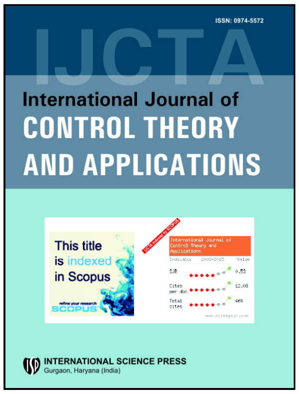

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Multipath Greedy Perimeter Stateless Routing (MGPSR) for VANET

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Abstract: To deploy the Intelligent Transport System (ITS) Vehicular Ad-hoc Network (VANET) is one of the most challenging research area. Especially if we talk about the routing, it becomes more challenging to design an efficient routing protocol for VANET. In this paper the Greedy Perimeter Stateless Routing (GPSR) has been enhancedas a Multipath Greedy Perimeter Stateless Routing (MGPSR). Results of MGPSR are compared with original GPSR and multipath on-demand routing protocol called AOMDV. The obtained results show the impact of node density in the packet delivery ratio, average end-to-end delay, average throughput and normalized routing load.

Keywords: GPSR, MGPSR, AOMDV, VANET, Packet delivery ratio, Average End-to-end delay, Average Throughput and Normalized routing load.

1. INTRODUCTION

The VANET routing protocols are broadly categorized into four categories: proactive, reactive, cluster based, position based and hybrid. The taxonomy of VANET routing protocols is as:

VANET has evolved itself as a new branch of the MANET. The basic difference in the MANET and VANET is, VANET is highly dynamic in nature as compared to MANET, the topology gets changed very fast. Thus, the importance of routing protocols become more crucial in such case where nodes are highly dynamic. VANET routing protocols are categorized into four categories such as topology base, position based, cluster based and hybrid. Further the topology based routing protocols are subdivided into two categories, proactive and reactive.

The topology based routing is very well suited for the MANET environment due to its dynamic characteristics in nature[1]. Topology in VANET is highly dynamic, thus position based routing is an alternative which can be usedfor VANET environment such as Greedy Perimeter Stateless Routing (GPSR) [2], which uses geographical information to achieve very small per-node routing state, extremely robust packet delivery and small routing protocol message complexity on a densely deployed wireless network. This study proposes a Multipath Greedy Perimeter Stateless Routing (MGPSR) for VANET environment, which will deal with a congestion and improves the quality of service. The obtained simulation results have been compared with GPSR and Ad-hoc On-demand Multipath Distance Vector (AOMDV) [3] routing and found that the performance of MGPSR is better than

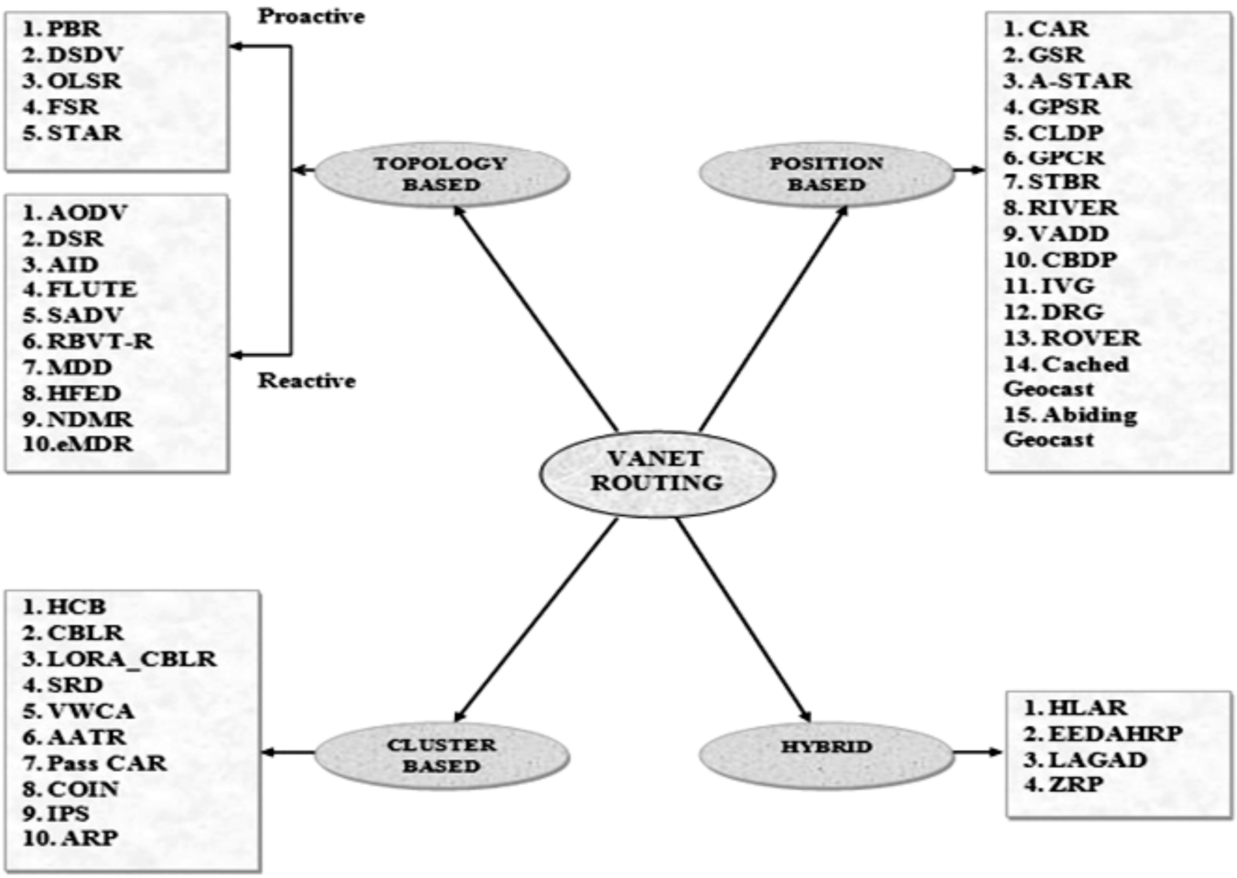

Figure 1: Taxonomy of VANET Routing Protocols

GPSR and AOMDV. In MGPSR the multiple paths have been constructed during the transmission of packets between source and destination identical to AOMDV. AOMDV maintains multiple loop free paths whereas MGPSR will have one alternative path whenever possible between each pair of source and destination.

The rest of the paper is organized as follows. The related work is given in section II which describes the literature survey. The proposed work is given in section III and section IV describes the experimental setup and result analysis. At the last section V contains conclusion of the proposed protocol.

2. RELATED WORK

It has been observed that position based routing (PBR) deals with urban highway networks very efficiently. PBR dependson the navigation system.There are large number of routing protocols which use the geographical information of vehicles. A new approach has been proposed in [4] known as geographic source routing (GSR) which uses topological information in the PBR. Another improvement was proposed in [5] especially for inter vehicular communication (IVC) called Anchor- based Street and Traffic Aware Routing (A-STAR). That's why PBR is always a good candidate for urban scale IVC. This approach utilizes the geographical information of street. A-STAR calculates the anchor path with traffic responsiveness, but the proposed approach is not suitable for high performance paths in terms of connectivity and delay. Study in [6] presents the MOVE algorithm, which uses speeddata to provide intelligent resourcefulacceleratingchoices. This method make use of a HELLO-RESPONSE mechanism for approaching a mobile router. The mobility information is also encapsulated in the HELL RESPONSE messages. This study does not considered redundancy in the paths. One of the major disadvantage of this approach is that futuristic decisions are always typical to perform.

An improvement in the GPSR has been proposed in [7] called GpsrJ+. In this approach the packet must be given to the predicted node on the road section lying in its neighboring junction. GPSR uses the right-hand-rule to recover from local maximum. The prediction about the next node is based on the information that the forwarding node is having the information about all road segments on which its junction neighbors have neighbors. The neighboring node information is extracted and put into a modified beacon and broadcasted with the forwarding nodes which will carry out the predictions. In this approach, only one junction prediction is done so that the path construction will not be carried out.

A new approach which make use of the information about the movementto know the next forwarding node decision [8]. As the movement information and node speed is available thus, every node will be able to update the neighboring node location coordinates without having the communication about the location information. One more MOvement Prediction based Routing (MOPR) approach for VANET has been proposed in [9]. Having the fact that vehicles often have predictable mobility, a new approach proposed in [10] named Predictive Directional Greedy Routing (PDGR) to forward packet to the most suitable next hop based on both current and predictable future situations.

A new mechanism for optimizing the route of the Greedy forwarding phase of GPSR which gives a formula to compute a unique value for each neighbor using a mathematical model given in [11]. A Zone-based greedy perimeter stateless routing for VANET proposed in [12]. In a limited zone, the maintenance of routing information is easier as neighbor beacon message update neighbor's information periodically. It is a combination of GPSR and Zone Routing Protocol (ZRP) [13]. An improvement over GPSR protocol [14] by designing a system to overcome the problems like all the nodes move along the road in accordance with the same direction. Suppose that one vehicle S can cover five neighboring nodes X, Y, Z, P and Q, if S wants to send a data packet to a destination node D at time t, meanwhile, node Y is going away from node D. Another improvement has been proposed in [15] which is having three differences with GPSR first a special Hello Packet for setting precisely one-hop neighboring vehicles; second set the priorityfor the current vehicleto one-hop neighbors using the distance and velocity. The third difference is use a "Quorum" as a buffer and re-forward the data packet to solve the local maximum problem. An alternative to the perimeter mode used in GPSR called Greedy Buffer Stateless Routing-Building (GBSR-B) [16].

A new geographic routing protocol called GeoSVR proposed in [17] which selects a best forwarding route using the number of lane in the road in an urban VANET. It uses the natural connectivity feature of an urban map to calculate a forwarding route. It deals with the key issue of geographic routing are the local maximum problem and next-hop selection algorithm. An improved routing protocol is proposed in [18] called GPSR-MV whichhas taken the node's velocity and forwarding efficiency into account. GSPR-MV includes the improvement of two parts, the improved GPSR with a vector for movement and the simplification of perimeter forwarding. A performance evaluation of GPSR routing Protocol for VANETs using bi-directional coupling is done in [19]. They have considered the mobility factors such as beacon intervals and vehicles with different velocities may cause inaccuracy in the identification of the vehicle's position which will affect the performance of the position based routing algorithm. They found that as the traffic sources increases, the throughput increases because of the increase in transmission rate of data packets. They have not considered the multipath or an alternative path approach to improve the performance.

3. PROPOSED WORK

The proposed method is to improve the GPSR protocol for VANET environment using a multipath approach. In greedy forwarding approach source send data to that neighboring node in the range which is closest to the destination node. In the proposed method sender, will send data to the two nodes first the one which is closest to the destination and the second one is next closest to the destination in its own range. Figure 2 shows the multipath greedy feedback approach. From source S to destination D there are three paths exist P1, P2 and P3- through x, y and z respectively.

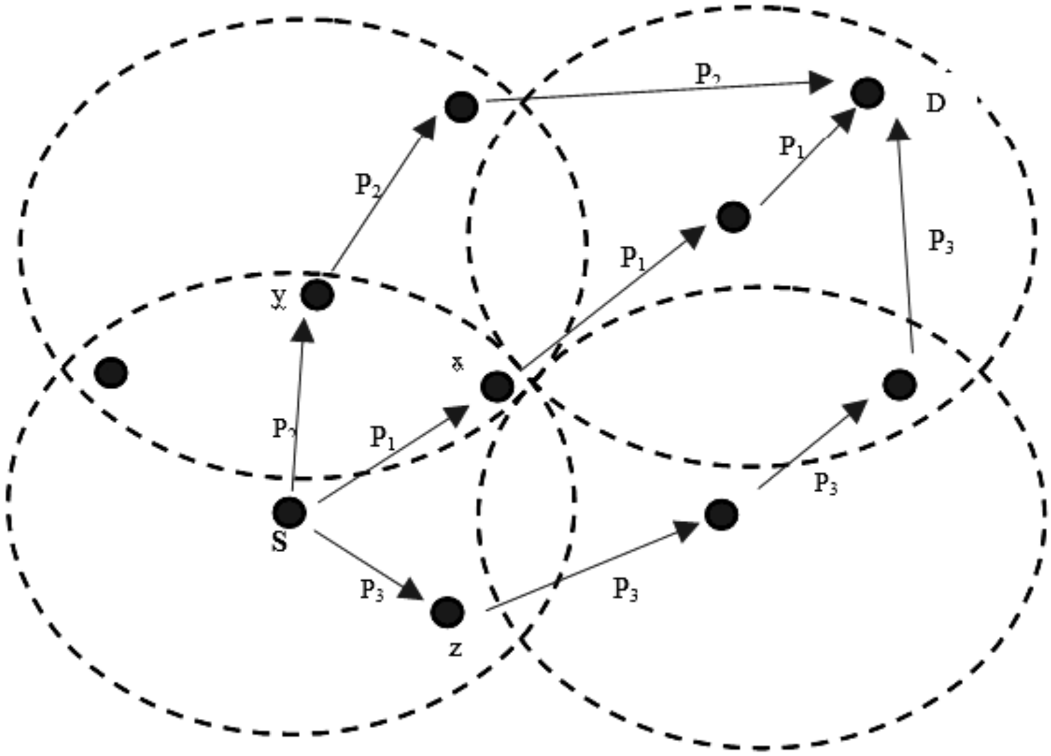

Figure 2: Multipath GPSR approach.

If we will consider GPSR it will select the P1 path between S and D. P1 and P2 path are having two hop cost. VANET is a highly dynamic in nature due to which the path break is very frequent. The proposed method will establish at least two path if possible between S and D. Source S establishes the first path through x node and the second alternative path through y node because y is the closet neighbor of D in the range of S node. The second phase of GPSR is perimeter forwarding which is implemented as such in MGPSR. The forwarding algorithm for MGPSR is shown in Figure 3 as a function.

```
        MGPSR(S, D)
Step 1: Start.
Step 2: find the closest nodes x and y for the destination D in the range of S;
Step 3: send a request to x and y;
Step 4: if (x = D or y = D)
        go to step 8;
Step 5: else
        Repeat step 6 and step 7 until (x != D or y != D);
Step 6: find closest node of D in the range of x & send request to this node and make it x;
Step 7: find closest node of D in the range of y & send request to this node and make it y;
Step 8: Stop.
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Figure 3: Greedy forwarding algorithm for MGPSR

To implement MGPSR a special city scenario has been designed. Two points of a city has been connected through a straight road and two alternative roads one is in left side and another is in right side in the given scenario shown in the figure 4. In the cross section the traffic light is installed. The same given scenario has been simulated for the 10, 20, 30, 40, 50 and 100 vehicles. All the vehicles will start moving from the same

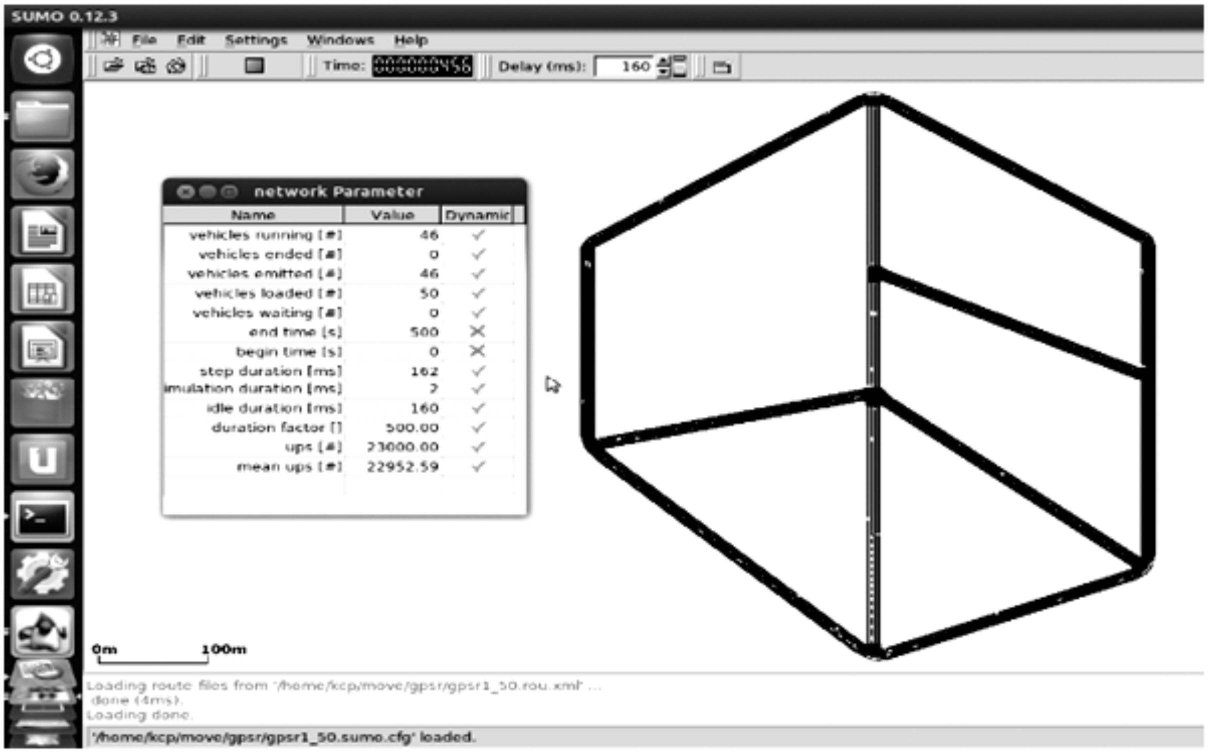

Figure 4: Scenario for implementing MGPSR

point. The straight route is damaged thus the vehicle who will move through that route will inform other vehicles to take alternative route form left or right. Figure 4 shows the simulation of MGPSR protocol running with the 50 vehicles. The movement of vehicle is random in the available roads or lane with traffic light forwarding model. The maximum speed a vehicle can achieve is 70 to 80 kmph which is an average speed in the urban environment.

The given scenario shows that all the vehicles will start their journey from the top.

4. EXPERIMENT AND RESULT

The proposed protocol MGPSR has been simulated using NS-2.35, SUMO and MOVE tools. In which MOVE tool is used to represent vehicle and multi lane road in the network, SUMO is used to show the mobility pattern of the vehicles and NS-2.35 is used to simulate and analyze results through trace. For experimental setup, the different parameters used in the simulation and their brief description is shown in table 1.

We have compared the proposed protocol MGPSR with the original GPSR and the multipath reactive routing protocol AOMDV [3]. To provide reliability we must have an alternative path to complete the communication. We have created a special scenario shown in figure 2, to implement the proposed protocol. The proposed protocol is based on multipath thus we have compared it with a well-known multipath protocol called AOMDV.

The four-performance metrics which have been used to evaluate the performance of proposed protocol MGPSR, are Packet delivery ratio (PDR), Average throughput, average end_to_end (E2E) delay and Normalized routing load (NRL). PDR is the ratio of successfully delivered packet and total transmitted packets, throughput is total data received per unit of time, E2E delay is the time needed to transmitted a data unit form one end to another end and NRL is total number of routing overhead needed to transmit a data packet.

Table 1
Simulation parameters used for MGPSR.

Simulation Parameter	*Number/Unit*	*Brief description*
No. of vehicles	10, 20, 30, 40, 50, 100	Density of the vehicles on the road
Dimension of space	800m × 700m	Area for the vehicles to move in the road.
Maximum velocity (v max)	20 m/s	Maximum speed of a vehicle
Simulation Time	500 Sec	Duration of a vehicle to move in the given scenario.
Item size	1024 bytes	Payload of a data packet
Source data pattern	5 packets per Sec	Packet rate of a sender
Traffic model	CBR	Constant bit rate.
Node Placement Strategy	Source of a Road	All vehicle will start from same point.
Pause Time	25s	Duration between two vehicles.
No. of Simulation	10	Simulation per setup in given scenario

4.1. Packet Delivery Ratio

Figure 5, shows the comparative results of GPSR, AOMDV and the proposed protocol MGPSR. Initially AOMDV has performed slightly better than the GPSR and MGPSR. For high density like for 50 and 100 nodes the proposed algorithm has performed better than the GPSR and AOMDV. The PDR of AOMDV, GPSR and MGPSR is 45, 48 and 52 for 100 vehicles. We can analyze that the PDR in case of MGPSR is higher than AOMDV and GPSR in case of high node density. As the density of node increases the performance of multipath is also increasingespecially in case of MGPSR.

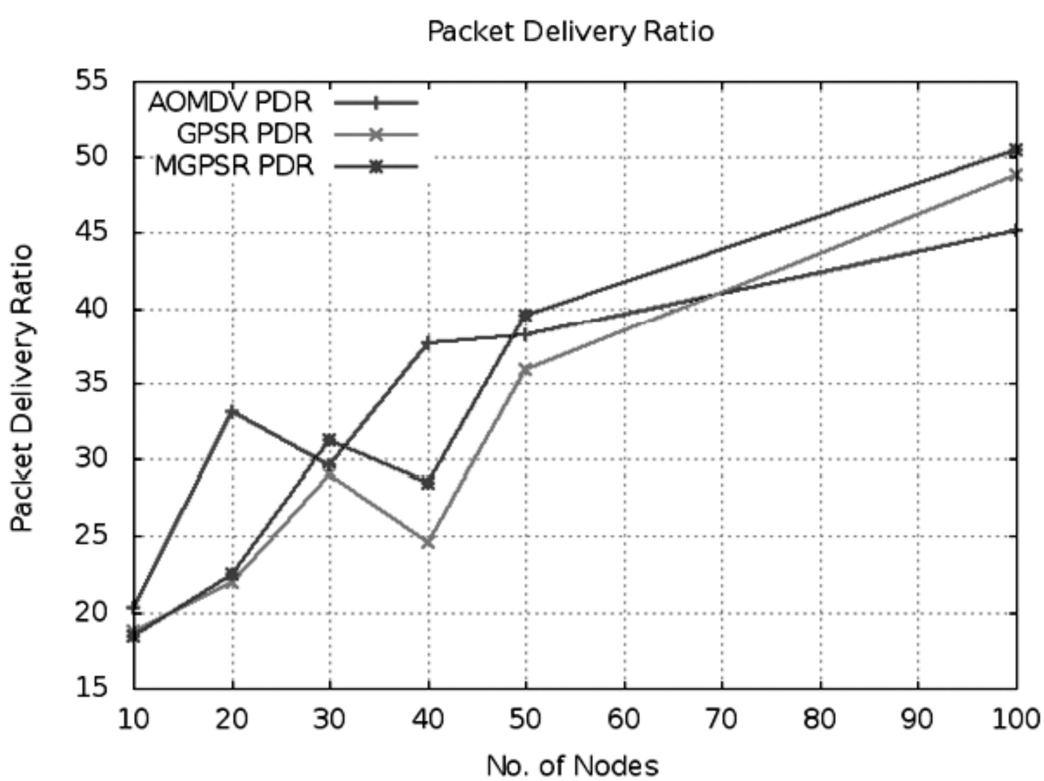

Figure 5: Packet delivery ratio for GPSR, AOMDV and MGPSR

4.2. Average Throughput

Figure 6 shows the average throughput for GPSR, AOMDV and MGPSR. Initially the throughput of AOMDV is better than the GPSR and MGPSR. As the number of vehicles are increasing the throughput of proposed protocol MGPSR is better than the GPSR and AOMDV. The throughput of AOMDV, GPSR and MGPSR is 27.5, 32.3 and 36.6 kbps respectively.

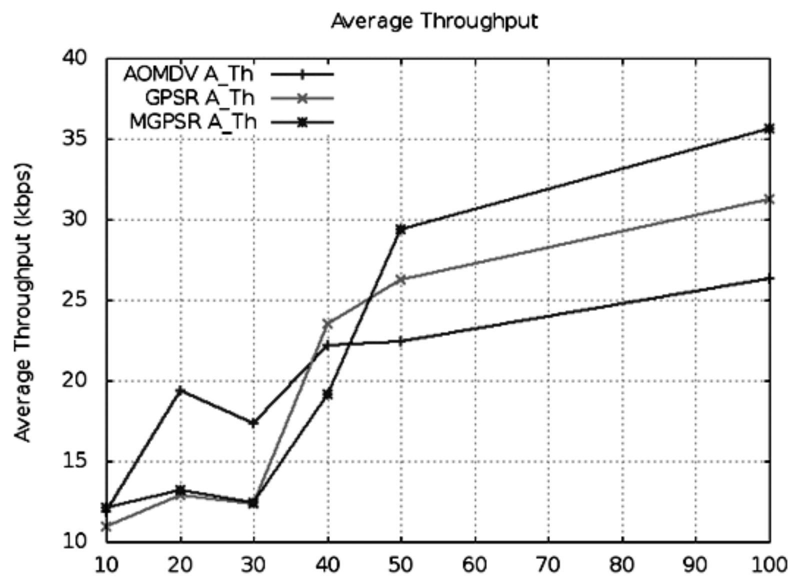

Figure 6: Average throughput of GPSR, AOMDV and MGPSR

As we can analyze the throughput of MGPSR is almost 15% greater than throughput of GPSR. As the number of nodes are increasing the performance of MGPSR is also increasing.

4.3. Average End_to_End Delay

Figure 7, shows the end_to_end delay for the AOMDV, GPSR and proposed protocol MGPSR.

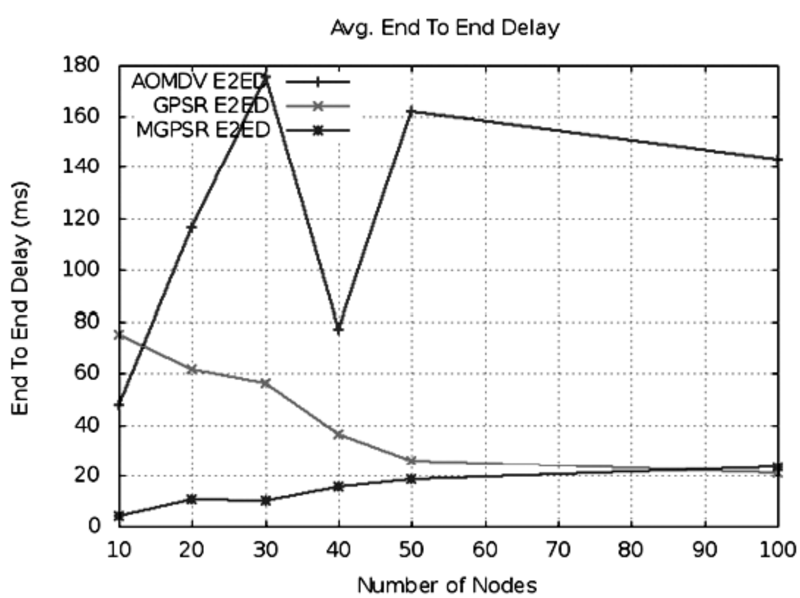

Figure 7: Average end_to_end delay for GPSR, AOMDV and MGPSR

The E2E delay of MGPSR is very less when the vehicle density is low but as the vehicle density increases the E2E delay of proposed protocol MGPSR and GPSR is same. We can analyze that the Average End-to-End delay in position based routing is much lesser than the on-demand routing. The minimum End-to-End delay is given by GPSR and MGPSR in case of high node density.

4.4. Normalized Routing Load

Figure 8 shows the Normalized Routing Load (NRL) for the AOMDV, GPSR and the proposed protocol MGPSR.

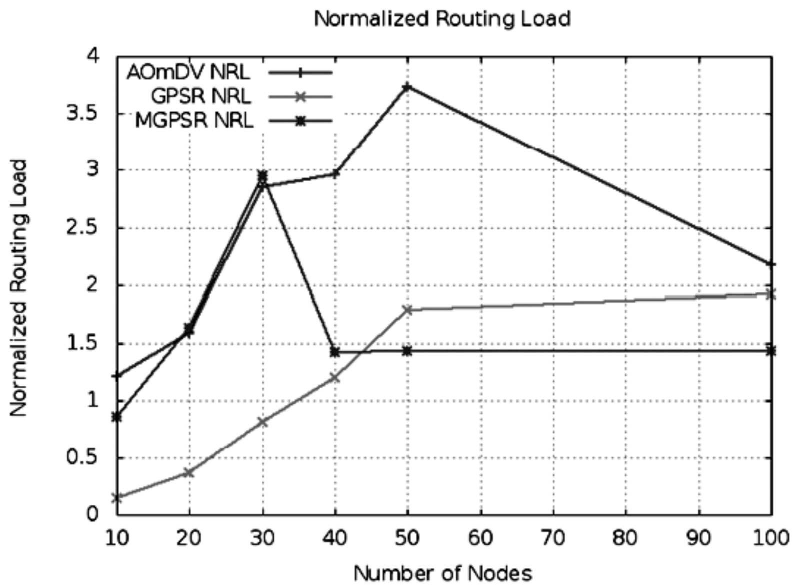

Figure 8: Normalized routing load of GPSR, AOMDV and MGPSR

For low density of vehicles, the NRL of AOMDV and MGPSR is slightly higher than the GPSR bust as the number of vehicles increases the proposed protocol depicted less overhead in comparison to GPSR and AOMDV protocol. The normalized routing load of position based routing is significantly less than the normalized routing load of on-demand routing. The routing load is initially high for multipath approach. As the density of nodes is increasing the MGPSR is having a better performance than rest all.

5. CONCLUSION

This paper proposes an enhanced geographical routing protocol for VANET environment named MGPSR using a multipath technique. MGPSR has shown more reliable delivery of data in-comparison to GPSR and AOMDV protocol. Due to frequent disconnect of path between source and destination the conventional approach of routing is not perfect for VANET environment. Thus, geographical routing is one of the alternative approach for such dynamic environment where we keep the geographical information of every node. The proposed protocol MGPSR has depicted high throughput and PDR when the density of vehicles is high. Also, the proposed protocol MGPSR has shown less E2E delay and overhead like NRL in comparison to GPSR and AOMDV. For more than 50 vehicles the performance of proposed protocol is better than conventional GPSR and AOMDV. Thus, we can say that the proposed protocol MGPSR performs efficiently for high density of nodes.

REFERENCES

[1] K. C. Purohit, S. C. Dimri, and S. Jasola, "PerformanceEvaluation of various MANET Routing Protocols for Adaptability in VANET Environment." *Accepted in IJSA http://link.springer.com/article/10.1007/s13198-016-0507-2*(2016).

[2] B. Karp and H.-T. Kung, "GPSR: Greedy perimeter stateless routing for wireless networks," in *Proceedings of the 6th annual international conference on Mobile computing and networking*, 2000, pp. 243-254.

[3] M. K. Marina and S. R. Das, "On-demand multipath distance vector routing in ad hoc networks," in *Ninth International Conference on Network Protocols*, pp. 14-23, 2001.

[4] C. Lochert, H. Hartenstein, J. Tian, H. Fussler, D. Hermann, and M. Mauve, "A routing strategy for vehicular ad hoc networks in city environments," in *Intelligent Vehicles Symposium, 2003. Proceedings. IEEE*, pp. 156-161, 2003.

[5] B. C. Seet, G. Liu, B.-S. Lee, C.-H. Foh, K.-J. Wong, and K.-K. Lee, "A-STAR: A mobile ad hoc routing strategy for metropolis vehicular communications," in *Networking 2004*, 2004, pp. 989-999.

[6] J. LeBrun, C.-N. Chuah, D. Ghosal, and M. Zhang, "Knowledge-based opportunistic forwarding in vehicular wireless ad hoc networks," in *Vehicular technology conference, 2005. VTC 2005-Spring. 2005 IEEE 61st*, 2005, pp. 2289-2293.

[7] K. C. Lee, J. r. O. HÃ£erri, U. Lee, and M. Gerl, "Enhanced perimeter routing for geographic forwarding protocols in urban vehicular scenarios," in *Globecom Workshops, IEEE*, pp. 1-10, 2007

[8] F. Granelli, G. Boato, D. Kliazovich, and G. Vernazza, "Enhanced gpsr routing in multi-hop vehicular communications through movement awareness," *Communications Letters, IEEE,* vol. 11, pp. 781-783, 2007.

[9] H. Menouar, M. Lenardi, and F. Filali, "Movement prediction-based routing (MOPR) concept for position-based routing in vehicular networks," in *Vehicular Technology Conference, 2007. VTC-2007 Fall. 2007 IEEE 66th*, 2007, pp. 2101-2105.

[10] J. Gong, C.-Z. Xu, and J. Holle, "Predictive directional greedy routing in vehicular ad hoc networks," in *27th International Conference on Distributed Computing Systems Workshops, 2007. ICDCSW'07.*, pp. 2-2, 2007.

[11] Z. Ning, Y. Jung, Y. Jin, and K.-C. Kim, "Route Optimization for GPSR in VANET," in *Advance Computing Conference, 2009. IACC 2009. IEEE International*, 2009, pp. 569-573.

[12] S. Sun, J. Kim, Y. Jung, and K. Kim, "Zone-based greedy perimeter stateless routing for VANET," in *Information Networking, 2009. ICOIN 2009. International Conference on*, 2009, pp. 1-3.

[13] N. Beijar, "Zone routing protocol (ZRP)," *Networking Laboratory, Helsinki University of Technology, Finland,* pp. 1-12, 2002.

[14] D. Xiao, L. Peng, C. O. Asogwa, and L. Huang, "An improved GPSR routing protocol," *International Journal of Advancements in Computing Technology,* vol. 3, 2011.

[15] L. Hu, Z. Ding, and H. Shi, "An improved GPSR routing strategy in VANET," in Wireless Communications, Networking and Mobile Computing (WiCOM), 2012 8th International Conference on, 2012, pp. 1-4.

[16] C. Tripp Barba, L. Urquiza Aguiar, and M. Aguilar Igartua, "Design and evaluation of GBSR-B, an improvement of GPSR for VANETs," *Latin America Transactions, IEEE (Revista IEEE America Latina),* vol. 11, pp. 1083-1089, 2013.

[17] Z. Liu, Y. Xiang, and W. Sun, "GeoSVR: A Geographic Stateless VANET Routing," in *Conference Anthology, IEEE*, 2013, pp. 1-7.

[18] H. Tu, L. Peng, H. Li, and F. Liu, "GSPR-MV: A routing protocol based on motion vector for VANET," in *12th International Conference on Signal Processing (ICSP)*, 2014, pp. 2354-2359.

[19] S. L. Ele, "Performance Evaluation of GPSR Routing Protocol for VANETs using Bi-directional Coupling," International Journal of Computer Networks (IJCN), vol. 7, 2015.