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GRPS:Greedy Routing Predictive Score Base in VANET

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***Abstarct*– Vehicular Ad-Hoc Networks are highly mobile wireless ad hoc networks. Routing of data in VANETs is a challenging task due to rapidly changing topology and high speed mobility of vehicles. Considering the fact that vehicles often have predicable mobility, we propose GRPS (Greedy Routing Predictive Score Base) to forward packet to the most suitable next hop based on both current and predicable future situations. We evaluate the performance of the solutions via simulations in highway and urban senarioes. Simulation results show that our solutions outperform existing ones in terms of packet delivery ratio, end-to-end delay.**

***Index Terms*– Vehicular Ad-Hoc Networks, Mobility and Predictive**

I. INTRODUCTION

VEHICULAR Ad-hoc Networks (VANET), a new technology to build a wireless network between vehicles (V2V) and vehicles to infrastructure(V2I).VANETs are based on short-range wireless communication (e.g., IEEE 802.11) between vehicles [1]. The Federal Communication Commission (FCC) has allocated 75 MHz in 5.9 GHz band for Dedicated Short Range Communication (DSRC). DSRC was conceived to provide architecture for vehicles in Vehicular Network to communicate with each other and with infrastructure. In DSRC, subsequently specialized as Wireless Access in Vehicular Environment (WAVE), GPS-enabled vehicles that are equipped on-board units can communicate with each other. Each vehicle's wireless network range may be limited to a few hundred meters, so providing end-to-end communication across a larger distance requires message to hop through several nodes.

Routing refers to move a data packet from source to destination and if required the assignment of a path to the destination. In multi-hop regime routing means to forward packets that contain information through other vehicles [2]. This information refers to alerts about events that already happened, like local danger warnings and traffic flow information. If no vehicle is within the communication range a packet is stored and forwarded as soon as a new vehicle comes into reach.

Routing is one of the key research issues in vehicular networks as long as it supports most emerging applications. Recent research showed that existing routing solutions for mobile ad hoc networks (MANETs) are not able to meet the unique requirements of vehicular networks. Thus, a lot of effort has been devoted during the last years to design VANET-specific routing protocols being able to exploit additional information available in VANET nodes [3] (e.g., trajectories of nodes, city maps, traffic densities, constrained mobility, etc).

II. VANETs CHARACTERISTICS

Unlimited transmission power: The power issue of mobile devices is usually not a significant one in VANET as that in the classical ad hoc or sensor networks. Vehicle itself can provide continuous power to computing and communication devices. Usually, the car battery can last much longer compared to those for hand-held mobile devices [4].

Higher computational capability: Vehicles can be installed with significant computing, communication,and sensing capabilities which can be evenmore powerful than regular desktops.

Predictable mobility: Unlike conventionalmobile ad hoc networks in which node mobility is hard to predict, vehicles in VANETs tend to move in a predictable way that is (usually) limited to street topology. Roadway information is often available from navigation systems and map-based technologies such as GPS. Given the average number of nodes, average speed, number of lanes, the future position of a vehicle may be predicted [5].

High mobility: The environment in which vehicular networks operate is extremely dynamic, and includes extreme configurations: on highways, relative speeds of up to 300 km/h may occur, while density of nodes may be 1-2 vehicles per kilometers on less busy roads. On the other hand, in the city, relative speeds can reach up to 60 km/h and network density can bevery high, especially during rush hours [6].

Partitioned network: Vehicular networks will be frequently partitioned. The dynamic nature of traffic may result in large inter-vehicle gaps in sparsely populated scenarios, and hence in several isolated clusters of nodes [7], [14].

Network topology and connectivity: Vehicular network scenarios are very different from classic ad hoc networks. Since vehicles are moving and changing their position constantly, scenarios are very dynamic. Therefore the network topology changes frequently as the links between nodes connect and disconnect very often. Indeed, the degree to which the network is connected is highly dependent on two factors: the range of wireless links and the fraction of participant vehicles, where only a fraction of vehicles on the road could be equipped with wireless interfaces [7].

III. ROUTING IN VANETS

A. GSR-Geographic Source Routing

Using the location of the destination, the map of the city and the location of the source node, GSR computes a sequence of junctions the packet has to traverse to reach the destination. The protocol aims to calculate the shortest route between origin and destination applying Dijkstra's algorithm over the street map. The calculated path is a list of junctions that the packet should go through [8], [9], [13].

From here, it applies greedy forwarding, where the greedy destination is the position of the next junction of the list. That is, a node forwards the packet to one that is the closest to next junction. Once a junction of the path is reached, the greedy destination is changed to the next junction and greedy forwarding is applied again.

The protocol works in this way until that packet eventually reaches the destination node.

B. GPCR- Greedy Perimeter Coordinator Routing

Because nodes are highly mobile in VANETs, node planarization can become a cumbersome, inaccurate, and continuous process. GPCR have observed that urban street map naturally forms a planar graph such that node planarization can be completely eliminated. In this new representation of the planar graph using the underlying roads, nodes would forward as far as they can along roads in both greedy and perimeter mode and stop at junctions where decision about which next road segment to turn into can be determined [6], [7].

C. GPSR- Greedy Perimeter Stateless Routings

Using this routing is an algorithm that consists of two methods for forwarding packets: *greedy forwarding*, which is used wherever possible, and *perimeter forwarding*, which is used in the regions where greedy forwarding cannot be.

The greedy forwarding algorithm [10] uses packets that carry the locations of their destinations. The packets are stamped by the source node. This way, the packets are always forwarded to the neighbor that is geographically closest to the destination.

The drawbacks of pure greedy forwarding [11], [13]:

- The position accuracy drops if the nodes move (mobility). It is possible that a location server node changes its position and before update process is performed some nodes remain without location server. This may lead to packet loss. Also, due to outdated neighbor table entries excessive re-sending of data may occur.
- Additional network load due to the beacons
- Missing of recovery from failure due to the link-layer broadcast of the beacons

This leads to failure in transmission, because nodes being close to each other are not recognized as such.

The recovery strategy of the GPSR called *Perimeter Mode* [8], [10] is used in order to avoid the lost packets that may occur in pure greedy technique when there is no neighbor available that is closer to the destination than the current forwarding hop. The perimeter mode of GPSR consists of two elements. First, a distributed planarization algorithm that locally transfers the connectivity graph into a planar graph by the removal of “redundant” edges. Second, an online routing algorithm for planar graphs that forwards a packet along the faces of the planar graph towards the destination node.

D. PDGR- Predictive Directional Greedy Routing Protocol

PDGR present the DGR algorithm and its predictive extension. PDGR assume every vehicle has a device to communicate with one another within its radio range. Also it has static digital maps and GPS (or DGPS) installed to get its accurate geographical location. PDGR give score to every neighbors according direction and location.

When it wants to send packets to a neighbor, the neighbor selected that have been higher score. PDGR also assume each vehicle has the knowledge of its own velocity and direction [12].

IV. GREEDY ROUTING PREDICTIVE SCORE BASE

The GRPS will select the nodes moving toward destination.

Among those nodes, the one closet to the destination will be chosen as next hop. This scheme intends to reduce routing loops in the forwarding process. But another problem arises when we look into the example in Fig. 1. Node Source want forward packet to destination. Node A is close node to source node. Node B is closet neighbour to destination. Node B moving in the oppositdirection. In duration time of hello packet when Node source wants to forward a packet to the destination, it can choose A as next hop if only directionfirst scheme is used. This may cause more hops and delay Fig. 2.

In Fig. 2 Node source receive hello packet from neighbors but the location of neighbors changed. So in this scenario node B forward the packet to node source again and make a loop problem. Our routing approach is designed for the general case in VANETs, which means it is able to perform well in the extreme cases discussed above. It motivates us to take both position and direction into future position and consideration when choosing next hop. Fig. 3 shows the forwarding packet according to urban scenario. To make a tradeoff be tween the merits of position-first and direction-first forwarding, we propose a mathematical model to reflect the relationship between these two factors. The next hop is selected by calculating weighted score W_i:

$$W_i = \propto * (1-D_i / Dc) + \beta * \cos(\vec{V}_i , \vec{P}_{i},d)$$

Here, $\propto$ and β are the weight for these factors and $\propto + \beta = 1$; D_i is the shortest distance from node i to destination; D_c is the shortest distance for forwarding node to destination; D_i/D_c is the closeness of next candidate hop; vi is the vector for the velocity of node i; p_{i},d is the vector from the position of node i to the position of destination; $\cos(\vec{V}_c , \vec{P}_{c,d})$ is the cosine value for the angel made by these two vectors.

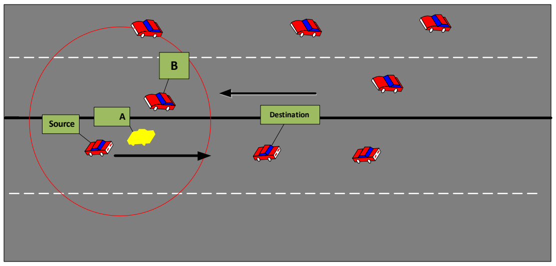

Fig. 1. A scenario of forwarding packat in duaration of hello packet at time t_1

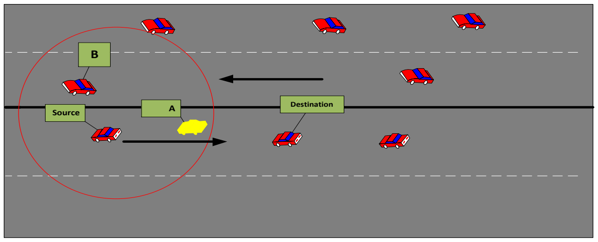

Fig. 2. A scenario of forwarding packat in duaration of hello packet at time t_2

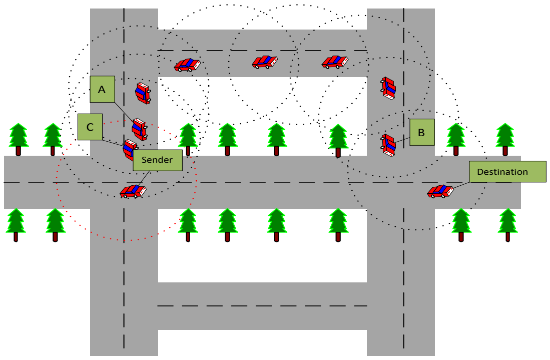

Fig. 3. A scenario of forwarding packat in duaration of hello packet in Urban scenario

Algorithm 1 Pseudo code for GRPS:

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currentnode: the current packet carrier
$loc_c$: the location for current node
$\vec{V}_c$ : : the speed vector for currentnode
dest: destination for the packet
$loc_d$: the location for dest
nextHop: the node selected as next hop
$neigh_i$: the $i_{th}$ neighbor
$loc_i$: the location of the ith neighbor
$\vec{V}_i$: the speed vector of the ith neighbour

1: $loc_c$ = get Location(current node)
2: $\vec{v}_c$ = getSpeed(current node)
3: $loc_d$ =getLocation(dest)
4: $D_c$ = distance($loc_{current}$, $loc_{dest}$)
5: $\vec{p}_{c,d} = loc_d - loc_c$
6: $W = \beta \times \cos(\vec{v}_c , \vec{p}_{c,d})$
7: nextHop = current node
8: for all neighbors of current node do
9:     $loc_i$ =getLocation($neigh_i$)
10:    $\vec{v}_i$ =getSpeed($neigh_i$)
11:    $D_i$ = distance($loc_i$, $loc_d$)
12:    $\vec{p}_{i,d} = loc_d - loc_i$
13:    $Wi = \propto * (1-D_i / D_c) + \beta * \cos( \vec{V}_i , \vec{Pi},d )$
14:    if Wi > W then
15:        $W = W_i$
16:        nextHop = $neigh_i$
17:    end if
18: end for
19: if nextHop $\neq$ currentnode then
20:     forward the packet to nextHop
21: end if
22: if current node is closet neighbour to destination then check for connectivity with another neighbors
23: if connectivity is available, forward the packet to next hop that have a connectivity
24: Go to 8
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V. SIMULATION RESULTS AND ANALYSIS

Table 1: Simulation Parameters

Parameter	Value
Hello Packet Internal	1 S
Packet Size	1052 Byte
Simulation Time For Urban	300 ms
SimulationTimeFor highway	150 ms
MAC Protocol	IEEE 802.11 DCF
Weighting Factor (M,W)	(0.9 , 0.1)

The performance metrics used to evaluate simulationresults are:

- Packet delivery ratio: the ratio of the packets that successfully reach destination to the original sent ones.
- End-to-end delay: the average time for a packet from its source to its destination.

A. Packet Delivery Ratio

In this paper, we compare the performance of GPSR, GPCR, PDGR and GRPS in terms of packet delivery ratio. The results show GRPS outperform at 3.5%, 7.7% and 29% higher than PDGR, GPCR and GPSR in highway scenario (Fig. 4 (a)). On the other hand Fig. 4(b) shows GRPS outperform at 20.4%, 15% and 21% higher than PDGR, GPCR and GPSR in urban scenario.

B. END-to-end Delay

In this paper, we compare the performance of GPSR, GPCR, PDGR and GRPS in terms of End-to-end Delay. The results show GRPS outperform at 8.1%, 30% and 28.8% higher than PDGR, GPCR and GPSR in highway scenario (Fig. 5 (a)). On the other hand Fig. 5(b) shows GRPS outperform at 18.4%, 14% and 16.6% higher than PDGR, GPCR and GPSR in urban scenario.

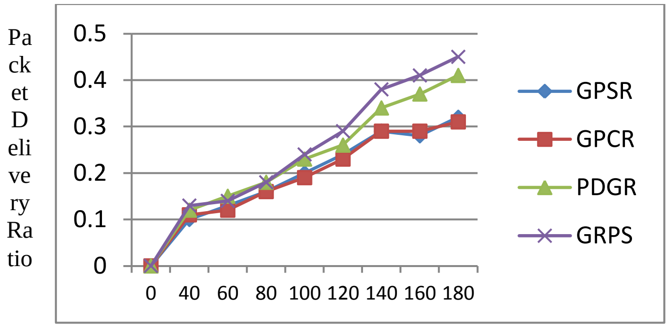

Fig. 4 (a): Packet Delivery Ratio in highway scenario

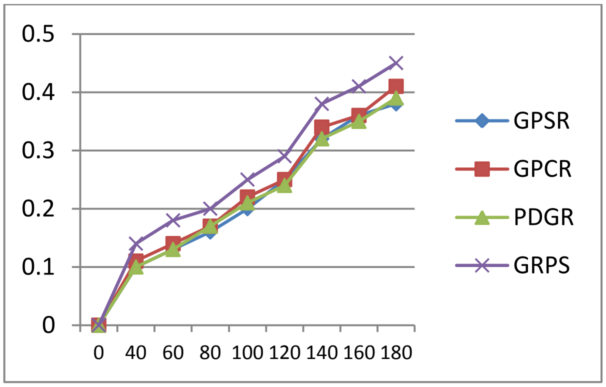

Fig. 4 (b): Packet Delivery Ratio in Urban scenario

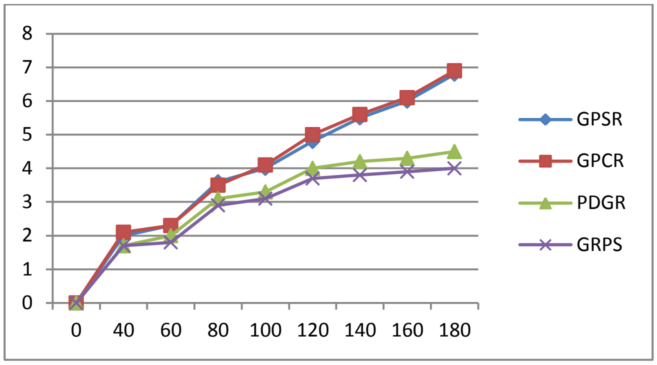

Fig. 5 (a): End-to-end Delay in highway scenario

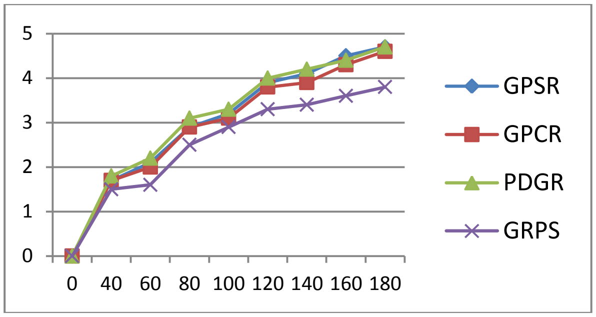

Fig. 5 (b): End-to-end Delay in Urban scenario

VI. CONCLUSION

In this paper, we have investigated routing aspects of VANETs.We have identified the properties of VANETs and previous studies on routing in VANETs. Also we describe characteristics of VANET. Our simulation results have shown GRPS outperform PDGR, GPCR and GPSR in term of packet delivery ratio and end-to-end delay in highway and urban senarios.

REFERENCES

[1] Hirantha Sithira Abeysekera, B., T. Matsuda, and T. Takine, Dynamic Contention Window Control Mechanism to Achieve Fairness between Uplink and Downlink Flows in IEEE 802.11 Wireless LANs. Wireless Communications, IEEE Transactions on, 2008. **7**(9): p. 3517-3525.

[2] T. Kosch, Technical concept and prerequisites of car-to-car communication, München: BMW

[3] Lin, Y.-W., Y.-S. Chen, and S.-L. Lee, Routing protocols in vehicular Ad Hoc networks: A survey and future perspectives. Journal of Information Science and Engineering, 2010. 26(Compendex): p. 913-932.

[4] Prasanth, K., Duraiswamy, K., Jayasudha, K., and Chandrasekar, C. (2009).Minimizing end-to-end delay in vehicular ad hoc network using edge nodebased greedy routing. Paper presented at the Advanced Computing, 2009. ICAC 2009. First International Conference on, 135-140.

[5] Zoican, R., and Galatchi, D. (2010). Analysis and simulation of a Predictable Routing Protocol for VANETs. Paper presented at the Electronics and Telecommunications (ISETC), 2010 9th International Symposium on, 153-156.

[6] Bako, B., and Weber, M. (2011). Efficient Information Dissemination in VANETs. Balon, N. (2006). Introduction to vehicular ad hoc networks and the broadcast storm problem.

[7] Moustafa, H., and Zhang, Y. (2009). Vehicular networks: techniques,standards,andapplications: Auerbach Publications.

[8] C. Lochert, H. Hartenstein, J. Tian, H. F¨ußler, D. Hermann, and M Mauve, “A routing strategy for vehicular ad hoc networks in city environments,” In *Proc. of the IEEE Intelligent Vehicles Symposium 2003*. Columbus, OH, June 2003:156–161.

[9] Hassnaa Moustafa , Yan Zhang “ Vehicular Networks Techniques, Standards, and Applications “ ,CRC press ,2009.

[10] Karp, B. and H.T. Kung. GPSR: Greedy Perimeter Stateless Routing for wireless networks. in 6th Annual International Conference on Mobile Computing and Networking (MOBICOM 2000), August 6, 2000 - August 11, 2000. 2000. Boston, MA, USA: ACM.

[11] H. Füßler, J. Widmer, M. Mauve, and H. Hartenstein, A novel forwarding paradigm for position-based Routing (with implicit addressing), Germany, 2003.

[12] Gong, J., Xu, C.-Z., and Holle, J. (2007). Predictive directional greedy routing in vehicular ad hoc networks. Paper presented at the Distributed Computing Systems Workshops,2007.ICDCSW'07. 27th International Conference on, 2-2.

[13] Ramin Karimi, Norafida Ithnin, Shukor Abd Razak, and Sara Najafzadeh, “Non DTN Geographic Routing Protocols for Vehicular Ad Hoc Networks,” International Journal of Computer Science Issues (IJCSI), vol. 8, Issue 5, no. 3, September 2011.

[14] Ramin Karimi, Norafida Ithnin ,Shukor Abd Razak , Sara Najafzadeh,” DTN Routing Protocols for VANETs: Issues and Approaches” , IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 6, No 1, November 2011.

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