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A Survey On Unicast Routing Protocols For VANET

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Abstract: *Vehicular Ad Hoc Network (VANET) is a subgroup of mobile ad hoc network (MANET). It is an emerging new technology to exchange information between vehicles to vehicles. VANETs are considered as one of the most noticeable technologies for improving the efficiency and safety of transportation systems. VANET mainly used to exchange traffic information between the vehicles and prevent accident. In VANETs the high mobility of the nodes is the major concern. This dynamic topology makes the route unstable and unreliable for exchange of information or messages among the vehicles in the ad hoc network. To improve the throughput and performance of the VANETs, routes between nodes must be reliable, less overhead and stable. It is a challenging task to design a routing protocols for VANETs which should support the intelligent transportation system (ITS) for enhancing the driver's safety, improving whole driver experience and regulating traffic. In this paper, the various challenges and issues of routing protocols of VANETs are discussed about its advantages and disadvantages in VANETs scenarios.*

Keywords: ***VANET, MANET, reliable path, ITS, routing protocols*.**

I. Introduction

Vehicular ad hoc networks are subclass of MANETs. It uses wireless technology to create a ad-hoc network and communicate among moving vehicles. In VANETs, every vehicle is considered as a wireless router or forwarder, allowing vehicle around 250 meters to 1000 meters coverage range to do communication with other vehicle and construct a network with a wide range. The primary aim of VANETs is road safety and non-safety while travelling. The details of vehicles like its position coordinates and current speed are sent with or without the Road Side Units (RSUs) along the road side. VANET not only give safety measures, it also provides infotainment services like finding nearest hotel, email services, audio/video sharing etc.

In VANETs, the wireless communication happens between vehicles-to-vehicle (V2V) and vehicles to Road Side Units (RSUs). Vehicular communications can be done by one hop communication (source vehicle node directly communicates with destination vehicle node) or multi-hop communication (source vehicles node cannot directly communicate with destination vehicle node).

Moreover, the multi-hop communication [1][2][3] nature in VANETs gets the need for a robust routing protocol, where more than one path is exists between the source and target vehicle. Concerning the routing protocol, the selection of the best path among multi-paths depends on the routing metric[4].The path obtains the best metric will be selected, and hence designing a routing metrics for VANETs technology is becoming an important issues, and has gained the focus of researches in this area.
VANETs technology can be applied for an extensive variety of safety and comfort applications like Intersection lane changing, Collision Warning, road hazard notification, Overtaking vehicle warning, traffic vigilance, Head On /Read End Collision Warning, position based services such as searching the nearest restaurant or hotel and nearby fuel station.

Continuous connectivity between the nodes, routing and security of data are major concern in VANETs because of dynamic topology of network [5][6] and it makes routing of packet from source to destination vehicle more challenging.

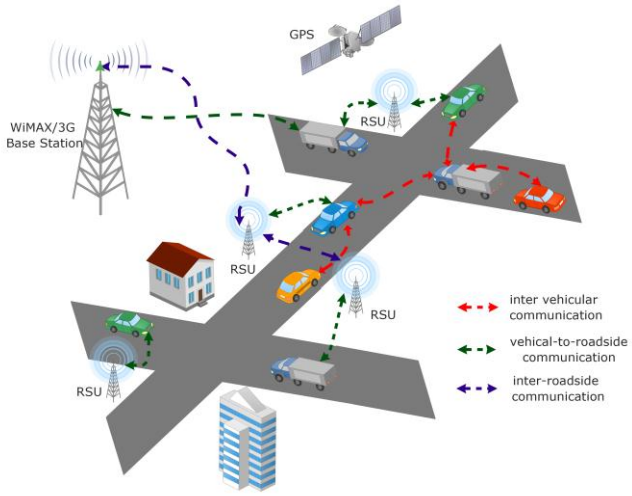

Fig. 1. Basic VANET communication scenario.

Some of the VANET operation like self-organization, radio transmission conditions and low-bandwidth are the similar to MANET technology. Because of this reason, MANET protocols are adopted for VANET scenarios. VANET possess certain uniqueness characteristics such as sufficient energy and storage, highly dynamic network topology, fragmented network and high density of vehicles which make them more challenging job to route the packets between vehicles. Further, it is an interesting task for researcher to provide reliable routing

and secure communication between the vehicles while travelling.

This paper is organized as follows: Chapter 2 explains the applications, challenges and characteristics of VANET. Chapter 3 explains about the various routing protocols in VANETs. Chapter 4 talks about the related works and Chapter 5 conclude this survey paper.

II. Application, Characteristics and Challenges

The VANET application are classified broadly into two groups i.e. safety related application and non-safety application. Safety related application is used to provide warning messages like collision, road block ahead etc., whereas non-safety application provide services like traffic managing, payment of toll, vehicle safety, position based services like seeking the nearest hotel or restaurant, nearby fuel station and infotainment applications like getting access to the Internet.

A. Safety application

Safety application used to provide safety related warning to the driver prior by sending and receiving information by other vehicles. Mostly, these alerts are path change caution, collision alert, event management and video streaming are straightly sent to the drivers. The safety application are categorized into following way.

- **Traffic optimization:** Here the optimization can be done by sending the signals to the driver like jam, accident to the vehicle so that they can select the alternative path to save their time and life.
- **Supportive Driving:** Drivers can get signals from the others vehicles like curve speed warning, lane changing warning which provide the driver for an uninterrupted and safe driving
- **Collision Driving:** According to the survey, 60% accident can be avoided if drivers were provided alert warning prior before collision. This prevent the accident and save the life of people.

B. Non-Safety application.

Non-Safety application are used for commercial purpose like finding the nearest fuel station or lodge, parking space, exchange of multimedia data and payment services.

- **Peer to peer application:** Services like sharing video, music, data etc. among the vehicles in the network. This all can be done by the user during driving period.
- **Internet Services:** This service provide the VANET user a constant connectivity of the internet. This allow user to exchange information and also used it for entertainment purpose.

C. Characteristics of VANET

Generally VANET have a few distinctive characteristics, which make it a specific challenging class of MANET.

- **Extremely dynamic topology:** In VANET the network topology of the vehicles is always changed because the vehicles are moving at very high speed. This make harder to calculate a node's position.
- **Intermittent connectivity:** Because of dynamic topology of networks the link between the two communicating vehicle are disconnected frequently.
- **Patterned mobility:** In VANET the vehicles followed a certain mobility pattern that is useful for the task like speed limits, underlying roads, traffic situation and drivers driving performances.
- **Propagation model:** The propagation model should not be made for a free space because there is lot of obstacle like trees, building and others vehicles that can degrade the performance or disconnection of communication between the vehicles.
- **Limitless battery Power and storage:** VANET technology uses the power from their car. Nodes can have abundant energy and computing power to communicate with others vehicle or road side infrastructure.
- **Unbound network size:** In VANET the network size is geographically unbounded and it can be implemented for one city, several cities or for countries.
- **Infrastructure access:** Here the vehicles can access to network server using the Road Side Units (RSU) and public hotspots.

D. Challenges in VANET

In VANET many challenges were there in terms of design of protocols to exchange information among the vehicles, privacy of data and communication platform. Few challenges are categorized below which imposes to deploy VANET.

- **Collision control:** The unbound network size in VANET creates a challenge because of this network partitions is frequently occur and hence network is congested and collision occur.
- **Continuous connectivity:** Due to high mobility vehicle the network topology changes rapidly due to which the communication structure can't be set up and maintained as rapidly the topology change.
- **Environmental obstacle:** Electromagnetic waves used in VANET for communicating between vehicles. This waves are disturbed by the obstacle like tree, building etc.
- **Security:** Privacy of the messages are provided for security purpose.
- **Protocol design:** Protocols have to be design in order to do communication between the vehicles.

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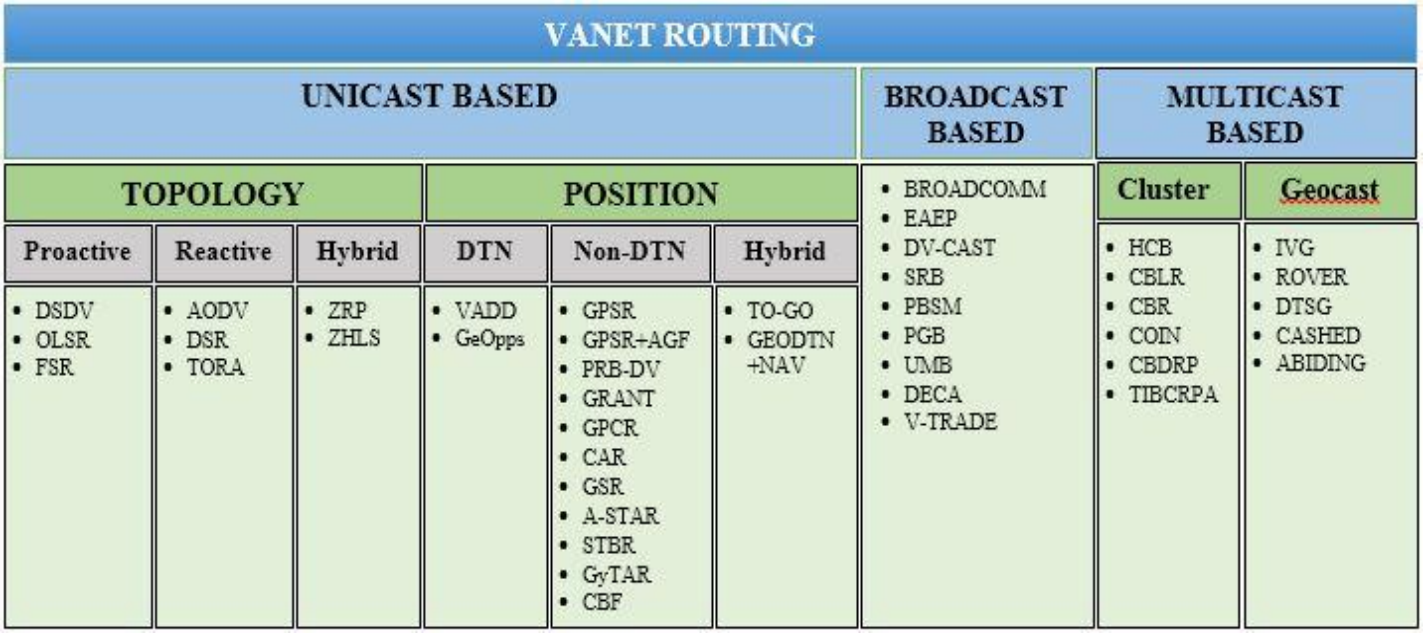

Fig. 2. Taxonomy of VANET Routing Protocols.

III. Routing Protocols for VANETS

The prevailing routing protocols of MANET technology are considered in the environment of VANETs. The basic difference between MANET and VANET is that under VANET technology the mobility of the vehicles or node is high as compare to the MANET technology where mobility is less. The routing protocols are used for establishing the route between the source vehicles and target vehicles, using forwarding methods, maintaining the route between the vehicles and recovery mechanism of route if the network disconnect.

VANET routing protocols are generally classified into the following types: unicast routing, multicast routing/geocast routing and broadcast routing which is shown in figure 2. These routing protocols are mainly used to maximize the throughput and minimize routing overhead packets. Unicast routing protocols are categorized into topology based and position based routing which is discussed further in this chapter.

A. Topology Based Routing Protocols

Topology based routing protocols uses links information to perform packet forwarding and routing operation. This protocols uses the routing tables that stored the path information from source node to target node[8]. The topology based protocols are again categorized into two i.e. proactive approach and reactive approach.

1) Proactive routing protocols

Proactive routing protocols are also recognized as table driven protocols and they are mainly depends on the shortest path algorithm. It maintains the information about all the vehicles and stored it in their routing table. The routing table consists of all the route information in it. These routing table's information are also distributed with their neighbors vehicles and all this node update their routing tables when the topology of network changes. Routing table updated frequently on dynamic topology. This information can be collect by discovering network topology information by periodically sending the beacon message. It increases the network overhead due to periodic broadcasting of message and consumes more resources for control message. Control packets in proactive routing protocols are constantly flood the messages among the nodes to maintain the path or the links even though some of the path never used. The most general proactive routing protocols are OLSR, DSDV, FSR and WRP[7][9].

	PROACTIVE APPROACH	REACTIVE APPROACH
ROUTE LATENCY	LOWER *A route is kept at all the times*	HIGHER *A route is never kept when not used*
ROUTING OVERHEAD	HIGHER *A frequent dissemination of topology information is required.*	LOWER *Fewer controls packets in general*

Fig. 3. Classification of Routing Protocols.

a) Destination Sequenced Distance Vector (DSDV)

The Destination sequence distance vector routing protocols is a proactive routing protocols. This protocol maintains the route to all targets before necessity of the path. It also provides the loop free routing and reduces the latency to find route by utilizing the frequent updating in the routing table [9]. It reduces the routing overhead and it always chooses the optimal path by using the shortest path algorithm. The routing table has entries as next hop, destination node and cost metric i.e. number of hops from source to target vehicles, sequence number assigned by destination to avoid loops. DSDV generates a large volume of control traffic because of periodic updates which consumes excessive amount of bandwidth.

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Destination	Next Hop	Cost Metric	Sequence Number	Install Time

Fig. 4. Field of routing table of each node.

Pros

- Reduce routing overhead.
- Low latency for real time application.
- Path is loop free due to use of sequence number.

Cons

- No sleeping nodes.
- More overhead as some of the information is never used and routing table are updating periodically that consume more bandwidth.
- Scalability is major problem.

b) Optimized Link State Routing protocol (OLSR)

OLSR protocol is a link-state routing protocol which is implemented by using link state policy. In this protocols, all the optimal route path are stored in each and every node routing table. OLSR improve the technique of transmission of control messages in order to save bandwidth by using multipoint relay[10]. OLSR works well in dynamic topology in which low latency is suitable during the data transmission. OLSR protocols do processing hop-by-hop routing, i.e. to route a packet it uses its most each and every node uses its latest information.

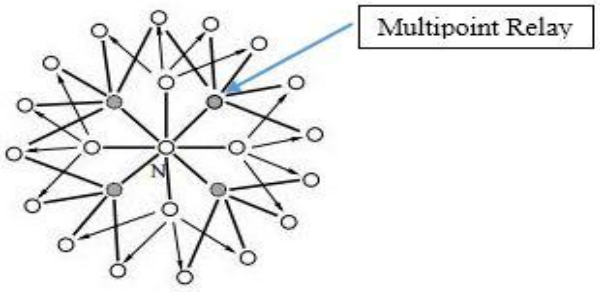

Fig. 5. OLSR multipoint relays nodes or retransmitting nodes.

Pros

- For ad-hoc networks this increases the protocols suitability with the rapidly changing of the source vehicles and destination vehicles.
- Less bandwidth consumption due to use of multipoint relay node.

Cons

- As compare to other routing protocols OLSR takes more time to reestablish a broken link.
- For discovering an alternative route it requires more processing power.

c) Fisheye State Routing (FSR)

Fisheye State Routing is a proactive link-state routing protocols which maintain the full topology map at each node. Here periodic exchange of topology tables is done within the local neighbors only. In FSR the topology tables update frequency decrease with distance to destination, i.e. updates for a near destination are propagated more frequently then updates for a remote destination[9][11]. Every node in FSR protocols holds next hop routing table, neighbor list, topology table and distance table. For a large network, the size of the routing update message will reduce by interchanging phases for routing table.

Pros

- Reduce overhead in routing.

Cons

- If the network size will increase processing overhead will also increase.
- Inadequate knowledge for route path discovery.

2) Reactive Routing Protocols

Reactive routing protocols is also called source initiated or on demand protocols which establish the routes when the source node desire. Once the route discovered, it will be maintained until either the target node become unreachable if the route is no longer needed. It reduces network traffic because it start establishing route when a node want to communicate with any another node. Here no periodic updates are done because of which routing overhead is lower.

The disadvantage of reactive routing is the route latency is high because a route is never maintain permanently, and the unnecessary overflowing of the packet in networks causes disruption of nodes communication. The different type of reactive routing protocols are DSR, AODV and TORA[10].

a) Ad Hoc On Demand Distance Vector (AODV)

AODV is a reactive routing protocol which works on distance vector routing protocols mechanism. This is on-demand routing protocols where a node does not discover route or maintenance process until it needed a service to other node. AODV protocol do communication hop-by-hop where routes are depend upon dynamic routing table entries. The order are allocated to the and routing table entries and routing path and every routing node maintain two counters i.e. broadcast ID and node sequence number [12]. AODV protocols contains three control message in communication, Route Request (RREQ) for requesting a route from source to destination, Route Reply (RREP) for responding back to node (source) along with route details, Route Error (RERR) packet messages for establishing connection between from source to destination nodes.

Source IP Address	Source Sequence Number	Destination IP Address	Destination Sequence Number	Broadcast ID

Fig. 6. AODV RREQ fields for route discovery.

Pros

- It can be useful for large scale Ad-Hoc networks.

- The AODV protocol provide loop free and avoids the count to infinity problems.

Cons

- AODV has higher processing demand.
- It consumes more share of the bandwidth.
- It takes more time to build the routing table.

b) Dynamic Source Routing (DSR)

In Dynamic source routing protocols "source routing" principal were used. Here the path travelled by the data packets were included in the header of data packet from source node to the destination node. Even there is a change in network it provide reliable data delivery. The DSR protocols is of two phases: Route discovery phase and route maintenance phase.

The route discovery phase is used to find the routes on-demand by which a source node expects to deliver a data packets to the target vehicle node. On the other hand route maintenance phase responsible to maintain the route which are currently in progress [2] between the vehicle nodes. It identify the broken link and invoke a route discovery mechanism to determine a new path [6].

Pros

- It is on-demand because of which it does not exchange routing update periodically.
- It can refers to cache for new route whenever the link fails.

Cons

- If the network is large there will be high route latency will be there to find the path.
- Traffic overhead is more.

c) Temporally Ordered Routing Algorithm (TORA)

TORA is a distributed routing protocols that reduces the communication overhead by designing the frequently changes in networks. In TORA directed acyclic graph (DAG) [1] were establish regarding the destination node on the basis of tree rooted height at source node. It is a subgroup of link reversal algorithm and it function is to limit dissemination of the control message dynamically mobility environment. Each node were responsible to initiate a route request packets whenever they need to communicate to the destination node. The packet were broadcast by forwarding node to the neighbor node. When the neighbor node receive this packet it check the packet header, if it is not meant for it than it rebroadcast the packet based upon the DAG details.

Pros

- Network overhead is less in TORA because no rebroadcast of message were done by intermediate node.
- Performs well in large networks.
- Multiple path created.

Cons

- TORA doesn't produce better result as compare to DSR and AODV.
- No scalability of node.

B. Position Based Routing Protocols

The Position based routing protocols forward the packet on the basis of geographic position coordinates of the destination node in the network. GPS technique were used to gather the nodes location information in the network. Through this the source node were able to know the position of the target node and start forwarding the packets. The source initiated request packets were consist of the details regarding the destination node. By sending the beacon message periodically one hop neighbor nodes position can be achieved. This routing protocols were further classified into three sub-groups, i.e. Delay tolerant network (DTN) protocol, Non-Delay tolerant network (Non DTN) protocol and hybrid protocols [13][14].

The advantages of position based routing is here no route discovery is needed and it is appropriate for node mobility pattern. The drawback of this protocols is due to low signal strength the GPS device doesn't work in the tunnel. This protocols needs position decisive services for communication.

1) Delay Tolerant Network (DTN)

Delay Tolerant Network enable communication where connectivity issue like high routing delay, error rates, more latency and no end to end connectivity. Whenever the opportunities arise the relay take the advantage of mobility for data forward to establish end to end connectivity. "Store-and-Forward" method is used where the data packets progressed and stored throughout the network to succeed reliable data delivery. The goals of a DTN routing protocols is to reduce the latency of message and enhanced message delivery rate.

a) Vehicle-assisted data delivery (VADD)

Vehicle-assisted data delivery protocol implemented the concept of carry and forward technique for forwarding the data packets to a static target node from moving vehicle node. In VADD routing protocols the node doesn't forward the message until it get a promising neighbor node based upon their coverage area, but it forward the data as quickly as possible. This protocols select the best optimal path which have the less packet delivery rate. The VADD protocols consist of three packets mode: straight way mode, intersection mode and destination mode. In fig 6 illustrates the three packets modes which shows how packet are forwarding. Intersection mode is used to optimize the packets forwarding direction. Straight way mode is responsible to forward the data packets to next intersection. Destination mode broadcast packets to the destination. VADD protocols is subdivided in three protocols: direction first probe, location first probe and hybrid probe.

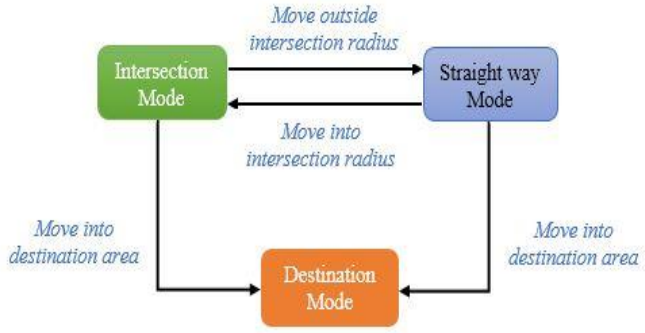

Fig. 7. Three packet modes of VADD.

Pros

- VADD protocol is appropriate for multi-hop data delivery.
- As compare to GPSR and DSR the VADD protocols performs high delivery ratio.
- Low data transmission.

Cons

- Selecting next node with less packet delivery rate is a bigger concern in VADD protocols.
- Due to dynamic topology and large traffic it causes large delay.

b) Geographical Opportunistic Routing (GeOpps)

GeOpps routing protocols make use of navigation system which advice the route vehicles to choose the next forwarding node nearer to destination node. During the course if any node has less arrival time than the data packet is sent to that node. The delivery proportion is totally depend upon the mobility pattern and the road topology, but doesn't depend upon the density of the road vehicles. GeOpps routing protocols use delay tolerant method. Here the vehicle node store the packets till it get the next hop.

Pros

- High delivery ratio.
- The delivery ratio rate depends upon the mobility pattern.

Cons

- Navigation details are disclosed in the network, so privacy is a major issue in this.

2) Non-Delay Tolerant Network (Non-DTN)

Non-Delay tolerant protocols is mainly used to decrease the packet delivery communication time between source node and destination node. It is also known as Min-delay protocols. Non-Delay Tolerant routing using Edge based greedy routing (EGBR) protocols for unicast and broadcast purpose and also for optimization of packet behavior [13]. Non-DTN protocols are categorized into beacon based, non-beacon based and hybrid protocols. To reduce packet delivery ratio, the packet should pass through minimum intermediate node and this path should be shortest and optimal. The node should have the knowledge of neighbor nodes.

Beacon routing protocols use the "HELLO" message to discover the neighbor node in the network. This routing protocol used to send hello message periodically to maintain the neighbor information list. It again classified into non-overlay and overlay network.

a) Non-Overlay

The Non-Overlay network use greedy forwarding method for sending of data between source vehicles to destination vehicle. Different protocols were proposed for recovery strategy. Some of the non-overlay network protocols are discussed below.

i) Greedy Perimeter Stateless Routing

GPSR routing protocols using a beacon message to select a vehicles which is nearer to the target vehicles. Greedy forwarding technique were used to select a node through which a packet will deliver. If this techniques fails than GPSR use perimeter forwarding mechanism to select the next forwarding node. If the data reaches a local minimum, GPSR introduce recovery mode strategy to send a data to a node vehicle that is nearest to the target node where the packets come across the local maximum.

Pros

- Forwarding of packets is easy because node has to be remember only one hop neighbor information.
- Dynamically we can make decision to forward packet or not.

Cons

- If the length of the route increase the maintenance become tougher Due to mobility environment the sending node neighbor's table have the outdated information of neighbor positions.

ii) GPSR+AGF (Advanced Greedy Forwarding)

Advanced Greedy Forwarding routing protocols is proposed to overcome the disadvantages of the GPSR protocols. AGF combines the speed and direction of the node and overall travel time in the packet. It also consist of packet processing time, up to the current forwarding node within the data packets.

Pros

- The intermediate node packet header is always updated with the destination node information.
- Information regarding the unreachable node of neighbor table easily detected.

Cons

- Does not give the optimal solution.

iii) Position Based Routing with Distance Vector (PRB-DV)

The PRB-DV protocols use AODV- route strategy method if the data packets comes into local maximum range. When the packet receive at the node, the receiver node check whether it is nearer to the destination node or fall in local maximum [7], otherwise it will store the node details from where request

packet came. Than the node rebroadcast the request packet or sent it back to the previous node from where it receive the message. The route request data packets consist of destination position details and node position details.

Pros

- Less overhead
- It provides better packet delivery ratio.

Cons

- In PRB-DV to determine the non-greedy route additional overflowing of packets is necessary.

iv) Greedy Routing with Abstract Neighbor Table (GRANT)

The GRANT routing protocols uses the mechanism of extended greedy routing where each node in the networks knows the information of it x hop neighborhood. The path length of GRANT protocols is shorter as compare to the other traditional greedy routing. ANT (Abstract neighbor table) divides the plane into different areas with one representative per area.

GRANT uses the metrics to choose the next forwarding node on the basis multiplication distance between the nodes, multi-hop neighbor [11].

Pros

- Shorter path length as compare to others greedy routing.
- Time taken by a packet to recover a route is less in GRANT routing protocols.

Cons

- Flooding range in GRANT protocol is small.

b) Overlay Network

In overlay network all nodes are interconnected with each other by logical links which are constructed on existing network. Here the network like city map, bus can be used as an overlay network.

i) Greedy Perimeter Coordinator Routing (GPCR)

GPCR protocols mainly used for inter vehicles communication on city environment. This works in high dynamic scenario where node density is more. It follows position based approach where intermediate node deliver the data to next node which is geographically nearer to the target node. Each and every node knows there position details, their next neighbor details and details of the target node.

GPCR take the advantage from the planar graph to get the details regarding the junction and street without using any street maps [6].

In restricted greedy routing the actual routing decision were taken in the junctions. Repair strategy doesn't need a graph planarization algorithm where the topology based upon the real world street and junctions. The GPCR protocols have two mechanism: Restricted greedy forwarding for forwarding the data packets to the communicating node and Repair strategy if the link will broke.

Pros

- It uses the underlying roads for representing the planar graph.
- It does not use street map to get information of the nodes.

Cons

- GPCR are totally depend upon the junction node.

  Curve road scenario and sparse road scenario failed in junction detection method.

ii) Connectivity Aware Routing (CAR)

The CAR protocols is mainly considered for inter vehicle communication. It works on highway scenario where the destination node is locating by finding the route between source and target node. Mainly the connectivity aware routing contain of four measures, i.e. route discovery, forwarding packets along the discovered path, error recovery and path maintenance.

For tracking the current position of the target node the CAR protocols used guards. To find the temporary state details standing guards were used, which is bind to geographical area.

Pros

- It discover the path which exist in reality but not geographically possible.
- It provide inter vehicle communication routing algorithm which can be operate in city and highway scenario with low overhead.

Cons

- If the traffic environment changes it can't be adjust with different sub-path.
- It select unnecessary nodes as an anchor node.

iii) Geographic Source Routing (GSR)

Geographic Source Routing Protocols use route map and discover short path from source to destination. This route maps convert the junctions and routes into graph where junction act as vertices and routes acts as edges. It forward data packets from junction to junction. It can also use recovery mode and greedy forwarding technique if there is no connectivity.

Pros

- As compare to other position based protocols this provide good packet delivery ratio.
- Scalability is good as compare to DSR and AODV.

Cons

- Performance degrades in sparse networks.
- Higher routing overhead due to use of hello message and control messages.

iv) Anchor-Based Street and Traffic Aware Routing (A-STAR)

The A-STAR protocol is mainly used in city scenario for inter vehicle communication. To calculate series of anchors it uses street map through which a data packets send to its destination. It calculate anchor route with traffic awareness. For route discovery A-STAR protocol uses two overlaid map: Statistically and dynamically rated map. Both map use for route discovery process. Statistically rated map use a graph of city route and make sure to that route have stable traffic. Dynamically rated map consist of real time traffic route information.

The difference between statistical and dynamic rated maps is the condition of the traffic. Here the packet delivery ratio is lower because it selects route which have higher connectivity

Pros

- A-STAR selects route which have higher connectivity.
- It works well in low traffic density to find the end to end message transmission.

Cons

- As compare with GSR and GPSR, the A-STAR has lower PDR.
- Static information were used in city bus route which create connectivity problems.

v) Street Topology Based Routing (STBR)

Street topology based routing protocols is consist three states: master node (master node will select on junction), slave node (other communicating node on junction) and node forwarder (the intermediary node between the junction). This protocol choose a master node in a junction and checks the links of next junction. It navigates multiple junction for long distance routing. All the master node consist of two level junction. First will be via neighbor node to its direct junction node. Second condition will be from neighbor node to their own junction nodes.

The complexity in STBR protocols is high because if old master node leave the junction it has to transfer the table information to the new master node in two hop.

vi) Greedy Traffic Aware Routing Protocol (GyTAR)

GyTAR protocols follow carry and forward technique to recover from local maximum problem. Here the packet are deliver between the concerned junctions by using greedy routing strategy. GyTAR uses digital map to identify the location of neighbor junction and gives score to each junction neighbor on the basis of destination distance and density of traffic. The maximum score junction can be select as next intersection junction.

c) Non-Beacon Based

In this type of protocols no beacon message were used to maintain the neighbor list. When the packets arrive then they find their neighbor node. Through this we can save bandwidth and reduces the packet collision.

i) Contention Based Forwarding (CBF)

Contention based forwarding (CBF) is a geographic routing protocols where no beacon message were used to maintain the neighbor list. In CBF routing protocols the packets are deliver to direct connected neighbor and the neighbor node will take decision to forward the data or not. Each CBF data packets contains details of the node position that recently forwarded the packets, the ID, final destination position details and the packet ID. The forwarding node can select by using disseminated timer based process. This algorithm allow the appropriate node to send the data packets.

Advantage: It saves bandwidth because no beacon message were require for proactive transmission. It decreases the packet collision and inefficient routings.

Disadvantage: It performance will be degrade in city scenario as compare to highway because in city scenario local maximum occurs frequently.

d) Hybrid Approach

The hybrid approach uses both the mechanism beacon based and non-beacon based.

i) TO-GO (Topology-assist Geo-Opportunistic) routing

Topology-assisted Geo-Opportunistic is a geographic routing protocols which deeds topology knowledge to define the target node forwarder. It improves the packet delivery ratio by including the opportunistic forwarding technique. This protocols works better when there is high node density and when the error are introduced in the network. Here all the node can hear one another because of no hidden terminals. End-to-end latency is higher as compare to GPCR and GPSR.

ii) GeoDTN + Nav

The GeoDTN + NAV is a combination of DTN and Non-DTN approach. This protocols use a greedy mechanism, perimeter mode and DTN mode. It can change from DTN mode to non-DTN mode by analyzing the connectivity of the network on the basis of number of hops a data packets travelled, neighbor node direction with respect to data deliver quality of neighbor and destination node. Virtual navigation interface (VNI) is used to achieve the quality of the delivery node. This VNI provide information of node to determine the forwarding node and route node.

Pros

- It have the ability to shift from DTN mode to Non-DTN mode
- It can identify partition in networks.

Cons

- In sparse networks the packet delivery ratio is decrease and the latency were increase.
- Difficulty in selecting the next forward node.
- If we compare RandDTN with GeoDTN + NAV, the RandDTN has lower latency and better packet delivery ratio.

IV.RELATED WORKS

The motivation behind vehicular communication is to provide safety in road by informing ahead to the driver through warning messages and this technology also provide services like automatic toll payment, finding restaurant etc.[15]. Unicast routing protocols used in VANET, aims at data transmission from one source to one destination by means of transmission through wireless multi-hopping or in a carrying and forward manner [3]. In figure 8 the categorization of VANETs protocols are shown on the basis of type and their working mechanism. Significant work has been carried out by many authors related to route discovery and transmission of packet between the vehicles in VANET network.

In VANET routing is one of a major concern. As compare to other traditional network, mobility in VANET is high. So we need to provide more attention to design a routing protocols for the network. There is various scenarios in VANET, where one scenarios include only vehicle communication with each other and the other includes vehicle communicating with Road Side Units (RSU).

Parminder Singh et al [1] compared Unicast routing with Multicast routing using varied data rates in VANET. They evaluate performance of both the protocols using parameters like packet delivery ratio, delay metrics and routing overhead.

The distinguishing factors among VANET protocols is organizing and recognizing paths between the source node and target node. Bara T. Sharef et al [7] discussed about various VANET protocols and proposed a taxonomy of this protocols by categorizing them in two categories. i.e. V2V routing protocols and V2I routing protocols. According to him this protocols cannot address the dynamic network and frequently disconnection in network.

Handoff is other major concern in VANET because the vehicle are continuously moving so it will become harder to transmit data when the vehicle are not in the communication range. According to Yibo Yang et al [5] VMIPv6 schemes and MIP reduces the handoff latency and improve the performance of MIP for VANET applications.

Osama M. Hussain Rahman et al [3] proposes a new sender-oriented broadcasting scheme i.e. bi-directional stable communication (BDSC) protocols. Its shows how BDCS protocols achieves lower end-to-end delays and improves reachability of alert messages over densely populated vehicular network.

Several position based protocols has been proposed and they require vehicle position coordinates for selecting of vehicles. Mohamed Saada Boba and Suleiman Mohd Nor [7] has done comparison of various greedy algorithm in urban scenarios and gives details about various issues regarding routing and design approach.

Secure routing over network is most crucial to establish between the vehicle nodes. Several approaches are used the cryptography techniques for secure communication. Nirav J. Patel et al [16] recommended a trust based method for secure routing which make V2V and V2I communication secure and maintain the privacy between the communicating nodes.

Sanjay Batish et al [12] discusses comparative study between the AODV, DSR and DSDV routing protocols. According to him when no RSU are used DSR protocols performs better than AODV protocols and the throughput is also higher than AODV which make it more efficient in real city scenario.

According to Ahmad Mustafa, Anna Maria Vegni et al [15] they proposes QoS-Aware node selection algorithm which is an algorithm for selecting the next forwarding node in vehicular network. This algorithm allow the vehicle on highway to select a node vehicle coming from opposite direction, this will enhance the QoS parameters for VANET network.

James Bernsen, D.Manivannan [10] discussed about various unicast based routing protocols and the design factors involved in that routing protocols, and the potential application for the technology for VANET environment.

Biajan Paul et al[6] discussed about advantage and disadvantage of various routing protocols for doing communication in VANET. In order to design an efficient routing protocols, the pros and cons can be identified to improve the implementation of a new protocols.

The convergence of computing and numerous services are approving the implementation of VANET technologies. Many researches has done and they are mainly focused on few areas like quality of service, routing, broadcasting and security. Sherali Zeadlly and Ray Hunt [17] define about different simulation tools that are offered for VANET simulation procedures. The VANET simulators tools are useful to researcher for analyzing the various parameters regarding the routing protocols and scenarios which is best suited for VANET goal in future.

Many VANET research work has been concentrated on precise areas including providing privacy among vehicle during communication, Quality of service (QoS), broadcasting and routing. VANET turn into an active area for academia, research and development because it improve the traffic efficiency, less time consumption, road safety, and suitability to drivers.

ROUTING PROTOCOL	FORWARDING METHOD	MOBILITY MODEL	OVERHEAD	PROPAGATION MODEL	SCENARIO
TOPOLOGY BASED					
a. Proactive Routing Protocols					
DSDV	Multi-Hop	IDM on Manhattan Grid	All link states	Unknown	City
OLSR	Multi-Hop	IDM on Manhattan Grid	All link states	Unknown	
FSR	Multi-Hop	IDM on Manhattan Grid	All link states	Unknown	
b. Reactive Routing Protocols					
AODV	Multi-Hop	MTS, IDM on Manhattan Grid, videlio	Path states	Road blocking, Probabilistic shadowing.	City
DSR	Multi-Hop	IDM on Manhattan Grid, Videlio	Path states	Road blocking	
TORA	Multi-Hop	IDM	Path states	Road blocking	
POSITION BASED					
a. Delay Tolerant Network					
VADD	Opportunistic	Unknown	Beacon	Unknown	City
GeOpps	Opportunistic	MTS	Beacon	Unknown	City
b. Non-Delay Tolerant Network					
GPSR	Greedy	MTS	Beacon	Road blocking	Highway
GPSR+AGF	Greedy	MTS	Beacon	Road blocking	Highway
PRB-DV	Greedy	Not specified	Beacon & Path states	Road blocking	Not specified
GRANT	Greedy	Static trace from a uniform distribution	Two-hop beacon	Road blocking	City
GPCR	Greedy	VanetMobisim	Beacon	Road blocking	City
CAR	Trajectory	MTS	Beacon & Path states	Two ray ground	Highway & City
GSR	Greedy	M-Grid	Beacon	Road blocking	City
A-STAR	Greedy	M-Grid	Beacon	Road blocking	City
STBR	Greedy	Not specified	Beacon	Not specified	City
GyTAR	Greedy	Free Way	Beacon	Free space	City
CBF	Greedy	RWP	Data Broadcast	Road blocking	Highway
c. Hybrid					
TO-GO	Greedy	VanetMobisim	Beacon and data broadcast	Road blocking	Highway
GEODTN+NAV	Greedy	VanetMobisim	Beacon	Road blocking	Highway

Fig. 8. Summary of vanet routing protocols

CONCLUSION

This paper has been analyzed of various routing VANET protocols. Here we discussed about the different VANET unicast routing protocols on the basis of their type, forwarding method, propagation model, mobility model, working scenarios suited for them and their advantage and disadvantage. We categorized them into two groups i.e. topology based and position based. We have seen that position based protocols were using opportunistic and greedy approaches to forward the data packets between the vehicles. Whereas, the topology based routing protocols used multi-hop strategy for forwarding the data packets to the destination. This literature survey is concentrated on unicast routing protocols and standards such as, delay latency, routing overhead packets, packet delivery ratio (PDR), number of hops, delay latency, link reliability and buffer size can be used as a performance metrics for each protocols. VANET turn into an active area for academia, development and research because it improve the traffic efficiency, less time consumption, road safety, and suitability to drivers.

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