International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 7, Issue 6, June 2017)

A Review on Vehicular Ad Hoc Network and its Routing Protocol

Komal Jain[1], Ashish Gupta[2]
[1]Research Scholar, [2]Assistant Professor, NITM. Gwalior, India

***Abstract*-- In This survey paper we analyze the various techniques to understand the vehicular ad hoc network characteristics. And in this paper, we try to understand how VANET works, what is role of RSU how many types of communication mode are used in VANET environment and also discuss the various protocols that have been proposed to improve the performance of overall network.**

***Keywords*-- VANET, RSU, OBU, V2V, V2I and I2V.**

I. Introduction

By studying various researches have been done, as we come to know that due to accidents by vehicle lots of life are lost [1]. The traffic in the roads is increases due the use of the vehicle are maximized. Therefore, it become very important to provide safety to the drivers and decreases the congestion of the traffic. In this direction, currently the vehicles are available with advance technology such as GPS and Wi-Fi equipment which are able to establish "vehicle to vehicle i.e. V2V" communication for the "Vehicular ad-hoc network i.e. VANET" .So, to effectively ignore the vehicle crashes and properly manage the traffic route in dense urban areas, the companion vehicles of "VANET" continuously exchange the up to date data that contains information about the traffic condition of the road. A trustable information delivery can be ensured by the "VANET" network.

A "Vehicular Ad Hoc Network i.e. VANET is a special type of "Mobile Ad Hoc Network i.e. MANET" in which each node behave as a vehicle and lace with the modern technology of communication for transmission of updated information to create a secure network.

To create an environment of "VANET", the standard "802.11p or 802.16 WiMax" had been defined by IEEE. Various communication technologies can be used to interconnect the vehicles of the network depend on the required range such as Cellular System, Wi-Fi standards, CALM standard, Bluetooth standard, DSRC/WAVE standard etc. Different standards have their different advantages and limitations. "Dedicated Short Range Communication i.e. DSRC" are widely used technology in the VANET environment due to its low latency and reliability. In USA its 75MHz of spectrum in the 5.9GHz band and in Europe its 30 MHz of spectrum in the 5.9GHz band is allocated and used by "Intelligent Transportation Systems i.e. ITS" [2].

"VANET" is mainly designed to support two type of application i.e. Safety and Non Safety applications. The aim of safety application is to provide the safety to the driver of the vehicle at the time of critical emergency condition through providing them the prior information about the road condition, vehicular crashes and traffic situation. On the other hand, Non-safety application allow the passenger to entertain themselves by providing them access to the different internet services during the travelling .The main difference between these two applications are safety application is allowed to but non safety applications do not have access the real time information [2].

This paper is organized as follows: Section 2 provides the overview of the VANET in which we discuss the characteristics, component, communication and architecture of it. Section 3 present the literature review and last Section 4 contains the conclusion.

II. Overview Of VANET

A. VANET Characteristics

The main characteristics of VANETs [5-8] are:

A.1. High mobility

In VANET, the vehicles are normally running at a very fast speed. [6].These vehicles makes difficult to protect them from attacks and only saved if their location is predictable.

A.2. Dynamic Topology

The topology is changed rapidly due to the higher speed of the vehicle with respect to other [7]. For example- if two nodes are running at a speed of 50 m/s away from each other .If the communication range between them is 500m .So, the link between these two vehicles will last only for 5sec. This is known as frequently changed topology.

A.3. Power

The vehicles in VANET have sufficient battery power and storage capacity [8]. In future, modern vehicles equipped with unlimited power and capacity of computing. It became useful for successful transmission of data and making routing decision.

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A.4. Time Factor

In VANET, the delivery of the message must be in limited time period so the neighbor vehicle can make decision and work according to it.

A.5. Unbounded Network Size

In VANET, the size of the network does not have any limit geographically it can be for any city or for any country.

A.6. Wireless Network

In VANET, the connection of the nodes are wireless. So , it create a wireless network.

B. Commnication In VANET

There are main five categories of communication in "VANET"

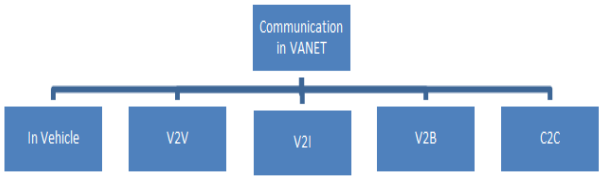

Fig1. Communication In VANET

B.1. In-vehicle communication

In this type, the communication is done between the system and the driver to keep the track of performance of vehicle. This communication system detects the fatigue and drowsiness of driver.

B.2. Vehicle to vehicle (V2V) communication

In this type, the communication is done between the vehicles to exchange their data about the condition of road, warning message, to track the road's current position

B.3. Vehicle to infrastructure (V2I) communication

In this type, the communication is done between the vehicle and infrastructure unit to exchange their data about the condition of weather, traffic, to track the traffic and weather current position

B.4. Vehicle to broadband (V2B) cloud communication

In this type, the communication through broadband cloud to exchange their data about the more traffic information and infotainment, to track the vehicle and to provide entertainment.[3].

B.5. Cluster to cluster (C2C) communication

In this type, the communication is done between the auto managed groups of the cluster which form by splitting up from a network through a "Base Station Manager Agent i.e. (BSMA)" [4].

C. Architecture Of VANET

WAVE is a wireless technique that made communication between "V2V" or an "RSU" and vehicle. The core components of this communication system are "On Board Unit i.e. OBU, Application unit i.e. AU and Road side unit i.e. RSU". The services provided application that is hosted by RSU is used by OBU which is a companion device. So, RSU are the provider and OBU referred as user. In VANET environment, each vehicle installed with "OBU and sensors that exchange the information with RSU or other vehicles and manipulate the data. The AU is also installed in vehicle that utilizes the OBU connection to make use of application provided by the RSU. AU's of all vehicles can also connect to the server through RSU.

C.1. On Board Unit (OBU)

An OBU is a device that is installed on a vehicle, is used for data communication with RSUs or other vehicle's OBUs.

Its main function to exchange information with RSU's or OBU's, ad hoc routing, geographical routing ,congestion and traffic control ,security of data etc.

C.2. Application unit (AU)

The AU is also installed in vehicle that utilizes the OBU connection to make use of application provided by the RSU. AU's of all vehicles can also connect to the server through RSU. It equipped with OBU in one unit and communicates through it.

C.3. Roadside unit (RSU)

RSU is a static device that is situates at the road side of the route of the vehicle in VANET environment. The RS installed with network device to exchange their data with different devices such as OBU's, AU's of vehicle and others RSU[5].

D. Challenges In VANET

There are many problems that arise in the "VANET" running scenario .The main motto of VANET is to reduce death case due to vehicle accidents. In this direction the network has to face many issues and challenges, some of them are as follows.

D.1. Signal fading

There were various objects such as buildings, towers or other obstacle that comes in between the two vehicle that are communicating. The result of these obstacle are signal fading means the signal does not reach to the destination.

D.2. Bandwidth limitations

The next issue is not providing a proper bandwidth due to the absence of the central hub that provide coordination between different communicating vehicles.

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Due to this the time delay and disseminating messages problem arises in the network.

D.3. Connectivity

The next main issue that arises in the VANET are the connectivity problem due to the rapidly changes in the topology. This problems leads to increasing transmission power thus degrade the throughput of the network.

D.4. Security and privacy

Another one of the important issue is to provide security and privacy in the network. The two problem of it is to find out the trustworthy sender or receiver and trustable information.

D.5. Routing protocol

The last but not least issue to provide a routing protocol that can effectively enhance the throughput and packet delivery ratio of the network and degrade the packet delay.[5].In this paper we discuss the different routing protocol that have been made for VANET.

III. Literaure Review

Routing Protocols of VANET

Lots of research and studies have been done in the direction of providing a best routing protocol to the VANET.As the different researcher focuses on different routing protocol for different network such as single ad hoc routing protocol, position based routing protocol, topology based routing protocol etc. to provide a best solution of the challenges face by the VANET environment. This leads to the study of these all routing protocol based on network type in comparative manner. So, according to this routing protocol of VANET can be classified in five main categories [6].That are

A. Topology based routing protocol
B. Position based routing protocol,
C. Cluster based routing protocol
D. Geo cast routing protocol
E. Broadcast routing protocol.

A. Topology based routing protocol

These routing protocols utilize the route information that resides in network to forward the packet to the destination. These can be classified into two types [7]:

A.1. Proactive routing protocol

These protocols are table driven protocol, this means that it create, manipulate the table at each node by updated information. VANET needs to manage more than one table to transmit the information to the destination node [7].

These protocol use the shortest path algorithm to find out the path to the destination. It usually uses "Link State Strategy" and "Distance Vector Strategy" to find out the route [8].

Various routing protocol is designed that is based on the proactive ad hoc routing protocol. Some of them we are discussing like "FSR i.e. Fisheye state routing", in this protocol each node manage a topology table and updated according to the upgrade information exchange from the neighbors [11].In "DSDV i.e. Destination-Sequenced Distance-Vector Routing [12]", next-hop table is maintained by each node. This table is updated by exchanging it from the neighbors. It reduces the overhead of control and route repetition, thus convergence speed increases. In "OLSR i.e. Optimized Link State Routing Protocol" [13] author tries to reduce the retransmission of packets by chose a no of nodes as "MPR i.e. multipoint relays". In [14] author creates a protocol that works for cluster wireless network in the place of single network called as "CGSR i.e. Cluster head Gateway Switch Routing". In [15] "WRP i.e. Wireless Routing protocol" is completely table driven protocol and tries to increase efficiency by keeping four table at each node. "TBRPF i.e. Topology Dissemination Based on Reverse Path Forwarding" [16] is designed for ad-hoc network in which source tree is constructed by each node to keep path to each reachable nodes. Table is updated by only getting the information of previous and next network state using HELLO message.

A.2. Reactive routing protocol

Reactive routing protocol is on-demand routing protocol.

It decreases the load of the network by making a route only when it is needed. When the packets are overflow in the network it creates a phase of route discovery and complete it when founded the route [7].

It also include various routing protocols such as "AODV i.e. Ad Hoc on Demand Distance Vector" [17] is work through two packets that are RREQ for broadcast query and RREP for obtaining complete path using backward learning. "PGB i.e. Preferred Group Broadcasting" [18] is extension of AODV with reducing route overhead by selecting the preferred network. "DSR i.e. Dynamic Source Routing" [19] is based on the ID's of intermediate node in the header of the packet that is used to traverse the path by the source. "TORA i.e. Temporally Ordered Routing Algorithm" [20] is based on the directed acyclic graph which gives the surety to provide link to each node of the network. In order to reduce the problem of proactive routing protocol such as overhead of control reactive routing protocol such as delay due to initial route discovery.

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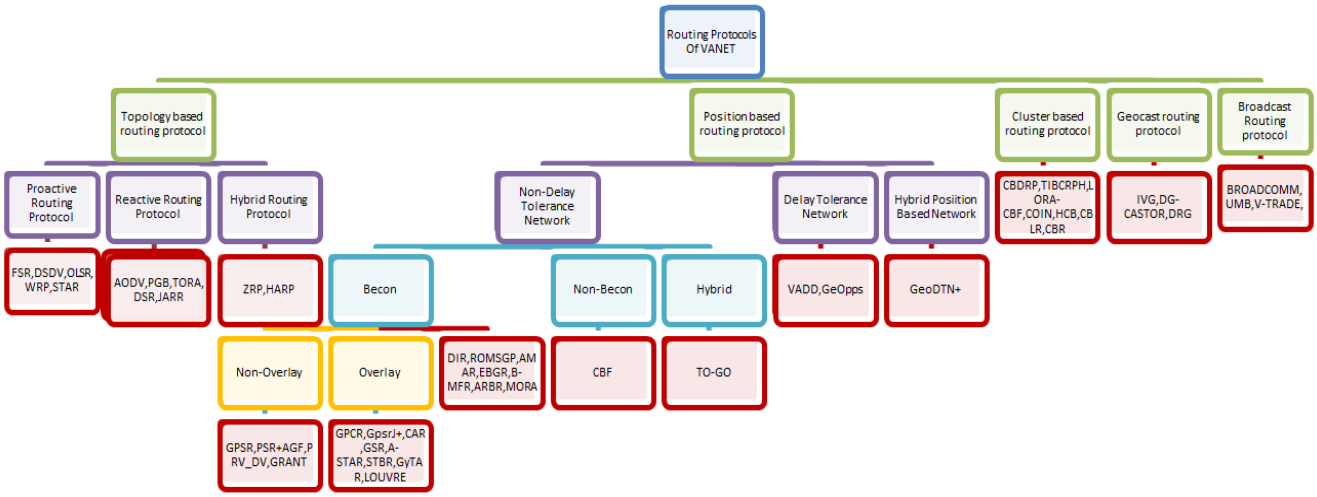

Fig2. Routing Protocol Of VANET

A.3. Hybrid routing protocol

Hybrid routing protocol introduce as the combination of both these protocol and provide the better facility than these protocols[9].

In this section only two protocols included first is "ZRP i.e. Zone routing protocol" [21] which divide the whole network into overlapping zones, some are intra-zone and some are inter-zone. The proactive routing protocol is used for intra-zone communication and reactive routing protocol for inter-zone communication. And second is "HARP i.e. Hybrid Ad Hoc Routing Protocol" [22] is same as "ZRP" but it tries to create a stable route to avoid delay but not suitable for high mobile ad-hoc network.

B. Position based routing protocol

Position based routing protocol is also known as Geographic based routing protocol deliver a packet based on the geographic position instead of network address. These protocol depend on the "Geographic Position System i.e. GPS" to find the location of its neighbor. It is considered as more stable than Topology based routing protocol due to its no need of route discovery; table management and knowledge of topology change [8].These are further classified as non-delay tolerant network, delay tolerant network and hybrid.

B.1. Non- Delay Tolerant Network

In this type of routing protocol, there is need to connect the nodes continuously. This can be further divides as Becon, Non Becon and Hybrid.Becon. And Becon is subdivided as Non-Overlay, and Overlay.

This protocol attract the attention of many researchers so as to improve its efficiency many protocols is designed such as GPSR: Greedy Perimeter Stateless Routing [23] in which packet is forward to the destination closer node called as greedy mode and on reach local maxima recovery mode is applied , "PRB-DV i.e. Position-Based Routing with Distance Vector Recovery" [24] works similar to GPSR, only its recovery mode is based on AODV's RERQ ; "GRANT i.e. Greedy Routing with Abstract Neighbor Table" [24] is also similar to GPRS , only it knows about its x neighborhood for best path to avoid reaches to local maxima ; "GPCR i.e. Greedy Perimeter Coordinator Routing" [25] does not use any static external make and apply GPRS with a repair strategy ;"GpsrJ+" [26] is work on the prediction of the junction of its neighbor node an take decision according to this prediction and forward packet ; "CAR i.e. Connectivity Aware Routing Protocols" [27] is reducing overhead by keeping track of successful path pairs; "GSR i.e. Geographic Source Routing" [28] is similar to GPR, it change only its recovery mode as perimeter mode; "A-STAR i.e. Anchor-Based Street and Traffic Aware Routing" [29] is similar to GSR but it is aware about the traffic and uses static rated map and dynamic rated map ; "STBR i.e. Street Topology Based Routing"[30] is the extension of A-STAR with the computation facility of connectivity at the junction ; "GyTAR i.e Greedy Traffic Aware Routing protocol" [31] have process as above described protocol that is greedy based ; "LOUVRE i.e. Landmark Overlays for Urban Vehicular Routing Environments" belongs to the second camp of geographic greedy overlaid summarized by Lee, which is geo-proactive [32]; "DIR i.e. Diagonal-Intersection-Based Routing Protocol" [33] make the set of diagonal intersections between source and destination and forward the packet following this set ;

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"ROMSG i.e. Receive on Most Stable Group-Path" [34] is an combination of most stable path with grouping of nodes depend on the velocity vector of nodes ; "AMAR i.e. Adaptive movement aware routing protocol" [35] is also an greedy based approach with the information of vehicle movement ; "EBGR i.e. Edge node based greedy routing protocol" [35] is also a greedy based approach with the node selection having limited transmission ; "B-MFR : Border-node based most forward within radius routing protocol" [35] is the extension of greedy based approach with the compatibility with high vehicular density environment; "ARBR i.e. The Associativity-Based Routing" [36] is based on Signal Stability-Based Adaptive Routing protocol (SSR) for the route selection with "stronger" connectivity ,also define a metric known as degree of association stability ; "MORA i.e. Movement-Based Routing" [37] is designed to work on infrastructure-free ad-hoc networking scenario for C@C communication ; "VGPR i.e. Vertex-Based predictive Greedy Routing" [38] uses fixed infrastructure for packet forwarding through valid junction ; "MIBR: Mobile Infrastructure Based VANET Routing" [39] usus bus as basic element to choose rout because bus has two heterogeneous wireless system and find road density through bus line information ; "DTSG Dynamic Time-Stable Geocast Routing"[40] is designed to work in sparse density network , it adjust itself dynamically according to network density and speed of vehicle ; "TO-GO i.e. Topology-assist Geo-Opportunistic Routing" [41] is the extension on greedy based protocol with better packet delivery and recovery forwarding ; "CBF i.e. Contention-Based Forwarding [42] is a geographic routing protocol because it not uses becon and save bandwidth.

B.2. Delay tolerant network

In this type of routing protocol, there is no need to connect the nodes continuously.

It included protocols are "VADD i.e. Vehicle-Assisted Data Delivery" [43] is based on the carry and forward scheme which depend on the predictable mobility of vehicle and "GeOpps i.e. Geographical Opportunistic Routing" [44] used the navigation system of vehicle and follow the short path from suggested path.

B.3. Hybrid Position Based Protocol

In order to rectify the problem of Non–delay tolerance and delay tolerance protocol, Hybrid Position Based Protocol introduces as the combination of both these protocol and provide as facility of partial connectivity [9].

It includes only one protocol that is GeoDTN+Nav [45] used both DTN and Non –DTN protocol, so includes greedy, perimeter and DTN mode.

C. Cluster Based Routing Protocol

A new routing concept that is known as Cluster Based Routing is introduce in the direction of reducing the traffic ,congestion and overheads of routing. In this cluster refers to the small vehicle's group that forms a network. In this protocol, one head knows as cluster head leads the main role and broadcast the packets to each node of the cluster for which it refers to. The designed routing algorithm decides the cluster's size and depends on the number of nodes and nodes geographical position [10].

The various protocols that are designed in this section are "CBDRP i.e. Cluster-Based Directional Routing Protocol", "TIBCRPH i.e. Traffic Infrastructure Based Cluster Routing Protocol with Handoff", "LORA-CBF i.e. Location Routing Algorithm with Cluster Based Flooding"," COIN i.e. Clustering for Open IVC Network", "HCB i.e. Hierarchical Cluster Based Routing", "CBLR i.e. Cluster Based Location Routing", "CBR i.e. Cluster Based Routing".

D. Geo Cast Routing Protocol

This protocol is based on location. In this protocol, every node communicates to only that node which is its defined geographical region and it is called to as Zone Of Relevance. Sender node does not have capability to send the message beyond the relevance zone. Each node delivers the packet to all other nodes that are within a specified geographical region which is said to be as zone of relevance [9].

The various protocols that are designed in this section are "IVG i.e. Inter-Vehicle Geocast", "DG-CASTOR i.e. Direction-based GeoCast Routing Protocol for query dissemination in VANET", "DRG i.e. Distributed Robust Geocast", "ROVER i.e. Robust Vehicular Routing", "DTSG i.e. Dynamic Time-Stable Geocast Routing".

E. Broadcast Routing Protocol

These routing protocols [9] are utilized where there is need to exchange the messages which are related to safety. The broadcast routing protocol uses the flooding method to rebroadcast the message by each node to another node. This ensures the message arrival at the destination node. The disadvantage of this protocol is its high cost. It is more suitable for low number of nodes because for high number of nodes it causes collision in the network.

The various protocols that are designed in this section are "BROADCOMM", "UMB i.e. Urban Multihop Broadcast Protocol", "V-TRADE i.e. Vector Based Tracing Detection", "DV-CAST i.e. Distributed vehicular broadcast protocol", "EAEP i.e. Edge-aware epidemic protocol", "SRB i.e. Secure Ring Broadcasting", "PBSB i.e. Parameter less broadcasting in static to highly mobile wireless ad Hoc".

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IV. CONCLUSION

From last few decades the routing process in VANET attracts many researchers .In this paper we give an overview about t e different routing protocols used for different type of VANET environment. Since the routing protocol area of VANET is very huge so we try to give short description of Topology based and position based routing protocol. In the next paper we will discuss about the remaining type of protocol description and its comparison so that it can help the researchers to get the adequate information about the various protocols.

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