A Theoretical Research on Routing Protocols for Vehicular AD HOC Networks (Vanets)

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ABSTRACT--- In the past few years we observe various protocols for Vehicular AdhocNETworks(VANET) considering certain features. VANET's are powerful in dealing with changing environmental conditions and high movability of vehicle hence protocols depending on position or geographic routing protocols are proved best and enough.MobileAdhocNETwork(MANETs) use IP address whereas these protocols use geographic location of the vehicle by using the best forward path.VANETs protocols will neither exchange link state data nor maintains established route as in MANET. Hence VANET is powerful and has high mobility. By checking various designing protocols future enhancements are done based on advantages and disadvantages of geographic based protocols. The protocols include the geographical and topological routing techniques.

Keywords—VANET, Routing, Adhoc, Network

I. INTRODUCTION

One of the applications of MANET is VANET[1] which gets an Intelligent Transport System (ITS) plan to improve road safety by normalizing the operation of vehicles. As these protocols neglect the costly infrastructure as it is mostly wireless which is cheap and also reliable which can be installed at roadside to in vehicle thus alerting driver early to danger. It also give traffic,weather conditions along with internet service which makes trip comfortable.

VANET is self-organized and movedautomatically along the roads while communication as V2V as vehicle to vehicle andV2I vehicle to infrastructure and road infrastructures in the range or within a multi-hop neighbouring nodes acting as relays forinter vehicle communication represented in fig.1. Wireless communication can also help in knowing traffic conditions and accidents. V2V communication though does not have permanent connectivity due to movability but is efficient. V2I communication gives basic internet services by communication with backbone networks by best use of sharedresources and levy's given by Road side Units access points still it stands insufficient for road safety applications as the roadside infrastructure is not good at delivery times.

Vehicle having devices which can communicate without wires,positioning systems and digital maps form a VANET.IEEE 802.11p and wave combined give a DSRC standard [2] for VANET. Wave standard is the network layer and MAC layer of OSI model. IEEE 802.11 p is used at physical layer.DSRC forms a standard for adhoc network by giving high data transfers and low latency transmission in smaller regions. DSRC is used for both V2V and V2I infrastructures where vehicle speeds is greater than 200 km/h and between 30 to use for both 1000 m with 6 to 27 Mbps bandwidth.

Routing of data packets becomes difficultin VANET as it structure changes frequently and has vehicles with high speed and high mobilitywhich makes it difficult to check with adhoc networks [3][4][5][6]. Consideringlocation based and high trafficking cases DSR compared to topology based routing ,the requirements are different[7][8]. As Vehicle are equipped with GPS now a days,the every vehicle has got its own geographic location and is battery power and storage space are not limited.Though this systems have certain pattern for mobility,they are highly dynamic compared to general adhoc networks.

VANETS routing protocols are divided into 5 categories.

1. Ad-Hoc
2. Cluster based
3. Broadcast
4. Geocast
5. Position based

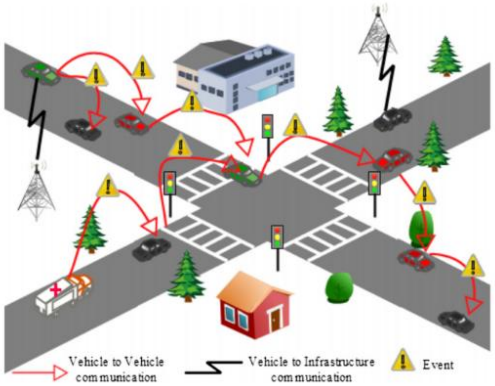

Fig 1: VANET structure

Out of the above,position based is a trending one and performs better comparablewith high mobility [9][10] it uses geographic location to check with direction of data forwarding,this is decided based on geometric parameters that choses a direct neighbour which is close to destination

Revised Manuscript Received on June 10, 2019.

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called Greedy Forwarding [11]. This algorithm require position information as it is based on direct neighbour. Every node here should be aware of

1. Its and neighboursposition
2. And its final destination

Obtaining node using GPS, position of the direct neighbours is communicated through beaconing messages having present position and direction along with speed.Hence source node requires such information along with current geographic location of destination to include packet header,this info is given by location service [12].

The disadvantage of greedy forwarding is when there is no info available or no neighbour close to destination which turn to risk of packet getting stuck in void. To avoid this a plan is designed to transfer packet to node close to destination rather than a void node. Using right hand rule [11] we can discover a node as such. IF node Xx reaches void the next edge to b crossed is the counterclockwise from the virtual arc formed by x and the destination.

A protocol moves to greedy mode as soon as it finds a node closer to destination. Other method is when void occurs, node carries the packet to possible neighbour or till it reaches destination called as Carry and forward approach. Some methods will check with a new path instead of checking with above methods.

II. CHALLENGES IN THE DESIGN OF POSITION-BASED ROUTING PROTOCOLS FOR VEHICULAR AD HOC NETWORKS

VANETs should have different structure and characteristics which could make it different from MANETs and other protocols. The below are proposed characteristics

A. High dynamic topology

VANETs are dynamic as they work on vehicular movement with high speed which does not happen in sensor and Adhoc networks where structure does not change. Consider a vehicle with speed 25 m/sand 200 m radio coverage hence will have link for 8 sec,which is a small duration which makes communication difficult.

B. Frequent network disconnection

There would be more network partings due to density variations as the vehicle keep on moving which occurs in spent area where we have radio obstructions. Vehicle with high density gets good connectivity between nodes hence good communication goes on and vice versa.Hence it becomes important to check alternative connectivity and disconnections also.

C. Mobility modelling and prediction

Prediction of nodes in a moving vehicle is quite difficult as the movement changes but depending on traffic environments ,speed ,drivers behaviour we can plan a network using a traffic simulator that can add effecton results [13][14]. Packet delivery reduces when a real vehicle traces are taken for simulation [15] when compared to unreal traces which is shown in [10]. Hence movable model is considered more likely along with real prediction which increases performance of routing protocol.

D. Propagation model

VANETswill getpropagation issue due to buildings,trees and vehicle hence it has to get a good model checking with interference with other vehicles.

E. Communication environment

MANET is restricted to space like indoor or outdoor whereas VANETs depend on vehicular movement related to infrastructure on road and mobility changes from highways to city area. Highways have high speed vehicles moving compared to city area with average speed with various crossroads junctions which obstructs V2V communication.

F. Delay constraints

Though MANETS don't need high data rates they have hard delay limitations. VANETs gives safety advices hence require minimum E2E delay as delay in reception of message may cause danger hence deliver time should be less.

G. Quality of Service (QoS)

This is one of the service needs essential for a communicating network .QoS for VANET becomes difficult hence we have to take up a method which can quickly and efficiently set up routes when the present routing paths are no longer available due to velocity changes ,position an topology changes or the vehicular distances.

VANETs has got ability to upgrade road safety,mobility and green environment which grabs more attention and it also does not base on fixed things which results in link breakages [16]. Hence routing protocol is responsible for the path selection where several methods are given to improve routing over vehicular networks. Important factors to be checked are velocity between connected vehicles,their density along with channel condition.

VANETs have got resistance to any kind of attacks and has high security [17]. Authentication can be said to be efficient if it has less complexity, low delay. VANETs are proposed for cluster based and high trust degree which is direct and indirect trust degree combination.Depending on trust degree CHs are selected later every vehicle is checked by verifiers and sender gives digital signs the messagesand encoded using a key given by trusted user and then is decoded to destination thus providing unique identity to sender and receiverand giving proper authentication with high security and less overhead and delay.

VANETs is preferable in real time application due to its cost of implementation when compared with other networks.Parameters considered in VANETS like topology,omnipresent,flow of traffic,and speed of vehicle are so precise that make simulation a simple task [18]. As many parameters were considered in VANET this paper is totally focused on packet error modelling of VANET simulation. In order to get best results we aim to test the three different densities of nodes and three channel capacities. Performance is only measured depending on packet error model results.The evaluation is totally based on multi hop scenarios. This is simple technique in which SNR Does not exceeds its threshold and errors begins to

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appear.This is not considered in all cases for example high traffic load

VANET routing protocols are of two types

1. Geographic routing protocols
2. Topology Based Routing Protocols

III. GEOGRAPHIC ROUTING PROTOCOLS FOR VANETS

The general classification of the VANET protocols based on the application they are used for is as follows:

- Non-Delay Tolerant Vehicular Ad hoc NETworks (Non-DTVANETs)
- Delay Tolerant Vehicular Ad hoc NETworks(DTVANETS)
- Hybrid

A. Non-DTVANETs location depended routing protocols

The non-deferment Tolerant Vehicular Ad hoc system of connections (Non-DTVANETs) protocols will not deal with infrequent connectedness. They assume a deeply colonized system of connections and utilizes the rapacious approach to on-ward the packets of information. Anyhow, the rapacious on-warding scheme can decline if there are no bystanders near to the goal when compared to the present node itself. In this condition, the developers mentioned that the packet has arrived at regional choice. To handle with specific conditions, various rehabilitation paths are projected in the protocols of this classification.

GPRS: This explains about the location-depended routing protocols known as Greedy Perimeter Stateless Routing whichever turn into one of the major repeated work [11]. It will have a regular mode known as greedy forwarding mode and a restoration technique known as circumference forwarding utilized in the condition where a regional optimum takes place. The example of greedy forwarding and circumference forwarding appears in fig.2.

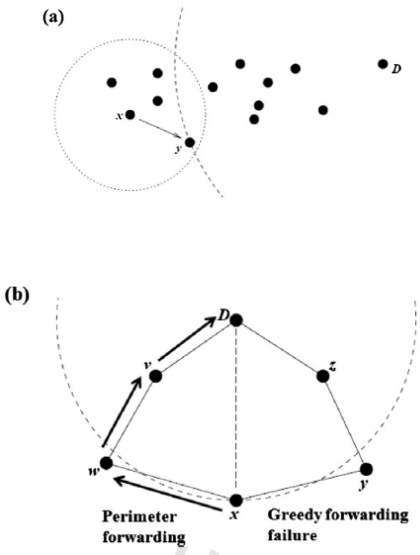

Fig.2.GPSR Protocol: (a)Greedy forwarding and (b)Perimeter mode.

The simple representation of ravenous advancing happens. Here, x needs to exchange a parcel intended for D. x progresses the bundle to y, as the length among the y and D is less when contrasted with the separation among the D and any of x's outstanding spectators. This voracious sending method is reduplicated similarly as the bundle degrees D. at the point when a neighborhood ideal happens, at that point the boundary sending of GPRS uses the long-realized right-hand rule for converging the chart.

GSR: To overpower the due dates of GPRS in the presence of a radio hindrances and discharges as it is the condition for metropolitan plans, [10] ventures topographical source steering. GSR partners avaricious directing and geography attention to the way to guarantee a propitious course in the presence of radio obstructions and uses backwards to voracious structure as a nearby rearrangement system. In GSR, if a source hub needs to exchange the parcel of data to the objective, it quantifies the précised path to the objective using the calculation known as Dijkstra calculation, and relying upon the information of the road map, the source hub picks on this entrance the request of cross intersections through which the bundle of data must be sent.

SAR:by taking the help of the GSR protocol spatially aware packet routing works and the utility of the spatial recognition to anticipate the constant local optimum and to overcome the failure of the routing in prior [19]. In the spatially aware packet routing, the spatial design is developed through the derived topology data and is mentioned as graph G(E;V) where V is the meaningful places and E is the interrelationship among the places. Rather than forwarding the information by the packets to the bystanders whichever is geographically the nearest to the upcoming interchange on the precise way, in SAR every promoting mode maps initially the locations of its bystanders into the graph model, and selects the bystander with the precise path to the goal including the GSR as the upcoming bounce.

CBF: Connection-Based forwarding [20] is a topographical routing protocol which does not need any aggressive broadcasting of beacon information's. The information packets are transmitted to the entire bystanders. The next decision is to how to forward the packet depended on a distributed timer-depended links method which acknowledges the highest convenient node forwarding the packet and restraining the remaining possible forwarders. The CBF information packets will have the locations of the node which has ethically sent the packets known as final-hop, the ID and the location of the last conclusion and an ID of the packet. A node which receives specific packets and is not the last target, it places a timer to find, when the packet has to be forwarded. The value of the timeout is measured depending on the evolution that the node gives against the destination packets. The stride of the packet for a represented node I is mentioned as

$$pi = dist(l, d) - dist(i, d)$$

Dist = Euclidian distance

I & d = the last hop positions

The value of the timer is calculated as

$$t = \begin{cases} \tau\left(1 - \left(\frac{P_i}{p_{max}}\right)\right) & 0 \le P_i < pmax \\ \infty & otherwise \end{cases}$$

p_{max} = Range of the radio

τ = highest forwarding delay

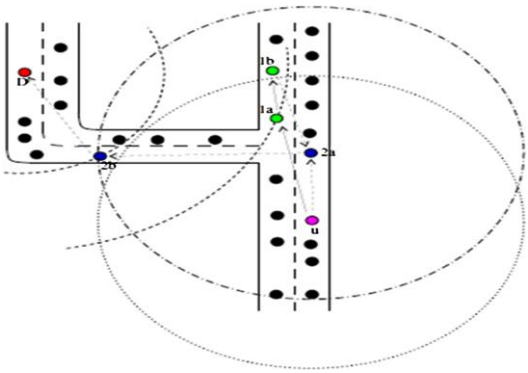

Fig 3: Greedy forwarding vs. restricted greedy forwarding

GPCR:the essayists in [21] anticipated insatiable border organizer steering. They advantage from the truth that the design of urban avenues through a characteristic overseer chart to use the RHR when territorial ideal emerges without using the calculations for plan emerging diagrams whichever are exceedingly costly in overhead conditions. To avoid the hindrances of radios while picking the forthcoming bounce voraciously, a hub known as composed hub, whichever is a hub present at the purpose of interrelation, is viewed as that a non-chief hub alike if the regulating hub isn't that much closer to the objective terminal. In fig.3, appearing of covetous sending versus limited ravenous sending.

GPSR+AGF: The writers of [17] majorly observed two issues with GPSR in vehicular ad-hoc networks. Initially because of the flexibility of the vehicles, the table of the bystander nodes frequently consists of out-of-the-date data of the bystander's position. This issue can be overcome by enhancing the bottleneck and promising destructions. The next issue is that the area of the target admitted in the header of the packet is not at all refurbished regardless of the target is affecting. Hence for resolving those two issues the developers suggested a method known as Advanced Greedy Forwarding (AGF) where exhortation on the energy and the direction of the vehicle are participated in the signal data's alongside the whole voyaging time and an opportunity to work the parcels. In this way, the up and coming spectator is chosen as for the information of the increasing speed vectors supplied in the table of onlooker, with the whole voyaging time, each propelling hub can upgrade the present zone of the objective.

GyTAR – The key component of upgraded Greedy Traffic Aware Routing convention [22] is to consider the thickness of the street before sending the information bundles. It embraces a crossing points based directing way to deal with course the information parcels. The following crossing points are picked powerfully and one-by-one so as to consider the constant vehicular traffic variety. To choose the following between segment goal, a vehicle getting a parcel at a crossing point begins by deciding the contiguous convergences. At that point, it doles out a score to every crossing point. This score considers two parameters: (I) the curvilinear separation D_j between the applicant convergences of the goal hub, and (ii) the thickness of the traffic T_jat the street section depending the present crossing point to the competitor convergence. In this way, the crossing point with the most astounding score S_jis the nearest to the goal hub and for which the traffic thickness is sufficiently high to achieve it.

B. DTVANETs position-based routing protocols

DTVANETs concentrates at vehicular network application suffering with delay and unsynchronized data transfer which can take some data loss. And also makes use of various plans reduce recurrent disconnections.Such networks include:

VADD – Vehicle-Assisted Data Delivery [23] using carry-forward method targets at reducing E2E delay for both dynamic and static vehicles to a scant destination.It utilizes expected vehicle versatility which thusly has limited traffic example and street format where vehicles are required to convey computerized maps with information giving road level data, traffic thickness and vehicle speed at various occasions in multi day. VADD underpins the beneath modes relying upon the situation of hub conveying the bundle.

Intersection node:It stores the packets which are moving n outgoing direction and tries finding a contact value for forwarding the packet in same direction. In fig 4, Routing with GPCR model represented.

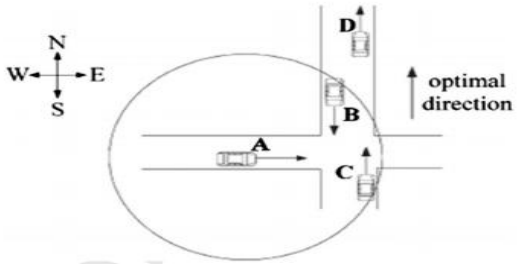

Fig 4: Routing with GPCR and the critical junction node (coordinator)

Choosing the next vehicle in order to forward packets [23]

In order to move a packet in required direction, let's say in north,the available contacts would be A,B from south and C from north. B is nearer to north and utilizes wireless communication whereas C moves in packet forwarding method using one of the protocols Location First Probe (L-VADD) and Direction First Probe (D-VADD). LVADD checks with close contact in the direction of next hop and D-VADD also follows same but it chooses contacts moving in the selected direction.

C. Hybrid position-based routing protocols

To utilize the networks with partial connectivity Non-DTVANETs and the DTVANETs can be used jointly.

Greedy method is used if the network is dense and if network disconnection occurs vehicle movement is used to forward packet till it reaches neighbour node or destination.

Greedy mode, Perimeter Mode and Delay Tolerant vehicular mod are used by GeoDTN+NAV – [24],which is a combination of Non-DTVANETs and DTVANETs.In Greedy mode first packet is forwarded and later using perimeter mode packet targets local optimum failing which DTVN mode is used depending on movement to deliver packet. Greedy mode works the same as GPCR where forwarding of packets happened among junctions where routing decision making nodes appear. Perimeter mode is used as recovery mode if local optimum is reached. Non-DTVANET mode to DTVANET modeare reversed by knowing the network connectivity based on hop count which packet has moved in perimeter mode, the neighbor's delivery quality anddirection in line to destination.Quality is given by Virtual Navigation Interface (VNI).

Fig 5: Virtual Navigation Interface

Expecting each vehicle is furnished with a Virtual Navigation Interface (VNI): (I) they order vehicles dependent on the traffic design into four general classifications:

1 – Deterministic (Fixed) Route: Vehicles entirely pursue pre-arranged courses. These vehicles won't go astray far from their courses. Likewise, moving bearings can be effectively known with their courses

2 – Deterministic (Fixed) Destination: Vehicle can course on different ways to achieve goal.

3 – Probabilistic (Expected) Route/Destination: vehicle may pursue most regular ways to achieve goals. The steering may change as per proposals.

4 – Unknown: Vehicles couldn't reveal data about their course, however they don't move arbitrarily either. (ii) Retrieving course information and certainty from vehicles:

1 – Route data: It speaks to the vehicle's course data. Data comprises of definite way, goal and the bearing of vehicle it relies upon basic information source. As in Fig. 5, the VNI may most likely recover the point by point way data from a route framework while it might just recover vehicle's heading from an Event Data Recorder (EDR). What's more, the VNI can likewise recover the preconfigured course data.

2 – Confidence: Confidence bargains about the likelihood that the vehicle's development would regard the given course data. A certainty thoroughly relies upon level of course data in the event that it is with 0% it characterizes vehicle moves in irregular way in the event that it is 100%, at that point it pursue course information i.e vehicle development history.

GeoDTN+Nav beats GPCR and GPSR as far as bundle conveyance proportion as it enhances the diagram openness to instruction by utilizing the defer tolerant store-convey forward answer for alleviate the effect of the discontinuous network. Be that as it may, in an inadequate system, GeoDTN+Nav is probably going to fall back to the Delay Tolerant mode much of the time. This builds the dormancy and furthermore, diminishes the parcel conveyance proportion.

CMGR - By checking with delay caused due to vehicular traffic on roads and to improve packets received, using Connectivity-awareMinimum-delay Geographic Routing protocol [25] roads connectivity is check is network is scanty.Gateway (GW's) where backhaul arrange connections are conveyed among the roadside and if any vehicle needs to get a way to any GW, course revelation needs to occur and furthermore communicated to organize. Among the RD's gathered at GW, it picks an appropriate one according to CMGR rationale to produce Route answer (RR) message. RR is either send back to target vehicle or conveyed utilizing convey and-forward strategy till it achieves neighborhood ideal happens.

At the point when the RR is returned back to the objective vehicle, and it found that it has changed its underlying position the procedure to follow where precisely target is known from its speed vector in its guide bundles. The outcomes for CMGR observed to be better 25% when contrasted and VADD and A-STAR for the high vehicle densities and goes up to 90% better for the low vehicle densities. In any case, the following component proposed for a moving goal will surely fall flat on the off chance that we won't discover any hints of vehicle in a meager territory.

ROAMER – Roadside Units are the message switches [26] which are utilized to send the parcels to inaccessible areas within the sight of RSU (Road side unit) in VANETS so as to verify it will create arbitrary number as character rather than its unique personality which makes information exchange secure. A vehicle S requesting to send a group P to a far away vehicle D can send the bundle to the nearest RSU (R1) as it uses most constrained way count if RSU isn't in range it will slant toward RSU2.The strategy uses to trade data is multi skipping. This last joins position-based guiding and pass on and-sending framework to guilefully course messages to and from the RSU in thick and pitiful framework conditions. The fundamental motivation of ROAMER behind using RSUs is that the RSUs are a settled system. It is significantly less requesting to send a package to a settled nearest RSU than to a remote moving article. The deferral of sending the package through the settled RSU framework will be not actually through the VANET; if any delay in trading data, by then there will be mishap in trading groups.

Topology Based Routing Protocols

As routing protocols make active decisions for routing in network hence are used mostly to transfer data. Topology Based Routing Protocols are of two split as Proactive and Reactive which have finite performance compared to position based routing protocols [27] as they need an extra node while the routing decision process.

A. Proactive Routing Protocols

The proactive steering conventions keep up tables speaking to the topology. In these table qualities changes over and over and sends data from one hub to other.it is likewise called table driven conventions because of its inclination. We can discover two sorts refreshes relies upon occasional and activated updates because of its capacity misfortune and data transmission in the system [28]. In this table size increments because of its heap because of that goal sequenced separation vector (DSDV) and fisheye state directing (FSR) Proposed. Proactive conventions are not fitting for expansive system due to overhead in directing tables [29]. These conventions are commonly base on most limited way calculations.

DSDV - Loop free routes and single source to destination along with distance vector shortest path algorithm is made available in Routing (DSDV) Destination Sequence Distance Vector Routing (DSDV). Protocol incremental and full dump are thetwo protocolsused where full dump send routing information whereas incremental updates full dump utilizing whichdegrades the bandwidth and upgrades the overhead in networks. This is not that usable for large networks for bandwidth and updating procedures [30-31].

OLSR-Depending on standard link-state algorithm there is a point to point algorithm designed as Optimized Link State Routing Protocols (OLSR) which is a multipoint relay for best message and flooding process for route setup and maintenance.This also reduces active relays for covering neighbours[32]. This increase accuracy and stability of data network.OLSR has MPRS and Optimized State which is covers hops and sends link information for route maintenance. Every node can transmit data once and also unselected packets cannot transmit updates. The advantage being routes and destinations known and are checked before operation and also nodes move fast as to compute optimal node delay which might be impossible in some cases[33].

Thee major advantage of this protocol is the all routes and destinations are known and maintained before the operation. On the other hand, the nodes are moving fast, due to calculation of optimal node may be impossible in some cases.

FSR-Building table for nodes and upgrading network related data to other nodes is done by Fisheye state routing protocol (FSR) which also lowers the updated message size which ismeasurable for large networks butthe accuracy is not enough and also to there isincrease in network routing table size. FSR aims at lies out of scope of source nodehence discovery of route fails

B. Reactive/Ad-hoc based routing

Reactive protocols cannot have data maintained for structural changes as proactive protocols do not also queries flow when source node transmits data and also the discovered node is stored until other nodes are accessible. Have low bandwidth due to low route discovery mechanism Popular Reactive protocols are Dynamic Source Routing (DSR) and Ad-hoc On-Demand Distance Vector routing (AODV).

AODV-AODV has got DSDV and DSR algorithms which makes it reactive and puts in demand. It works on various routing protocols giving different process by distributing packet and Route Request (RREQ) packet in a way that maximum hops are obtained by forwarding packet through neighbours till it finds active route as RREQ has no data about active route. Packet delivery ratio,routing overhead and path optimality [34] these parameters makes AODV efficient which is proved by many analysis. Future improvements are on AOMDV, S-AOMDV, RAOMDV, SD-OMDV which are on demand protocols.

AOMDV-For calculating disconnections and multiple loop free depending on single path protocol importance AODV is added with Ad-hoc On-demand Multipath Distance Vector routing protocol called as AOMDV which has precedence with information availability in AODV protocol and cam handle multiple loop free with low overhead coordination hence is best compared to AODV. Link disconnection where last hop disjoints give us better information [35] is mostly used as its best for high mobility [36].Data such asnext hop, last hop, hop count, and expiration timeout are additional addedin AOMDVstructural table of AODV.

The comparison of routing protocols in Vehicular Ad Hoc Networks represented in table 1.

Author	Protocol	Analysis	Parameters
Geographic based routing protocols			
B.Karp, H.T. Kung	GPRS (Greedy Perimeter Stateless Routing)	Optimal No.of hops, pause time, length of routes independent	Packet delivery high, Routing overhead low
C. Lochert, H. Hartenstein	GSR (Global State Routing)	High mobility, Transmission range more	Latency period, No.of hopes more
J. Tian, L.Han, K. Rothermel, C. Cseh	SAR (Security Aware Ad-hoc Routing)	Priority of sender node high, Communication overhead more	PDR more, Delay low, Avg hop count, Avg packet size
H. Fubler, H. Hartenstein, J. Widmer, M. Manve, W. Effelsberg	CBF (Contention Based Forwarding)	Forwarding overhead low, Limiting area usage	Throughput high, Transmission cost high

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K. Shafiee, VCM. Heung	CMGR (Connectivity aware minimum delay geographic routing)	Vehicle density calculation, Retransmit messages due to collision	PDR high, Delay low, Dropping ratio low
Topology based routing protocols			
Ade S, P. Tijare	DSDV (Destination Sequenced Distance Vector routing)	Own routing table, Highest sequence no.	Delay low, Dropping ratio low
Haerri J, F. Filali, C. Bonnet	OLSR (Optimized Link State Routing)	Minimizes No.of active relays, Data traffic rate less	Routing overhead, Expected data route length, Delay low
Santoso.GZ, K. Moonsoo	AODV (Ad hoc On-Demand Distance Vector)	On-demand, Max.No.of hops, Unicast and Multicast, Loop free	Path optimality, PDR high, Routing overhead low
Maowad. H, E. Shaaban	AOMDV (Ad hoc On-Demand Multipath Distance Vector Routing)	Queuing delay at the interface, Retransmission delay at MAC layer	Speed and Direction to hop count, Normalized Routing load

Table1: Comparison of Routing protocols in VANET

CONCLUSION

This paper presents a detailed literature of the latest state of the art algorithms for routing in VANETs. The types of VANET systems namely, geographical routing and topology based routing.

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