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A Comparative Analysis of Routing Protocols in Vehicular Ad-Hoc Network

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***Abstract*— Vehicular ad hoc network (VANETs) is a future reliable communication model that integrates ad hoc network, cellular technology and wireless LAN (WLAN) to bring about intelligent inter-vehicle communications and enhanced road traffic efficiency and safety. A Vehicular ad hoc network has focused mainly on well-organized routing protocol schema under circumstances where there are comparatively massive numbers of nearly dispersed nodes. VANET featured by dynamic topology, variable network sizes that are also the basis of the difference between MANET & VANETs. However, these features pose unique challenges in the design of routing protocols. The aim of the paper is to establish a hierarchy of the vehicular Ad hoc routing protocols with comparative study and contrast the different protocols under each class of the routing protocols.**

***Index Terms*—Vanets; Routing; Vehicles; OBU; RSU**

I. INTRODUCTION

Vehicular ad hoc network (VANETs) is one of the practical application of mobile ad hoc technology in transportation systems, it has become an important part of Intelligent Transport System [1] [4]. Vehicular Ad hoc Network (VANETs) is an originating sub-class of the MANET. Vehicles are arranged on the road that constitute as versatile mobile nodes. Active security and intelligent transportation are important applications of VANETs, which need suitable vehicle-to-vehicle communication technology, especially routing technology. Routing protocol needs to design, to address challenges of VANETs such as high mobility of nodes, random topology, and heterogeneous network [3] [22]. Routing protocols are the protocols which are used to determine the route the packets between the nodes (vehicles) so that it reaches to its destination. Routing protocols ensure that information is exchanged between entities, and follow the procedure in establishing a route, decision in forwarding and covering or maintaining from route failure. VANETs constitute two existences of entities i.e. Access points and vehicles, the access points are static and connected to the internet. [2] [4] VANETs build the mobile (wireless) communication between vehicles (V2V), and between vehicles and infrastructure access point (V2I). Vehicle to vehicle communication (V2V) has two types of communication: one hop communication (direct vehicle to vehicle communication), and multi hop communication (vehicle relies on other vehicles to retransmit). The main goal for routing protocol is to provide optimal paths between network nodes via minimum overhead.

VANETs also have special feature that differentiates it from other mobile ad hoc networks. [2] [5] Many Routing Protocols have been developed for VANETSs environment, which can be layered in many ways, according to different parameters such as: protocols characteristics, techniques used, routing information, quality of services, network structures, routing algorithms, and so on.

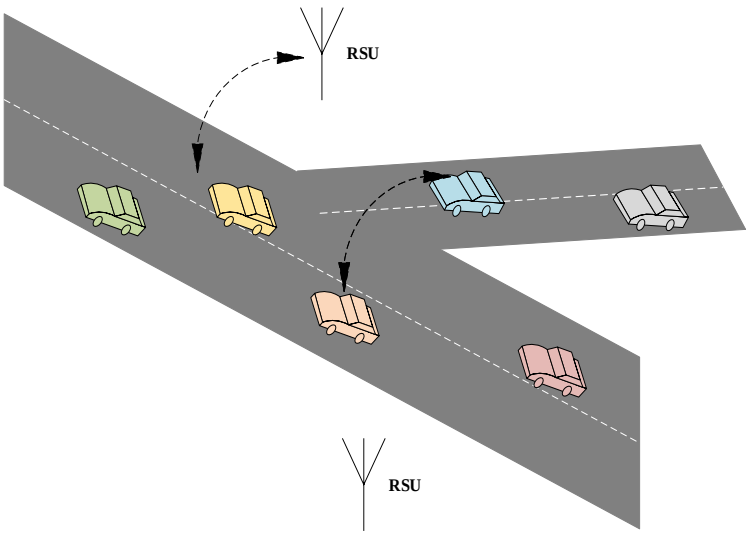

Fig.1 Different Possibilities for route of packets between the nodes

The figure 1 highlights the scenario of the VANETs in which the vehicles are moving on the road & sending out the packets through the specified route. The packets are routed by following the particular route and in this way allows the communication between different vehicles.

II. EASE OF USE

A. Network framework of vehicular ad hoc network

Vehicular Ad hoc network collaborates in itself many features for implementation of the architecture based scenario. [9][12] The architecture of VANETs is according to three categories that are mentioned below.

As far as concerned, the pure cellular/WLAN architecture, the road side units (RSUs) is actively participating in the communicating with the vehicles and serve vehicular applications. These RSUs provide the vehicles a way in which other vehicles are able to communicate easily, but this architecture is costly due to an infrastructure feature added into it, so the cost per increases as more and more RSUs are used. Another type of architecture is pure ad hoc, considering it consists of vehicles directly communicating with each other and there is no need of the RSUs for communication. [2] [7] Thus, it is known as infrastructure less communication includes sensors embedded in the vehicles. Sensors help the vehicles in knowing the required incident happening and provides the safety precautions to avoid the problems of crashing. Next, the hybrid network architecture includes both the infrastructure and infrastructure less type of the architecture i.e. the communication between the vehicles is directly or with the accomplish of the RSUs. This architecture provides greater flexibility and provides an area of urban monitoring, safety, driving assistance.[1] [8]

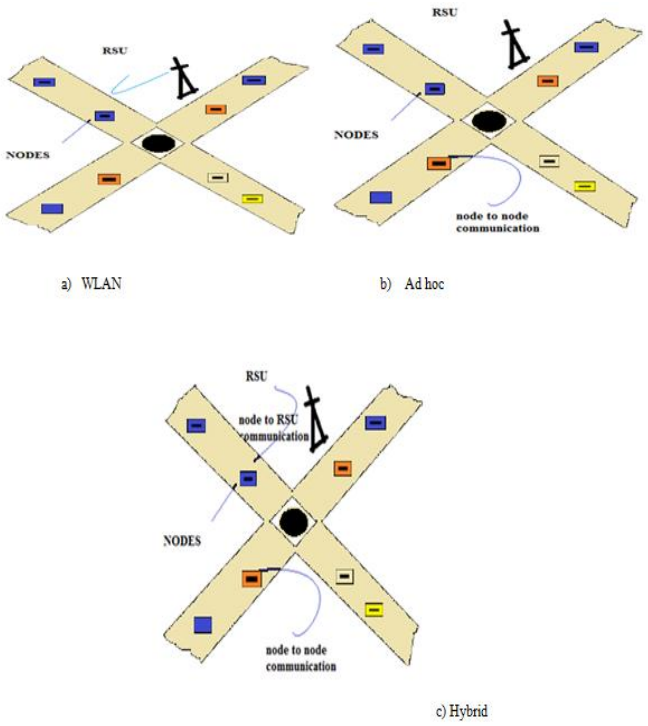

Fig. 2 Communication Models in VANETs

B. Attributes of vehicular Adhoc network :-

As analogous to a network such as (MANETs), nodes in VANETs are self-formulated and self-governed data in a dispersed manner without a centralized authority. Moreover, mobile nodes, thus making information transmission less predictable and insignificant. Apart from these features, VANETSs acquire a few differentiated characteristics, presenting itself a peculiar class of MANETs. [9] [18]

Highly dynamic topology: Variation in the direction of vehicular nodes in the vehicular ad hoc network is random, so the topology formed by VANETs is changing. In frequently disconnected networks, [22] [10]. The information disappears between the nodes when they are communicating and the cause of disconnection is the highly dynamic topology. The problem is further modified more node density where frequently travelled roads have more cars than non-frequently travelled roads. In order to recognize the frequent disconnectivity and provide a secondary link quickly to ensure continuous communication a robust communication protocol used

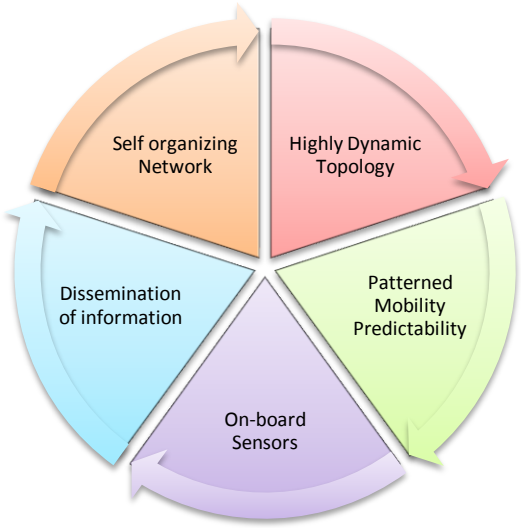

Fig. 3 Attributes of VANETs

- Patterned Mobility predictability: - Vehicles move in a certain mobility pattern that is with respect to the underlying roads, the speed limits, the traffic lights, traffic condition, and drivers' behavior. With the particular mobility pattern, calculation of VANETs routing protocols only makes sight from traces that are figure out from the pattern. Different VANETs mobility trace generators advanced for the very aim of testing VANETs routing protocols in simulation. Realistic mobility traces collected from vehicles have also been accumulated for the same purpose.[5] [11]
- Unlimited Battery Power and Storage: Nodes are assumed to have unlimited energy and computing power.
- On-board Sensors: Nodes are assumed to be embedded with sensors to maintain & to send information that is vital for routing purposes. Many VANETS routing protocols have assumed the availability of GPS unit from on-board system. Location data from GPS unit & speed from speedometer provides good examples for delivering of

information that are accessed by sensors to be utilized to enhance routing decisions.

- Self -organizing networks: vehicles in VANETs are able to establish different patterns anterior of the preceding information. [12].
- Dissemination of information: VANET is ad hoc in nature. It influences the nodes to collect required date from the nearby resident vehicles and roadside units. In respect of exchange of their information periodically.

C. Components in VANETs:-

VANETs consist of various types of resources such as an Access Point, vehicles, Road side units etc. Other types of components are used in the vehicular Ad hoc network is sensors such as On-board units, tamper proof devices that help in sending of the information to vehicles[7] [13]

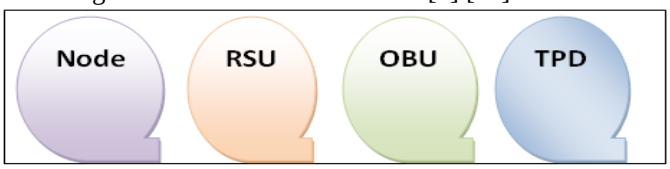

Fig. 4 Components in VANET

- **RSU:** Computing device located on the roadside that provides connectivity support to passing vehicle.
- **TPD:** Tamper proof device contains the secret information related to vehicles i.e. Keys, driver identity, trip details, speed, route etc. Safety device installed inside the vehicles.[6] It contains all the vehicle safety information, has its own battery and a watch for synchronization. It participates in all safety operations and it is accessible only for the authorized person.
- **OBU:** Communication device mounted on the vehicle is On-board unit. It detects the latitude, longitudes of the vehicle's position.
- **Vehicles:** Nodes are the names given to the vehicles for communication b/w other vehicles or roadside resources.
- **Communication channels:** Radio waves are the medium for the transfer of information

D. Communication in VANETs

Communication is a means through which different components communicate with each other in a reliable manner[3][17]. In VANETs, the communication is between different vehicles, between vehicles and RSU or the vehicle & the RSU. The common types are to be elaborated asunder:-

- V2V is the type of vehicle to vehicle communication that is for cooperative driving. In V2V, the vehicle to vehicle communication takes place for sending of information.
- V2I is the type of vehicle to infrastructure communication in which no. Of Access points are positioned with the static infrastructures.
- R2R is a type of communication between the roadside units positioned apart from each other.

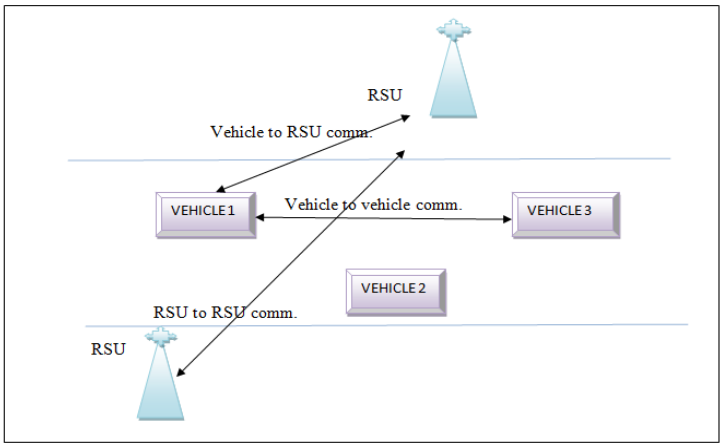

Fig. 5 Communication in VANET

III. Routing Protocols in VANETs

VANETs involve vehicles that act as both mobile nodes and routers for the purpose of data dissemination and enable ITS. Routing is a major research challenge in VANETs because of high mobility and abrupt changes in topology. Research is being done for designing an efficient routing protocol. [14] Due to the similarities between Mobile Ad-Hoc networks (MANET) and VANETs, the traditional ad-hoc routing protocols for MANET are also applied to VANETs. A routing protocol governs the way that two communication entities exchange information; it includes the procedure in establishing a route, decision in forwarding, and action in maintaining the route or recovering from routing failure. A **router** is a networking device that forwards data packets between computer networks. Routers perform the traffic directing functions of the Internet. A data packet is typically forwarded from one router to another through the networks that constitute the internetwork until it reaches its destination node. A router is connected to two or more data lines from different networks. When a data packet comes in on one of the lines, the router reads the address information in the packet to determine the ultimate destination [8][22]. Then, using information in its routing table or routing policy, it directs the packet to the next network on its journey. This creates an overlay internetwork.

A. Classes of routing protocols

There are 4 Different classes of routing protocols in VANETs. Each of them is unique from one another and are explained below:-

- Broadcast based routing protocol

- Multicast based routing protocol
- Position based routing protocol
- Topology based routing protocol

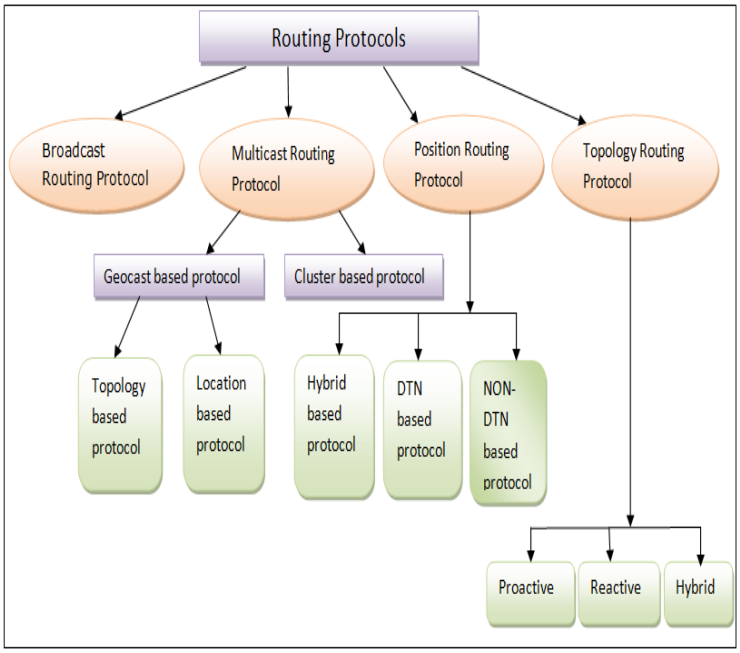

Fig. 6 Different Classes of Routing Protocol

B. Categories under each class of routing protocols

Categories under each class of routing protocols deals with various characteristics, functioning, pros and cons shown through diagram and detail study. Andrey Vladimirovich Ostroukh et al.[15] proposed a Broadcast Based Routing in which the message is out of range & there is a need to broadcast messages to each of the nodes. In this, packets are forwarded, but use the bandwidth of resource for delivering the information. Here, packets are sent to all devices over the network. With safely dissemination of packets that share regular updates, road conditions, and improved delay. The main shortcoming of this routing is a collision overhead problem. Different classes of Broadcast Routing are BROADCOMM, UMB, DV-CAST, DECA.

Broadcomm protocol [15] uses the strategy of creating the highway structure as that of hierarchical way and the area split

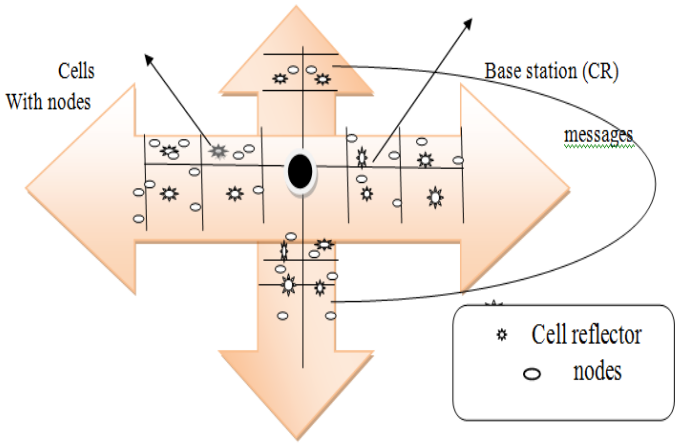

Fig. 7 showing highway split into virtual cells (BROADCOM Protocol)

into Virtual cells.[17] The 2 level of the hierarchy are used in which the Ist level includes all nodes in the cell The second

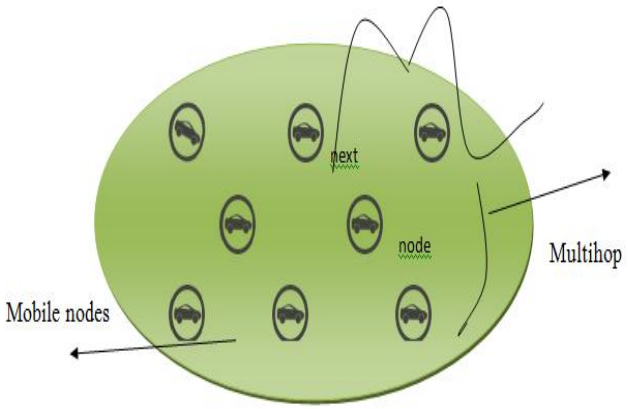

Fig. 8 Dissemination in UMB protocol

level includes the cell reflectors. The objective of the Cell reflectors is to act as cluster head for time interval and disseminate the emergency messages to different nodes or the nodes lying itself in the cell. This protocol improves delay.Another protocol under Broadcast, Urban multihop broadcast protocol (UMB) [4] [18] that uses

scheme of choosing the next nodes (further) in order to disseminate the messages without considering the perfection of the topology used by vehicle it acknowledges the messages. **T**he protocol overcomes interference, packet collision and hidden node problems. This protocol doesn't use any topology. Density aware reliable broadcasting (DECA) [9] [20] protocol is that in which the order to get and to share information regarding the mobile neighboring nodes are done through beacon messages. DECA uses store and forward strategy. In this, the selection of the next hop is used to Rebroadcast the message.[5] [17] The next hop selection is based on the quantity of the node information i.e. Largest density. Then the nodes add the next node ID to the packet that is likely to be delivered to the other nodes. The nodes that are not the next hop node will keep the packets with them and initialize the waiting timer. The two scenarios arise are:-

A) If the timer ends, then no dissemination of the packets takes place through rebroadcasting and instead the nodes itself forwards the packets.

B) If the nodes receive the broadcast packets, then it will add its ID to the beacon messages in order to inform other nodes about the nodes that had not received any broadcasted packet.

There is no use of GPS in this class of routing protocol. The drawback of the protocol is that flooding of the packets takes place, when the nodes waiting timing expires without receiving any broadcast packet. Preferred routing protocol (PGB) [20] is used to prevent the problems of broadcasting related to the route request broadcasting. In this, the nodes having the short timeout will rebroadcast the message on the basis of the signal strength RREQ broadcasting can be reduced in this protocol. In low density area, PGB is not used because there will not enough nodes to forward the packets based on signal strength.

Multicast based Routing based on dissemination of messages to multiple destinations from a single source to interested nodes is called as Multicast Based routing. [17] [23] .It consists of mesh and Tree based Routing. Further, Multicast routing protocols are classified as Flooding, Proactive and Reactive.AS Discussed under Multicast Based Routing are further classified as Geo cast and Cluster based multicast protocol. Geo Cast based multicast protocol objective is to transmit the messages to particular zones of reference (according to location) that increases the Scalability [21] The flaws Geocast Based Multicast Protocol is positioned not able to determine and partitioning of the network. Different protocols under this routing are ROVER, IVG, and Mobicast. The Geocast based multicast protocol categorized **as** Location and Topology based protocol. With Location based protocol the decisions related to routing are according to the sender, receiver and the neighboring nodes location. No Multicast tree is formed in this routing protocol [19] [26]. IVG, Gv-Grid, DRG, DTSG are some of the examples of Location based protocols. The Topology based protocol nodes disseminate information to other nodes on the basis of topology. The approach used in Topology based protocol are reactive, proactive and hybrid. The Tree based Routing forms the tree based structure and Mesh based Routing Protocol [6] [21] forms the mesh based structure to transmit messages. ROVER protocol falls under the Topology Based Routing protocol.

According to Cluster Based Routing [16], Clusters are made up of the vehicles and each of the clusters communicate with other cluster to deliver the information. As discussed by Farrah Wong et al. [22], Cluster size depends upon the no. Of vehicles. In this, cluster consists of the cluster heads and cluster members for communicating with each other. The overhead of the network can be decreased by dividing the network into different phase i.e. Forming cluster heads and other is cluster head intercommunicate with other heads [7] [17]. The categories under the Cluster based Routing are CBR, CBDRP, LORA-CBF, COIN.

Location Routing Algorithm with Cluster-Based Flooding involves the Cluster heads to communicate with other Cluster heads. It helps to minimize the overhead of retransmission of packets [21]. The routes are regularly up-to-date. Gateways are used to pass on control information. Cluster heads also retransmit packets. Robust Vehicular Routing, packets are flooded in the network & data is broadcasted. [16] In this, rectangular window is termed as ZOR with length & width is there. The window size is depending upon the area of lanes that is being covered. Messages are accepted when the nodes are in zone of reference else rejected. In ROVER, the low density environment is not suitable. Mobile just in time multicasting protocol (Mobicast) applies geographical based protocol and spatiotemporal scheme. [21] Transmission of packets to multiple mobile vehicles that is within the ZOR. This routing protocol influenced the Message dissemination rate and also reduced PDD. According to Mobicast, the shortcoming is that the speed of mobile vehicles fails the connection between the ZOR vehicles. Dynamic time-stable protocol is that in which the message is reserve for a certain time within the area of interest. [26] DSTG acts in two periods are Pre-stable periods that associate the transmission of packets in the respective regions and the Stable periods contains the packets that are transmitted between the intermediate nodes within a given certain time that uses the store and forward technique. The DSTG conduct takes an advantage of Store and forward strategy that improves its performance i.e. the vehicles speed or density of traffic and also Perform well in sparse scenarios. The issue that DSTG faced is message saving and delivery of the message. Cluster based Routing i.e. (COIN) Clustering for open Inter vehicle communication network protocol [20] [28] which is infrastructure less in which the speed of mobile nodes can maintain the communication between the cluster head and the cluster members. The formation of clusters on the basis of movements that includes mobility, position of mobile nodes and the behavior of nodes.

For transmission, the COIN allots time to each of the clusters that lessens the control overhead. It enhances the stability of cluster by choosing those nodes which have comparative relative movement and low mobility. As per this protocol, there are relatively shortcomings i.e. Radio connection is maintained for mobility between nodes and also the throughput and stability are low because of the mobility of the nodes.

Position Based Routing [22] based on finding the exact location coordinates (x, y) of the nodes such as source, destination and the next neighbor nodes using the GPS or other sources that is used to disseminate the packets at the required location. The route discovery mechanism to be performed. Position based routing is not in a need of maintenance and establishment of neither the route nor it needs to update the routing table. [21] [23]. Position about the nodes is transmitted to other nodes. Locations can be found from external sources such as maps, GPS or the routes of traffic models.The maintenance of Route Path and pattern of vehicles (topology) needs not to be maintained and position based protocol is more compatible with high mobile nodes.

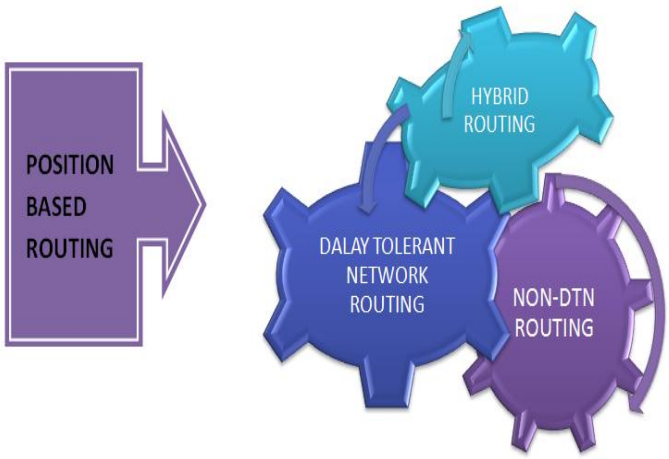

Fig. 9 To represent subclasses of Position Based Routing

The three categories of position based routing are Hybrid, Delay-Tolerant [6] [29] and Non-Delay Tolerant. Each of the protocol consists of different classes of protocols such as Geo+DTN +Nav, VADD, GRANT, GeOpps, GPSR, GSR, STAR, CAR, A-STAR, LOUVRE (Beacon based protocol and CBF (Beaconless based protocol) .

The hybrid routing protocol is a combination of both the protocols i.e. NON-DTN and DTN.Geographic DTN Routing with Navigator (Geo DTN + Nav) [8] [26] is a Hybrid Routing protocol apply the two modes, one is greedy mode and another is the perimeter mode. In greedy mode, the packets disseminate to those nodes which have, the more progress to the destination node from all other nodes. There may be problem arises when the packets are not delivered due to the obstacles as other nodes are not closer to the destination. This case can be solved by using the perimeter mode, which helps them to be in the greedy mode.With extensive simulations according to the author, the advantages of Geo DTN + Nav [26] is an increase in Packet Delivery Ratio. In a way to deliver the packets VNI i.e. the virtual navigation interface is used. There are more disconnections in dense network so not possible to use this protocol.

NON –DTN protocol is used in dense networks and delivers the packets to the nodes which are next to other nodes to reach to the destination. The dissemination fails if the nodes are not near to the destination [24] [27]. The Categories under the NON-DTN are GPSR, GSR, GPCR, CAR, A-STAR, TO-GO, CBF and so on. As Discussed below, some of the protocols.

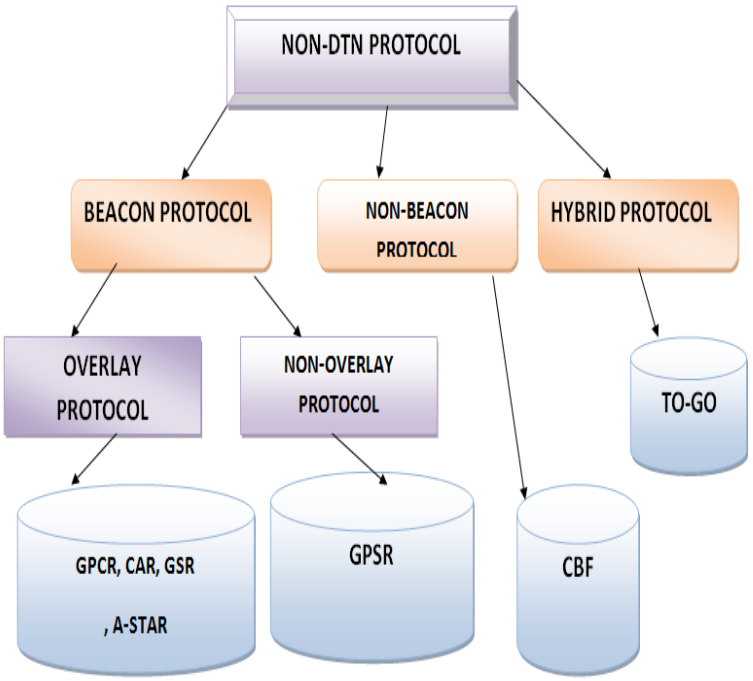

Fig. 10 Categories of NON-DTN protocol

Greedy perimeter stateless Routing (GPSR), each node knows the nodes that surround them and their positions [27] This situation may arise when surrounded node doesn't exist, then GPSR use perimeter mode for locating the destination. Geographic source routing (GSR) used to overcome problems in GPSR. In this routing protocol, the road patterns are used to

find the destination path that is available by using the road maps and SPF algorithm (short path finding) [7] [23]

Greedy perimeter coordinator routing makes use of planar graphs by learning the road patterns rather than depending upon the road maps. Packets are transferred to the coordinator. The decisions related to routing are done by the coordinator [28]. Topology Assist Geo –Opportunistic protocol [32] (TO-GO) i.e. Hybrid NON-DTN in which a set is formed in between the current node and the destination node in which the nodes listen each other's and cover the channel.The closest node wins when it is near to the destination node and is the next node to be accepted for delivering packets. With the extensive simulations, it is proposed that there is No replication of packets and Increase in PDR occurs in TO-GO protocol Contention based forwarding i.e. CBF in which the packets are broadcasted with the neighbor nodes and decide to deliver the packets to other nodes. In CBF, Collision for the delivery of packets reduces and is more suitable for Highways.

According to the performances, the DTN [29] protocol overcomes the frequent disconnections and the technique it applies is carry and forward. The source nodes empower to contact different nodes may store the packets and forward it when the nodes get to be reachable. All the nodes in the network guide each other in conveying the packets while in transit to destination. However, packet transmission may take larger lag [33]. The Categories under the DTN protocol are VADD, Ge Opps, GRANT. Some of the protocols are discussed as under.

Vehicle Assisted Data Delivery i.e. VADD [22][27] in which the carry and forward strategy are applied by the node. The dissemination of packet is done by choosing the path with negligible delays at intersections. There are 3 modes for packet i.e. Straight, intersection and the destination. Swapping is done for getting the optimal path. Geographical Opportunistic Routing (GeOpps) [30] operate with the navigation of the mobile node in order to deliver the packet to the node that is more nearer to the target node. Greedy Routing with Abstract Neighbor Table protocol i.e. GRANT in which the planes are split into areas that consists of only one neighbor for each area. .To overcomes the problems of GRA then GRANT is used. Works well in city scenarios.

Topology based routing protocol [16], the word topology defines the manner in which the nodes are interconnected in which the shortest path between the source and the destination is considered. Topology based routing maintains and stores all information in the routing table. The three categories of Topology based routing are Proactive, Reactive and Hybrid routing. Further, three categories include different protocols related to VANETs respectively.

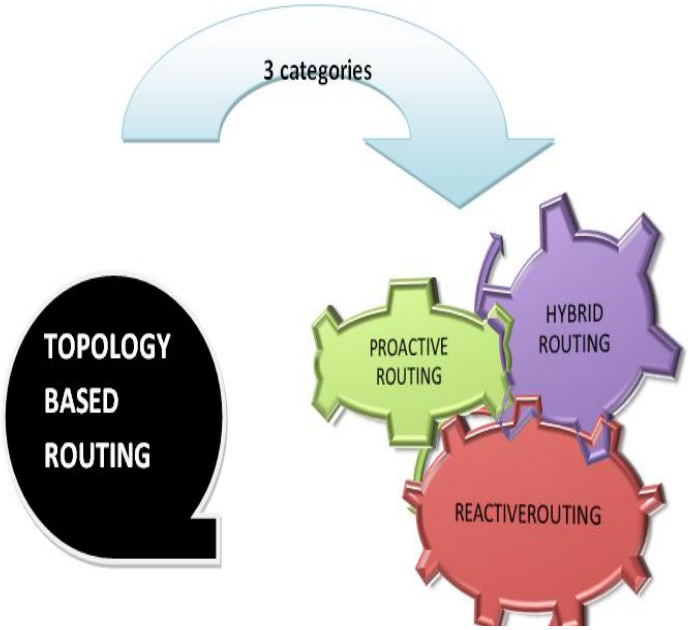

Fig. 11 categories of Topology Based Routing

Proactive protocol forms table for recording the information of each node using a shortest path algorithm. Routing table is updated with changes in the topology due to the new nodes that enters the area or that exits from it. Proactive protocol operatable in which route discovery is not required with Low delay of packets. But the Sharing of tables increases overhead. The categories in Proactive protocols are DSDV, GSRP, FSR, OLSR, WRP. Different Types Of Protocols in Proactive Routing are Destination –Sequence distance vector routing (DSDV) [10][33] based on the bellman ford algorithm. The mobile nodes hold the routing table which contains the respective entities i.e. Sequence no., Destinations and no. Of hops.The nodes forwarding their routing tables if any change occurs from the previous update. The tables are transmitted based on two circumstances: firstly, the whole update takes place from the previous one i.e. Called full dump and secondly, the selected update take place from the previous one i.e. Called incremental update. The decision of whether to discard the packet or not is done by the new protocol that overcome the problem i.e. R-DSDV protocol.

The DSDV holds the loop free path to the destination. Full dumps are sending with much time, but the incremental update sends within no time. Due to full dumps, there is a drastic decrease in bandwidth.It also not involve a multi - route to destination. Another one is, Optimized link state routing protocol (OLSR) [2] [23] makes use of the link state strategy. In OLSR, the nodes send the information regarding the change topology accordingly, which the routing tables are updated with the particular selected nodes which further re -transmit

the information to other selected nodes. If the nodes are not the selected ones, then they only read and process packets. OLSR used in some applications in which the transmission of data requires low latency and behave well in high density area. It causes congestion of network and neglects the basic performance parameters such as bandwidth, transmission range, etc.Fisheye State Routing (FSR)[35], the routing table is updated on the basis of the neighboring node information. In this, the topology map is maintained to provide route information and then maintain the table.The technique used in fisheye state routing for acquiring the graphical data, the size of information is reduced. This protocol capture the less detail when the distance is more for maintaining the exact distance and quality of the path of the next neighbor. The three tasks FSR contributes are Discover neighbor, Disseminate information and computation of the route. Simulation results showed that route discovery process, not necessary .

Reactive Routing is also called as Demand Routing. In this, messages are broadcasted in order to discover routes. Routes in this routing are built when needed. With this than the source node carry on the task of the route discovery process. In order to find routes the destination forwards the message of route reply to the source node. Reactive protocols used in large size networks and no beacon messages, send with minimum overhead in order to update the routing table. Simulation results showed that route discovery increases with time and bandwidth are desired for sending messages. Some of the protocols under reactive are TORA, AODV, DSR. Ad- hoc on demand vector routing (AODV) [23] for route establishment with demand. For DSDV, the better and improved version is AODV. AODV applies the route discovery and information of routing when there is a need of the node.

AODV performed within three phases route discovery, transmission data and maintenance of the route. In the route discovery phase, the RREQ packet is forward to the nodes that contain the source ID and the broadcast ID (that increment) in order to find the route to the destination. The node that receives the RREQ forwards the RREQ to other nodes if it is not the destination node else send back the RREP to the source. The transmission data phase, data delivers to the nodes

that contains the least no. Hop counts. The last phase is used when the nodes fail to transfer the information to other nodes.In this way the nodes do the route maintenance by using the route discovery phase. RERRs initiated when link breakage occurs. The extensive Simulation results showed that route duplicity reduces and excess of memory needed also reduces. Delay in setting up communication and the route establishment and more bandwidth needed that results into the disadvantage of the AODV.[13][31] Dynamic Source Routing (DSR) caches contain routes. It uses multi hopping. DSR main two phases constitute in it are route discovery and route maintenance. If the errors take place then, failed route from the cache is deleted and the route discovery phase initiated. Use of cache to minimize the load. According to the Simulations, DSR not able to deal with the link breakage and its performance degrades with high mobility. Temporally ordered Routing Algorithm (TORA), link reversal is the principle on which it works. A node contains the multi paths from source node to the respective node. This is used in the context where high mobility occurs. In this, few nodes hold the information of the topology of the network. In TORA three basic phases are route discovery, route maintenance and route erasure. Route discovery is done to deliver the information, from source to the destination, if the paths from source to destination is more than one than particular route than information is held by route maintenance phase and if the link breakage occurs than the route erasure takes place .

A hybrid routing protocol includes both the functionality of the proactive and hybrid type of routing. The main aim of hybrid routing is to split the network into zones in order to decrease the route discovery time. The Hybrid protocol contributes two types of zones that consider different routing for zone to zone communication. First one is Inside the zone for proactive Routing and Outside the zone for reactive Routing. Some of the protocols under reactive are ZRP, HARP. [9] [19] Zone Routing Protocol (ZRP) splits the network accordance with different performance parameters such as the speed, transmission power, strength of signal etc. The two zones ZRP includes are Inside and outside zones follows the Proactive routing and the Reactive routing, respectively. The objective of proactive routing in zones is to minimize the delay of delivering the packet, and the objective of Reactive routing in zones is to the find the route and delivering information to border nodes that forwards the information to the destination nodes. The ZRP protocol results not better in large networks. It performs as a proactive protocol for large zones and as reactive for small zones i.e. is the main drawback of ZRP. [34]Hybrid Ad Hoc Routing Protocol (HARP) formed the non –overlapping zones.A perfect route is formed to improvedelay. Two zones are used in this routing i.e. Inter zones and intra zones that are based on the destination node position.

Comparative Study of Different Classes of Routing Protocols					
S.NO.	**VANET ROUTING PARAMETERS**	**TOPOLOGY BASED ROUTING**	**BROADCAST BASED ROUTING**	**POSITION BASED ROUTING**	**MULTICAST BASED ROUTING**
1.	**STRATEGY**	**i)** For Forwarding of packets, linking information is maintained in the routing table. **ii)** Source node is responsible for disseminating of packet decision. **iii)** Depending on route discovery and route maintenance	**i)** When a message is out of range. **ii)** Need to broadcast messages to each node. **iii)** Usage of bandwidth of resources for delivering information	**i)** Periodic messages send. **ii)** Information of mobile nodes. **iii)** Use of sources such as GPS or maps.	**i)** Transmits messages to multiple destinations from a single source to interested one node.
2.	**CATEGORIES**	a) Proactive routing protocol b) Reactive routing protocol c) Hybrid routing protocol	--------	a) Hybrid routing protocol b) Delay Tolerant Network (DTN) c) Non-DTN	a) Geocast based routing protocol b) Cluster based routing protocol
3.	**DISSEMINATION TECHNIQUE**	Multihop forwarding	Heuristic technique	Multihop forwarding	Multihop forwarding for both Geocast and cluster based protocols
4.	**DIGITAL CARTOGRAPHY REQUIRED**	Not required	Not Required	Not required	• Not required for Geocast based routing. • Required for cluster based routing.
5.	**TRAFFIC FLOW**	Yes	Yes	Yes	**Yes**
6.	**REESTABLISHMENT SECHEME**	Forwarding using multihop scheme	Carry and forward approach	Carry and forward approach	Flooding
7.	**SUITABLE FOR AREA**	Urban area	Urban area	Highway area	• Highway and urban scenario
8.	**PROS**	**i)** Follows the shortest path. **ii)**Consumption of resource reduced. **iii)** Bandwidth preserved. **iv)** No periodic message.	**i)** Transmission of data is reliable. **ii)** Transmission of packets at less loss.	**i)**Destination position and next hop neighbor node position are responsible for disseminate of the packets. **ii)**Route maintenance & route discovery is not required.	**i)** Multiple copies are sending. **ii)** PDR reduces.
9.	**CONS**	**i)** Delay in route discovery. **ii)** Spot of route fails. **iii)** Flooding unnecessary.	**i)** Use of bandwidth more. **ii)** Path looping. **iii)**Congestion of the network. **iv)** Delay of packets. **v)**Collision of packets	**i)**Bandwidth not required. **ii)**Hindrance in highway areas. **iii)** Position services required. **iv)** Problem related to deadlocks in position servers	**i)** Consumption of bandwidth. **ii)** **C**lusters are formed. **iii)** Looping of the route.
10.	**PROTOCOLS**	a)DSDV,OLSR,FSR,WRP b) TORA, AODV, DSR c) ZARP, HARP	Broadcomm, UMB, DV-CAST, DECA	a) GeoDTN+Nav b) VADD, Geopps, GRANT. c) GPCR, CAR, GyTAR, GSR, CBF, TO-GO.	a) IVG, GvGRID, DRG, DSTG ROVER b) COIN, CBDRP.

Comparative Study Of Different protocols under each of the Class of Routing Protocol						
S.NO.	**PROTOCOLS**	**CLASS OF ROUTING PROTOCOL**	**DISSEMINATION TECHNIQUE**	**MAINTENANCE OF ROUTE**	**DELAY OF PACKETS**	**SUITABLE AREA**
1.	**FSR**	Topology-Proactive Based	Multihop forwarding	Routing table	Constant (less)	Urban
2.	**DSDV**	Topology-Proactive Based	Multihop forwarding	Routing table	Less	Urban
3.	**GPSR**	Position Based Reactive, NON-DTN And NON-OVERLAY Based	Greedy forwarding	Neighbor Routing table	More	Highway
4.	**AODV**	Topology - Unicast And Reactive Based	Multihop forwarding	Routing table	More	Urban
5.	**ZRP**	Topology-Hybrid Based	Flooding	Routing table	More	Urban
6.	**DSR**	Topology-Reactive Based	Multihop forwarding	Cache of the node	More	Urban
7.	**OLSR**	Topology-Proactive Based	Carry and forward technique	_____	_____	Urban
8.	**TORA**	Topology-Reactive And Broadcast Based	Multihop forwarding	Routing table	Less	Urban
9.	**DV-CAST**	Broadcast Based	Multihop forwarding	Routing table	Less	Highway
10.	**CBDRP**	Multicast-Cluster Based	Multihop forwarding	Routing table	Less	Urban
11.	**GSR**	Position Based NON-DTN, Beacon And OVERLAY Based	Greedy forwarding	Routing table	More packet delivery than AODV and DSR	Urban
12.	**IVG**	Multicast-Geocast Based	Multihop forwarding	Routing table	Less	Highway
13.	**GPCR**	Topology NON-DTN Beacon And NON-OVERLAY Based	Greedy forwarding	Routing table	Less	Urban
14.	**COIN**	Multicast-Cluster Based	Flooding	Routing table periodically updated	Less	Urban
15.	**GRANT**	Position Based DTN	Greedy forwarding	_____	_____	Urban
16.	**CAR**	Position Based NON-DTN Beacon & NON-OERLAY Based	Store-carry-forward technique	_____	Less	Highway

IV. CONCLUSION

Vehicular Ad-hoc network is another region of research, with a restricted yet quickly developing set of research results. In this research paper, we introduce a far reaching review of Routing Protocols strategies, categories, Dissemination Technique, traffic flow, re-establishment scheme, area suitable for routing, pros, cons and the protocols under each class of vehicular Ad-Hoc network protocols. They have the basic goal of attempting to expand the lifetime of the vehicular network while not trading off information dissemination. By and large, the Routing Techniques are categorized in view of the network structure into four classes: Broadcast, multicast, position and Topology based Routing protocols. We additionally highlight the comparative Analysis of the protocols under each of the classes, dissemination technique, maintenance of the route, delay of packets and the area suitable for routing. Although, a significant number of these routing protocols look encouraging, there are as yet many difficulties that should be explained in vehicular Ad-Hoc network.

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