DND TOLERANT ROUTING PROTOCOLS FOR VANET

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ABSTRACT—Routing in Vehicular Ad-hoc Network is challenging now a days due to increased no of vehicle, high mobility of nodes, dynamically changing topology and highly partitioned network, so the challenges on the roads are also increased like roads are full, safety problem, speed etc. Vehicular Delay tolerant routing protocols are using store and carry forward mechanism and Non delay tolerant routing protocols are using strategy to find best node who can forward packet faster than other. This paper gives detail of new vehicular routing protocol method which will perform well on both high density and low density network.

Keywords—VANET, DND, DTN, Delay tolerant network, NDTN, New, Routing Protocols

I. INTRODUCTION

Vehicular ad hoc networks (VANETs) are special kind of Mobile Ad hoc networks that are formed between moving vehicles. The routing protocol has the responsibility of finding a path between source and destination. In order to get compromised solution, Delay tolerant network was proposed by subsequently by some researcher [1][2].Delay tolerant networks try to extend the reach of networks. These networks can be connected if protocols are designed to accommodate disconnection. VDTN has potential to interconnect Vehicles in regions that current networking technology cannot reach [7]. Non Delay tolerant network protocols were proposed by subsequently by some researcher. When we use the popular MANET routing protocols in VANET environment the simulation results shows that, all the protocols have large packets overhead because the routs charge frequently due to high mobility. So we need the new routing protocols for VANET based on its characteristics and issues [7].

Several routing protocols have been proposed for VDTN to achieve high PDR, minimum delay, storage, bandwidth and exchange of control information. In Direct Delivery protocols source node carry message until it find destination node. First contact routing routes to first node it encounter as random walk to search for destination. **Epidemic routing** replicates messages to all encountered peers that still do not have them. If a message storage space is unlimited and contacts between nodes are long enough, the epidemic routing minimizes the delivery delay and maximizes the delivery ratio. Spray-and-Wait generates n copies of a message. In a normal mode, a node gives one copy to each contact; in a binary mode, half of the copies are forwarded to a contact. Spray-and-Wait is another example of protocols that limit message replication as compared with Epidemic routing. The PRoPHET protocol transfers the message to a neighbor if it estimates that the neighbor has a higher ”likelihood” of being able to deliver the message to the final destination based on the past node encounter history [3,4,5].

Mobispace introduce a virtual location routing scheme which makes use of the frequency of visit of nodes to a discrete set of locations in the network area in order to decide on packet forwarding. The MobyPoint of a node is not related to its physical GPS coordinate. The acquisition of the visit frequencies of the nodes to the location set is obtained by computing the respective fraction of time of being in a given location [10,14].

The Non-DTN Routing Protocols are also known as Min delay protocols. The protocols always trying to minimize the packet delivery time from source to destination that’s way most of the protocol trying to find the shortest path. Non-DTN protocols again classified in to beacon based, non-beacon based and hybrid routing protocols. Here is the Issues for non-DTN routing protocols [15,39]:

- As the non-DTN routing always try to reduce the packet delivery time. To achieve this, the packets should have to pass through minimum intermediate node and this path should be shortest and optimal.
- To find the shortest path the nodes should have the knowledge of neighbors.
- If there is problem in delivery of packets then protocols should have recovery mechanism.

Greedy forwarding is the commonly used technique in Non-DTN routing protocols. In this approach packets are forwarded to a neighbor who is geographically closer to the destination node. This approach have problem where a packets reaches to a node which has no neighbors that is closer to destination. This is called local maxima. Every routing protocols have their own recovery strategy to deal with local maxima problem[12,38].

The Non-DTN protocols assume that roads are densely populated. It do not work well in sparse roads where the connectivity is irregular.

The beacon based routing protocols use the "HELLO" beacon message to finds the neighbors. The node sends the beacons periodically to maintain the neighbor lists. It again classified into non-overlay and overlay. Like GPSR, PBR-DV, GRANAT, DGR, GPCR, GPSRJ+, CAR, GSR, A-STAR, STBR, GyTAR, LOUVRE. CBF protocol does not use the beacon message to maintain the neighbor lists. When the packets arrive then they find their neighbors. TOGO protocol use both approach beacons based and non-beacon based [21,28,30].
Rest of the paper is organized as follow. Section II describes various DTN and NDTN routing protocols. In section III, we have provided proposed DND routing protocol. Ccomparative analysis of few DTN and NDTN routing protocols is discussed in Section IV. Finally Section V discuss conclusion of this paper.

II. VEHICULAR DTN AND NDTN ROUTING PROTOCOLS

Zhao and Cao [17] proposed several vehicle assisted data delivery (VADD) protocols. All of them share the idea of storing and forwarding data packets. That is, nodes can decide to keep the message until a more promising neighbor appears on their coverage range, but trying always to forward them as soon as possible with parameters like current speed, distance to the next junction, and maximum speed allowed at junction.
GeOpps for vehicular networks [16] is a trajectory-based protocol that uses both the opportunistic nature of vehicular mobility patterns and the geographic information provided by navigation systems. It applies a delay-tolerant mechanism, therefore a vehicle store data packets until a suitable next hop for them is found later on. To choose the next hop, each node computes the closest point in their trajectory in direction of the destination of the packet.
GeoDTN+Nav- Geographic DTN Routing with Navigator routes packets in two modes: the first mode is the greedy mode, and the second mode is the perimeter mode. In greedy mode, a packet is forwarded to destination greedily by choosing a neighbor which has a bigger progress to destination among all the neighbors. However, due to obstacles the packet can arrive at a local maximum where there is no neighbor closer to the destination than itself. In this case, the perimeter mode is applied to extract packets from local maxima and to eventually return to the greedy mode [13].
PBRS [9] proposed a decision-based scheme which makes RSUs determine whether or not to release its data to a vehicle on the basis of certain criterion. The source RSU S has data to forward to the destination RSU D. However, there is no end-to-end path between S and D. The Vehicles passing by S make S become aware of the speed of those vehicles. PBSR calculates the release probability by utilizing the speed of vehicles. When a vehicle Vi enters a communication range of S, the S holds its data until the vehicle moves out of the range or a next vehicle Vi+1 enters the coverage area. If the Vi+1 is faster than Vi and Vi+1 is considered to reach D before the Vi does, S transmits its data to Vi+1.
ACSF utilized a store-and-forward technique for relaying data. However, it focused on the outage time of a target vehicle in an uncovered area. In the ACSF scheme, a message forwarding mechanism was proposed for reducing the outage time for vehicles [8].
The vehicles in Distance-Aware Routing with Copy Control (DARCC) [18] determine whether to transmit data or not to their encountering vehicles with 2 principles. If the location of the destination of data is available, the data is forwarded to the vehicle that is closer to the destination. Otherwise, DARCC prefers spreading the data to different direction to increase the probability to meet destination. Each vehicle in DARCC is equipped with a GPS, thus the vehicle can calculate its current motion vector. The motion vector is the speed of vehicle and its moving direction. The vehicle A turns left in junction during certain time t, then its motion vector of time t is calculated. Each vehicle periodically broadcasts a beacon message including its location, current motion vector, and the list of the messages it has. If the vehicles are moving in different directions, the replication helps to perform the successful delivery, because the other vehicles may reach its destination on its way before the source. Thus, the vehicles A and B replicate their packets to each other, respectively.
The authors of DAWN (Density Adaptive routing With Node awareness) [19] assume urban sensing applications. There are$N$fixed sensor in roadside, and one base station for data gathering. The sensors are regularly deployed and the base station is located at the center of the network area. The data packets are generated at the sensors, and each packet includes its origin location and generation time. The vehicles and mobile nodes are more like travelling in the random cells. When the vehicles move into new cell they collect the data packet from sensors and store it in its buffer. If two vehicles meet, they replicate their packets to each other. The data forward strategy in DAWN is decided by the density of the cell. If density is low the forward strategy is the same as epidemic, that is, a node replicates all the data it has to encounter nodes. On the other hands, if the density of cell increases, the throughput is restricted by congestion due to the limitation of wireless channel capacity.
GeoSpray [20] uses the principles of single-copy single-path. GeoSpray adopts the replication approach of the spray-and-wait protocol to limit the number of copies. It uses a single-copy forwarding scheme. GeoSpray clears the delivered bundles from vehicles' storage by propagating the delivery information. As a result, it achieves

better delivery ratio than GeOpps at the cost of high replication overhead. However, this overhead is less than the epidemic protocol and similar to spray-and-wait.

In FFRDV, the roads are divided into logical blocks based on geographic information. Each vehicle can get its current location by GPS and it shares its location and speed with other vehicles in the same block by hello messages. When an emergent event occurs, FFRDV selects message ferries which have the responsibility of relaying data according to velocity based strategy [6]. First, the vehicle which senses an event becomes an initial ferry. It selects the fastest vehicle within its block as a next ferry. Second, if the ferry enters a new block Bi, it broadcasts a hello message to find a new ferry. Any nodes, which are able to receive a new data, send a response message, including their current speed.

MaxProp is a routing protocol designed for vehicular DTNs. The MaxProp protocol is based on a store-carry-forward mechanism which is usually utilized in a DTN environment. However, the authors in [11] proposed an algorithm which enables the nodes to assign the priority to the packets. On the basis of the given priorities, each node can decide either to transmit or drop the packet. In VDTNs, the transmission duration and opportunities for each node are limited, since the nodes move fast in sparse areas. Moreover, the buffer of node is also limited in a real environment. Therefore, to decide the priority of packets in a buffer of nodes is important when performing efficient routing. In MaxProp, when two nodes communicate, they exchange packets in a specific order. If the node currently in contact is the destination node of some packets, these packets are transmitted first. Secondly, the routing information is exchanged which includes the estimated probability of meeting any node. The calculation of the probability is based on the number of encounters between two nodes.

GSR-Geographic Source Routing 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 [22].

From here, it applies greedy forwarding, where the greedy destination is the position of the next junction of the list.

A-STAR-Anchor-based Street-and Traffic- Aware Routing is having consciousness of the physical environment around the vehicles; the protocol can take wiser routing decisions [23]. On the other hand, the use of anchor-based routing is not novel either. It consists of including within the packet header the list of junctions (anchors) that the packet must traverse. This approach has been employed in the GSR protocol. In fact, A-STAR relies on GSR to perform the routing task. However, one novelty provided by A-STAR is the inclusion of traffic density information to weigh the streets of the scenario.

CAR- Connectivity-Aware Routing algorithm is divided into three stages: (i) finding the location of the destination as well as a connected path to reach it from the source node, (ii) using that path to relay messages, and (iii) maintaining the connectivity of the path in spite of the changes in the topology due to the mobility of vehicles [24].

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[25].

GPSR- Greedy Perimeter Stateless Routings 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 [26] 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:

- 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 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.

Contention-Based Forwarding (CBF) [27, 41] is a mechanism for position-based unicast forwarding, without the use of neighborhood knowledge. Instead, all suitable neighbors of the forwarding node participate in the next hop selection process and the forwarding decision is based on the actual position of the nodes at the time a packet is forwarded. This algorithm eliminates the drawbacks of pure greedy solution. In position based routing [27] the principle is that the forwarding of the packet, from one hop to another, is done based on the local geographical position of the nodes.

RDGR is a reliable position based greedy routing approach which uses the position, speed, direction of motion and link stability of their neighbours to select the most appropriate next forwarding node [29]. It obtains position, speed and direction of its neighbour nodes from GPS. If neighbour with most forward progress towards destination node has high speed, in comparison with source node or intermediate packet forwarder node, then packet loss probability is increased.

Lee introduces a routing solution called "Landmark Overlays for Urban Vehicular Routing Environments" (LOUVRE), an approach that define urban junctions as overlay nodes and create an overlay link if and only if the traffic density of the underlying network guarantees the multi-hop vehicular routing between the two overlay nodes. LOUVRE [31] contains a distributed traffic density estimation scheme which is used to evaluate the existence of an overlay link. Then, efficient routing is performed on the overlay network, guaranteeing a correct delivery of each packet.

Advanced Greedy Forwarding (AGF) was proposed in 2006[32] to combine the speed and direction of a node in the beacon packet and the total travel time, including the time to process the packet, up to the current forwarding node within the data packet. Results show at least three times of improvement in packet delivery ratio.

Position based routing with distance vector (PRB-DV) uses AODV routing to recover from local maxima. When the packet reaches to the local maxima it will broadcast a request packet. The request packet contains the node position and destination location.

Directional Greedy Routing (DGR) uses the combination of two forwarding strategies.

- Position First Forwarding: The position-first strategy tries to find the closet node towards destination as the next hop.
- Direction First Forwarding: It will select the nodes which are moving toward destination. Among those nodes, the one closet to the destination will be chosen as next hop. It takes both position and direction into consideration when choosing next hop [29].

DGR uses combination metrics of position-first and direction-first forwarding. The node with largest weighted score among current node itself and its neighbors will be chosen as next hop. If the current node has the largest score, it will carry the packet and forward it later.

Predictive Direction Greedy Routing (PDGR) extends DGR and predicts the future neighbors. The PDGR calculate the weighted score for current node, its current neighbors and possible future neighbors. The packet carrier use 2-hop neighbors to get the knowledge of possible future neighbors. According to all these weighted scores, next hop is then decided [33]. So PDGR has two parts. One is to calculate weighted score for current neighbors, which is the same as DGR. The other is used for future neighbors in a short interval.

In GRANT (Greedy Routing with Abstract Neighbors Table) every node knows its x hop neighborhood. Using this information every node can find better route and avoid local maximum. The matrix use in selection the next forwarding neighbor E is based on the node N, X hop away from E and the Destination, the shortest path from N to E, The cost per hop for multi hop neighbors. The neighbors E which provide the smallest such matrix will be selected at the next hop. It is very necessary to select the most promising neighbor as in beacon transmitting x-hop neighbors is too much overhead [35]. GRANT divides the whole plane into small areas and has only one representative neighbor per area.

GpsrJ+ minimizes the packet forwarding node by removing the unnecessary stops at junctions without changing the efficient planarity of topological maps. It considers the two-hop neighbor beaconing to choose the next road segment at junction which is taken by its neighboring node. Nodes consider its two hope neighbor and predict the next forwarding node. If the next forwarding neighbor node is in different direction then the packet forward to the junction node. And if it is on the same direction then it bypass the junction and forward to its furthest neighboring node [36]. When it reaches to local maxima then it use the perimeter mode where GpsrJ+ uses the right-hand rule to find the best forwarding node. if the junction's next node is the best node in the same direction, then it is considered as the best forwarding node; otherwise, the best forwarding node is consider to be the junction's node.

Street Topology Based Routing proposed new update to A-STAR where ever junction node will have the information about road connectivity. A node at the junction will compute the link up to the next junction and it will find that link is up or down. This junction node is called as master node. So every junction will have a master node and they will have a table about the links to the next junctions. And they will broadcast there link information to other master links [37]. It calculates the geographic distance from packet's current position to the street where destination nodes currently present, and send the packet to next node which has less geographic distance then the current position.

Greedy Traffic Aware Routing protocol [40] uses new parameter traffic density to find robust routes. This protocol has two parts. Junction's selection: In this the protocol selects the junctions through which the packets must go through. The selection of these junctions are done dynamically and one by one, it calculate a traffic density and the curve-metric distance (the distance measured when following the geometric shape of a road.) for next junctions when a vehicle wants to forward the packet. The source vehicle or an intermediate vehicle looks for the position of the neighboring junctions using the map. Forwarding data between two junctions: Once we found the destination junction, the improved greedy strategy is used to forward packets towards the selected junctions. The current node marks all data packets with the location of next selected junction. When a packet is received by a node, it forwards the packets to the node which is geographically closest to destination node. The selection of next node is done by current node based on the parameter (velocity, direction and the latest known position) recorded in neighbors table. If the packet reached to local maxima then it will follow the "carry and forward" strategy. The node carry the packet until it reached to next junction or any other new node comes to its range, As soon as it reached to next junction or any other new node it will forward the packet.

TOpology-assist Geo-Opportunistic Routing (TO-GO) is a geographic routing protocol. It use the knowledge acquired via GpsrJ+'s 2-hop neighbor information and it select the best target forwarder from the forwarding set between the sender and the target node. It not uses previous approaches where a forwarding region is defined between the current sender and the destination. The target node is next promising node other than the junction node which is normally chosen by greedy or recovery mode [34].

III. DND TOLERANT ROUTING PROTOCOL

DND Routing Protocol work as below mentioned steps.

ALGORITHM DND_PROTO

Step 1: Initialize Required Parameters.
Step 2: Calculate Average Density ($AVG_{D)}$ of Network through Hello packet and send that to every node.
Step 3: Calculate $TTL=C/(1+AVG_D)$.
Step 4: Fetch Neighbour node L_D for source Average Array.
Step 5: Calculate $DRP = (L_D / T_D) *100$
Step 6: Set Mode=N and call DND_PROTO_N if current Mode=D && $DR_P > U_T$
Step 7: Set Mode=D and call DND_PROTO_D if current Mode=N && $DR_P > L_T$
This algorithm will run every fixed amount of time so that it can move from DTN to NDTN or NDTN to DTN mode. Rest of the supporting algorithm will work as below.

ALGORITHM DND_PROTO_D

Step 1: Initial Packet will be forwarding packet as a broadcasting message with Destination Node, Node Forwarder and Current time.
Step 2: Every node save first catch Node forwarder who forward packet ID 945 and forward it to another node in its range for particular period of time depend on TTL.
Step 3: Increase TTL value if required by value of 45ms for maximum 4 times otherwise drop packet.
Step 4: As soon as destination receives, it will reply to backtrack path to the source node.
Step 5: After receiving reply source node will start sending packet with packet id 0,1,2,…,944,0,1, ….

ALGORITHM DND_PROTO_N

Step 1: Apply Compass Routing and find Geographic location of all nodes in route.
Step 2: Also find out euclidean distance of destination node from source node.
Step 3: Select node in the direction of destination node with difference of T_{theta} angle depend on distance and location until it will arrive at destination node.

ALGORITHM AVG_DEN

Step 1: Initialize Average Array to zero for all nodes.
Step 2: Send Hello packet to all neighbors and set Average Array.
Step 3: Forward to next node until all node will initialize Array.
Step 4: Take Average of Average Array and return it.

IV. COMPARISON OF DTN AND NDTN ROUTING PROTOCOLS

Comparison is as shown in Table 3.1 on different parameter.

Table 3.1 Comparison of DTN based VANET routing protocols.

Protocol	Forwarding Metrics / Propagation Model	Topology assumption / Mobility Model	Implementation/ Best Scenario	Target/Delivery
VADD	Density of nodes and Priority	4000x3200m 150,210 vehicles	NS2	PDR, Packet delay and traffic overhead

GeOpps	Density of nodes	260,000 vehicles 15 km × 15 km area	OMNet++	Optimize PDR, delay, and Overhead
GeoDTN+	Probability of nodes connection	1500x4000m	Qualnet 3.95	Packet delivery ratio
PRBS	Velocity-based probability	20 km one way road vehicle; interarrival time: 5–120 seconds	Java-based Simulator	Reduce packet Replication
ASCF	Minimum outage time of node	Not available	Numerical analysis	Maximum Connectivity
DARCC	Location of destination moving direction of nodes	100 vehicles in 3000 ×3000area; road has 4lanes; average speed of node60 km/h	Opportunistic N/W Environment Simulator	Reduce packet Replication
DAWN	Density of nodes	5000 taxi in Beijing city 30 days of trace 25 × 25 Manhattan grid	Simulation with real environment Data	Optimize channel Usage
GeoSpray	Density of nodes and different data size	100 nodes with an average speed 50 km/h, time: 6 hrs	VDTNsim	Optimized routing with minimum delay
FFRDV	Velocity of node	1500×1500m area average speed of 60 km/h	NS2	Minimize intermittent nodes
MaxProp	Hop count historical data	30 Buses in 1502 miles; 60 days of trace	Real environment (UMass DieselNet)	Gives priority to packets in buffer
GSR	Road blocking	Videlio,M-Grid mobility	City	Best Effort
ASTAR	Road blocking	M-Grid mobility	City	Best Effort
CAR	Probabilistic shadowing	MTS	City	Best Effort
GPCR	Road blocking	VanetMobsim	City	Best Effort
GPSR	Probabilistic shadowing	MTS	Highway	Guaranteed
CBF	Two-Ray ground	Random way point	Highway	Best Effort
PDGR	-	-	City	Guaranteed
LOUVRE	Road Blocking	VanetMobsim	City	Best Effort
GPSR+ AGF	Probabilistic shadowing	MTS	City	Guaranteed
PRB-DV	-	-	-	Guaranteed
DGR	-	-	City	Guaranteed
PDGR	-	-	City	Guaranteed
GPSRJ+	Road blocking	VanetMobsim	City	Guaranteed
STBR	-	-	City	-
GyTAR	Free space	Proprietory	City	Guaranteed
TO-GO	Road blocking	VanetMobsim	Highway	Guaranteed

Conclusions

This paper proposes new DND routing protocol in VANET. From given description, it is clear that proposed algorithms will perform better in both DTN and NDTN mode of routing with best PDR amongst all previously available algorithms.

References

[1] Trivedi B., Patel H., Survey Paper on Reactive (on-demand)-Topology Based Routing Protocol in VANET,IJCSET, Vol-6 Issue-2,Feb 2015, pp48-52

[2] Trivedi B., Patel H.," Enhancement in AODV-reactive topology based routing protocol in VANET", IJSRD, Vol-3 Issue-8, Oct 2015, pp469-472

[3] A. Bujari, C. E. Palazzi, D. Maggiorini, C. Quadri and G. P. Rossi, "A Solution for Mobile DTN in a Real Urban Scenario," WCNC 2012 Workshop, April 2012.
[4] Kumar, S., S. H. Ahmed, U. Qasim, Z. A. Khan, N. Amjad, M. Q. Azeem, A. Ali, M. J. Ashraf, and N. Javaid. "Analyzing Link and Path Availability of Routing Protocols in Vehcular Ad-hoc Networks." (2014).
[5] Xing, Kai, Weili Wu, Ling Ding, Lidong Wu, and James Willson. "An efficient routing protocol based on consecutive forwarding prediction in delay tolerant networks." International Journal of Sensor Networks 15, no. 2 (2014): 73-82.
[6] D. Yu and Y.-B. Ko, "FFRDV: fastest-ferry routing in DTNenabled vehicular Ad Hoc networks," in Proceedings of the11th International Conference on Advanced Communication Technology (ICACT '09), pp. 1410–1414, February 2009.
[7] Panchal J., Patel H., "A Review on Multi-Hop Message Dissemination Strategies in VANET Environment", IJSRD, Vol-3, Issue-1,Apr-2015, pp-803
[8] D. Wu, G. Zhu, and D. Zhao, "Adaptive carry-store forward scheme in two-hop vehicular delay tolerant networks," IEEE Communications Letters, vol. 17, no. 4, pp. 721–724, 2013.
[9] M. J. Khabbaz, W. F. Fawaz, and C. M. Assi, "Probabilistic bundle relaying schemes in two-hop vehicular delay tolerant networks," IEEE Communications Letters, vol. 15, no. 3, pp. 281– 283, 2011.
[10] A.AHanbali, M.Ibrahim,V.Simon, A Survey of message diffusion protocols in Mobile Adhoc Networks, 2008
[11] J. Burgess, B. Gallagher, D. Jensen, and B. N. Levine, "MaxProp: routing for vehicle-based disruption-tolerant networks," in Proceedings of the 25th IEEE International Conference on Computer Communications (INFOCOM '06), vol. 6, pp. 1–11, Barcelona, Spain, April 2006.
[12] Makwana K., Patel H., "Survey Paper on Proactive Topology Based Routing Protocol in VANET", IJSRD, Vol-3, Issue-3,May-2015, pp-846
[13] Cheng P.,-C., Weng, J.-T.,Tung,L-C.,Lee,K C.,Gerla.M.,and Harry J., (2010), "GeoDTN+Nav: Geographic DTN Routing with Nvigation prediction for Urban Vehicular Environments", 2010
[14] J. Leguay, T. Friedman, and V. Conan. Evaluating mobility pattern space routing for DTNs. In Proc. Of IEEE INFOCOM, Barcelona, Spain, Apr 2006
[15] H.Moustafa, Y.Zhang, Vehicular Networks, Techniques, Standards and Applications, CRC press, 2009.
[16] I Leontiadis, C Mascolo, Geopps: Geographical opportunistic routing for vehicular networks, World of Wireless, Mobile and Multimedia Networks, 2007. WoWMoM 2007. IEEE International Symposium, on a , vol., no., pp.1-6, 18-21 June 2007.
[17] Zhao, J.,and Cao, G., VADD: Vehicle-Assisted Data Delivery in Vehicular Adhoc Networks, In proc of IEEE INFOCOMM, Barcelona, Spain, Apr 2006
[18] W.-Z. Lo, J.-S. Gao, and S.-C. Lo, "Distance-aware routing with copy control in vehicle-based DTNs," in Proceedings of the IEEE 75th Vehicular Technology Conference (VTC '12), pp. 1–5, IEEE, June 2012.
[19] Q. Fu, L. Zhang, W. Feng, and Y. Zheng, "DAWN: a density adaptive routing algorithm for vehicular delay tolerant sensor networks," in Proceedings of the 49thAnnualAllerton Conferenceon Communication, Control, and Computing, pp. 1250–1257, Monticello, Ill, USA, 2011.
[20] V.N.G. J. Soares, J. J. P. C. Rodrigues, and F. Farahmand, "Geo-Spray: a geographic routing protocol for vehicular delaytolerant networks," Information Fusion, vol. 15,no. 1, pp. 102–113, 2014.
[21] Upadhyay R., Patel H., "AODV Routing Protocol in VANETs in Comparison with OLSR and DSR", IJSRD, Vol-2, Issue-11,Jul-2015, pp-329
[22] 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.
[23] Seet, B.C., et al., A-STAR: A mobile ad hoc routing strategy for metropolis vehicular communications. Networking 2004, 2004. **3042**: p. 989-999.
[24] Naumov, V. and T.R. Gross. Connectivity-aware routing (CAR) in vehicular ad hoc networks. in IEEE INFOCOM 2007: 26th IEEE International Conference on Computer Communications, May 6, 2007 - May 12, 2007. 2007. Anchorage, AK, United states: Institute of Electrical and Electronics Engineers Inc.
[25] Lochert, C., Mauve, M., F¨ussler, H., and Hartenstein, H., "Geographic routing in city scenarios," SIGMOBILE Mob. Comput. Commun. Rev., vol. 9, no. 1, pp. 69–72, 2005.
[26] 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.
[27] H. Füßler, J. Widmer, M. Mauve, and H. Hartenstein, A novel forwarding paradigm for position-based Routing (with implicit addressing), Germany, 2003.
[28] C.J. Adler, Information dissemination In vehicular ad hoc networks, München, 2006.
[29] K.prasanth, Improved packet forwarding Approach in vehicular ad hoc networks Using RDGR algorithm, 2010.
[30] Hassnaa Moustafa , Yan Zhang " Vehicular Networks Techniques, Standards, and Applications " ,CRC press ,2009.

[31] Lee, K., Le, M., Haerri J., and Gerla, M. (2008), "Louvre: andmark overlays for urban vehicular routing environments," Proceedings of IEEE WiVeC, 2008.

[32] Naumov, V., Baumann, R., Gross, T. (2006), An evaluation of Inter-Vehicle Ad Hoc Networks Based on Realistic Vehicular Traces, Proc. ACM MobiHoc.

[33] Jiayu Gong, Cheng-Zhong Xu, and James Holle (2007), Predictive Directional Greedy Routing in Vehicular Ad hoc Networks, IEEE 27th International Conference on Distributed Computing Systems Workshops.

[34] Lee, K.C.; Lee, U.; Gerla, M. (2009), TO-GO: TOpology-assist geo-opportunistic routing in urban vehicular grids, Wireless On-Demand Network Systems and Services, 2009. WONS 2009. Sixth International Conference, pp.11-18.

[35] Schnaufer, S., Effelsberg, W. (2008), Position-based unicast routing for city scenarios, World of Wireless, Mobile and Multimedia Networks, 2008. WoWMoM 2008. International Symposium on a, vol., no., pp.1-8.

[36] Lee, K. C., Haerri, J., Lee, U., and Gerla, M. (2007), Enhanced perimeter routing for geographic forwarding protocols in urban vehicular scenarios, Globecom Workshops, 2007 IEEE, pp. 1–10.

[37] Forderer, D (2005). Street-Topology Based Routing. Master's thesis, University of Mannheim.

[38] 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.

[39] Jerbi, M., Senouci, S.-M., Meraihi, R., and Ghamri-Doudane, Y. (2007), An improved vehicular ad hoc routing protocol for city environments, Communications, 2007. ICC '07. IEEE International Conference, pp. 3972–3979.

[40] Moez Jerbi*, Rabah Meraihi*, Sidi-Mohammed Senouci*, and Yacine Ghamri-Doudane, "GyTAR: improved Greedy Traffic Aware Routing Protocol for Vehicular Ad Hoc Networks in City Environments", Proceedings of the 3rd international workshop on Vehicular ad hoc networks Sep 2006 ACM pp 88-89

[41] Holger Fußler a, Jorg Widmer a, Michael Kasemann a, Martin MauveHannes Hartenstein, "Contention-based forwarding for mobile ad hoc networks", 2003 Elsevier, Ad Hoc Networks 1, 2003, pp 351-369