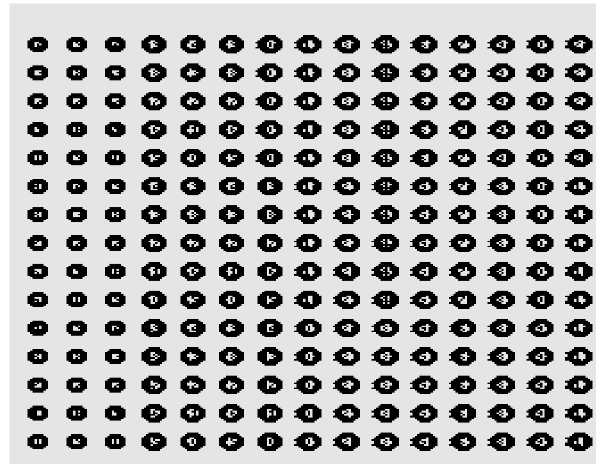

Fig 6. Snapshot of Node deployment for n=225.

In fig 4 shows the snapshot of simulation when n=36 and p=0.1 and fig 4 shows the snapshot of flooding algorithm for when number of node is 36. In fig 5 shows the how we have deployed the nodes in the simulation area when number of nodes is 225 are deployed.

TABLE 3(A)

VALUE OF PDR WITH DIFFERENT VALUE OF PROBABILITY AND NUMBER OF NODES

Broadcast Probability	**No of nodes**			
	25	36	49	64
0.1	14.9583	16.58472	26.72001	27.37938
0.2	14.95237	16.79714	22.19474	28.23787
0.3	12.53139	15.98569	20.25287	25.41184
0.4	11.95905	16.02106	20.65038	24.54625
0.5	11.80366	15.96245	20.02624	21.96514
0.6	11.08429	13.80751	16.18794	20.00724
0.7	11.03823	14.6289	16.98467	18.87625
0.8	10.12938	12.73513	13.41681	17.72958
0.9	**9.86544**	12.67237	13.4129	16.26605

TABLE 3(B)

VALUE OF PDR WITH DIFFERENT VALUE OF PROBABILITY AND NUM-

BER OF NODES

Broad-cast Proba-bility	No of nodes			
	100	169	196	225
0.1	44.74569	78.58425	**83.56629**	79.10344
0.2	43.06935	56.50717	67.35748	70.43942
0.3	36.19645	43.92315	49.50677	48.17908
0.4	32.79958	37.65447	42.62175	40.40304
0.5	27.49097	33.36514	28.26565	28.46729
0.6	24.33346	26.00031	25.8327	23.87187
0.7	24.5071	24.1111	19.51238	20.11281
0.8	21.39716	18.15165	17.10252	15.27812
0.9	18.08374	13.55761	14.26087	12.5451

5 CONCLUSIONS

In this paper we have analyzed the performance of flooding and probabilistic broadcast protocols to deliver messages inside a geocast region for vehicular ad hoc networks. The performances of these protocols are analysed for varying node density and different value of p for probabilistic broadcast. From the result analysis it is clearly evident that when the network is sparsely populated, the successful delivery of message is nearly 15% for p=0.1. But for densely populated network the highest value of PDR is 83.5 for n=196 and p= 0.1. Further, we conclude that probabilistic broadcast protocol outperforms flooding in all the cases except p=0.9 and n=64. It is also observed that for better delivery ratio, message broadcasting should be done with minimum value of p.

References

[1] Hassnaa Moustafa and Yan Zhang, "*Vehicular networks: Techniques, Standards, and Applications*", CRC Press, Taylor & Francis Group, Boca Raton London, New York, 2009.

[2] Marc Emmmemann, Bernd Bochow and Christoper Kellum, "*Vehicular Networking Automative Applications and beyond*" A John Wiley and Sons, Ltd, Publication, United Kingdom, 2010.

[3] Y. B. Ko and N**.** Vaidya, "Flooding-Based Geocasting Protocols for *Mobile* Ad Hoc Networks", Journal of MOBILE NETWORKS AND APPLICATIONS, VOL 7; NUMBER 6, pp. 471-480,2002.

[4] Y. B. Ko and N**.** Vaidya, "Location-aided routing (LAR) in mobile ad hoc networks," in Proceedings of the ACM / IEEE International Conference on Mobile Computing and Networking (MOBICOM'98), pp. 66–75, 1998.

[5] Y. B. Ko and N**.** Vaidya, "Geocasting in Mobile Ad-hoc Networks: Location-Based Multicast Algorithms", In 2nd IEEE Workshop on Mobile Computing Systems and Applications, New Orleans, Louisiana, pp. 101-110, February 1999.

[6] Y. B. Ko and N**.** Vaidya, "GeoTORA: A Protocol for Geocasting in Mobile Ad Hoc Networks", In IEEE International Conference on Network Protocols, Osaka, Japan, pp.240-250,2000.

[7] W.H Liao, Y. C Tseng, K. L Lo and J. P Sheu, "GeoGRID: A Geocasting Protocol for Mobile Ad Hoc Networks Based on GRID", Journal *of Internet Tech*. Vol.1 No.2, pp. 23–32, 2000.

[8] Stefano Basagni, Imrich Chlamtac, Violet R. Syrotiuk, and Barry A. Woodward, "A distance routing effect algorithm for mobility (DREAM)", In MobiCom'98:Proceedings of the 4th annual ACM / IEEE international conference on Mobile computing and networking, pp. 76-84, 1998.

[9] Guoqing Zhang,, Wu. Chen, Zhong Xu,, Hong Liang, and Li Gao Dejun Mu, "*Geocast Routing in Urban Vehicular Ad Hoc Networks*", in R. Lee, and G. Hu, H. Miao, Eds. Computer and Information Science 2009, SCI 208, Springer-Verlag Berlin Heidelberg,pp.23-31, 2009.

[10] E.Ahvar and M. Fathy, "Performance evaluation of routing protocols for high density ad hoc networks based on energy consumption by GlomoSim simulator" in the Proceedings Of World Academy Of Science, Engineering And Technology, Volume 23, pp. 97-100, August 2007.

[11] Senouci, S.M. and Rasheed, T.M., in IFIP International Federation for Information Processing, Volume 229, Network Control and Engineering for QoS, Security, and Mobility, IV, ed. Gaiti, D., (Boston: Springer), pp. 137-146, 2007.

[12] Neng-Chung Wang, Jong-Shin Chen, Yung-Fa Huang, and Si-Ming Wang, "A Greedy Location Aided Routing Protocol for Mobile Ad Hoc Networks". In proceedings of the 8th WSEAS International Conference on Applied Computer and Applied Computational Science (ACACOS '09) Hangzhou, China, pp 175-180, 2009.

[13] Christian Lochert, Hannes Hartenstein Jing Tian, Holger Füßler, Dagmar Hermann, and Martin Mauve, "A Routing Strategy for Vehicular Ad Hoc Networks in City Environments", Proceedings of IEEE Intelligent Vehicles Symposium, pp.156–161,2003.

[14] F.De Rango, A.ha, A.Molinaro,and S. Marano, "A Modified Location Aided Routing Protocol for the Reduction of Control Overhead in Ad-hoc Wireless Networks", ICT2003, vol.2, February 23 -March 1, pp. 1033-1037, 2003.

[15] N. Wisitpongphan, O. K. Tonguz, J. S. Parikh, P. Mudalige, F. Bai, and V. Sadekar , "Broadcast storm mitigation techniques in vehicular ad hoc networks", IEEE Wireless Communications. Vol. 14, pp. 84-94, 2007.

[16] Sze-Yao Ni, Yu-Chee Tseng, Yuh-Shyan Chen, and Jang-Ping Sheu The Broadcast Storm Problem in a Mobile Ad Hoc Network, in *Proceedings of ACM MOBICOM ' 99* , Seattle, WA , pp. 151 – 162, 1999 .

[17] Jun Zheng and Abbas Jamalipour, "*WIRELESS SENSOR* NETWORKS *A Networking Perspective*", John Wiley & Sons, Inc., Hoboken, New Jersey, pp-166, 2009.

[18] S. Das and D.K. Lobiyal, "A Performance Analysis of LAR Protocol for Vehicular Ad Hoc Networks in City Scenarios", Proc. of Int. Conf. on Advances in Computer Engineering, pp.162-166. DOI: 02.ACE.2011.02, 2011.

[19] Y. Sasson, D. Cavin, A. Schiper, "Probabilistic broadcast for flooding in wireless mobile ad hoc networks", Proc. IEEE Wireless Communications & Networking Conference (WCNC 2003), pp.1124-1130, 2003.

[20] Y. Sasson, D. Cavin, A. Schiper, “Probabilistic broadcast for flooding in wireless mobile ad hoc networks”, EPFL Technical Report IC/2002/54, Swiss Federal Institute of Technology (EPFL), 2002.
[21] The Network Simulator. http://www.isi.edu/nsnam/ns/.
[22] The Math Works: http://www.mathworks.com