Critical Analysis of Various Routing Protocols in VANET

N. Gayathri, S. Rakesh Kumar
Department of Computer Science and Engineering,
Thiagarajar College, Tamil Nadu, India

Abstract: Vehicular plays an important role in day-to-day world in the field of automobiles. VANETs are the subclass of mobile ad-hoc Networks which have no central infrastructure. Nodes are highly mobile in VANET. VANET is distinguished from MANET by their features, design and applications. In this paper VANET features, architecture, challenges, applications are discussed. Also various routing protocols are also detailed based on various classifications

Keyword: VANET, MANET, RSU, V2V, V2I

I.   INTRODUCTION

Vehicular Network is a new class of wireless ad-hoc network that aids in communication between the vehicles on the road [1]. In those days, drivers used their voice, horns to communicate between vehicles [3] movements. At present, information could be transferred so easily through mobile phones and walkie-talkies.

VANET [6] is an emerging technology which brings new generation wireless networks into automobiles. This technology aims to provide drivers and others who travel on the vehicle with the updated information on accidents, any commotion, traffic jams and rainfall. By using this information, drivers may find it easy to decide routes and avoid the smashup.
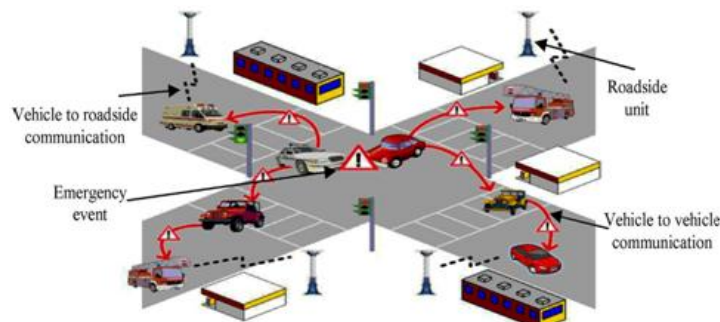

Figure.1.Basic Structure of VANET

In this paper, the specialty of VANET over MANET is clearly brought out. VANET characteristics, challenges and various VANET routing protocols are also discussed in detail.
The paper is coordinated as follows:
Section II deals with VANET characteristics. Section III deals with challenges in VANET. Section IV primarily focuses on architecture. Section V provides the difference of VANET from MANET. Section VI broadly classifies the various routing protocols that come under VANET. Section VII concludes the paper.

II.   VANET CHARACTERISTICS
VANET which is a special type of MANET has its unique characteristics [17] namely

A. Pre assumable mobility:
Mobility in VANET is predictable as the vehicles have to move according to topology of the road and also respond to traffic rules and move with other vehicles in a congenial manner.

B. Energy constraint free:
Energy/power in VANET is not an issue as the vehicles have the capacity to enable continuous power through long life battery.

C. Network topology:
There will be rapid change in network topology in VANET. This vehicular behavior is affected by the need to react to the traffic flow pattern which causes changes in network topology.

D. Energy traffic efficiency:

As VANET helps in communication among the vehicles, it provides information for all vehicles travelling in a same direction in case of traffic jams or about current road status. Thus it enhances the efficiency of the traffic in the current situation.

III. CHALLENGES IN VANET

There are various challenges [9] in VANET:

A. *Increased network breakage:*

Due to high and varied speed movement of vehicles, VANET will not have consistent network connectivity[16]. So in the application which requires high network connectivity, more number of access points could be installed on the road side to maintain continuous connection.

B. *Message confidentiality and security:*

In applications like intimating flood, accidents which are of prime importance, the information is vital for all road users. So there is no point in confidentiality of message in this scenario. Yet balance must be maintained in securing the message from unwanted receiver.

C. *Modeling of the mobility:*

Nodes are highly mobile in VANET. Yet the position of the vehicles could be modeled or predicted based on the speed of the vehicles and road structure.

D. *Fading of the signal:*

Signal strength may decreases between the vehicles which exchange information among themselves. This signal fading may be due to some other vehicles which impedes the signal transfer or may be building.

IV. VANET ARCHITECTURE

VANET defines three types of architecture [18] namely Pure Cellular/Wireless Local Area Network (WLAN), Hybrid and Pure Ad-hoc Architecture.

Pure cellular architecture is called vehicles-to-infrastructure (V2I) communication and this brings together the various technologies like cellular systems, IEEE 802.11 and LTE. In this architecture VANET collect information through WLAN or access points to connect to the network.

Pure Ad-hoc infrastructure is known as vehicle-to-vehicle (V2V) communication. In this architecture vehicles communicate information among themselves in an infrastructure less environment.

In Hybrid architecture (V2I and V2V), wireless devices are fixed in cellular towers and automobiles to enable communication of information among them Hybrid architecture is better as it offers content sharing flexibility.

V. DIFFERENCE OF VANET FROM MANET

VANET differs from MANET [10] [14]in following properties

PROPERTIES	VANET	MANET
Density of Nodes	Dense and Variable	Sparse
Node Lifetime	Depends on lifetime of the vehicle	Depends on Power resource
Bandwidth	1000 kbps	100 Kbps
Topology change	Frequent and very fast	Slow
Production cost	Expensive	Cheap
Reliability	High	Medium
Node's moving pattern	Regular	Random

VI. VANET ROUTING PROTOCOLS

Routing protocols determine the route of the packet[4] between the vehicles. The major aim of these protocols [5] is to maximize the throughput and minimize the overhead and packet loss.
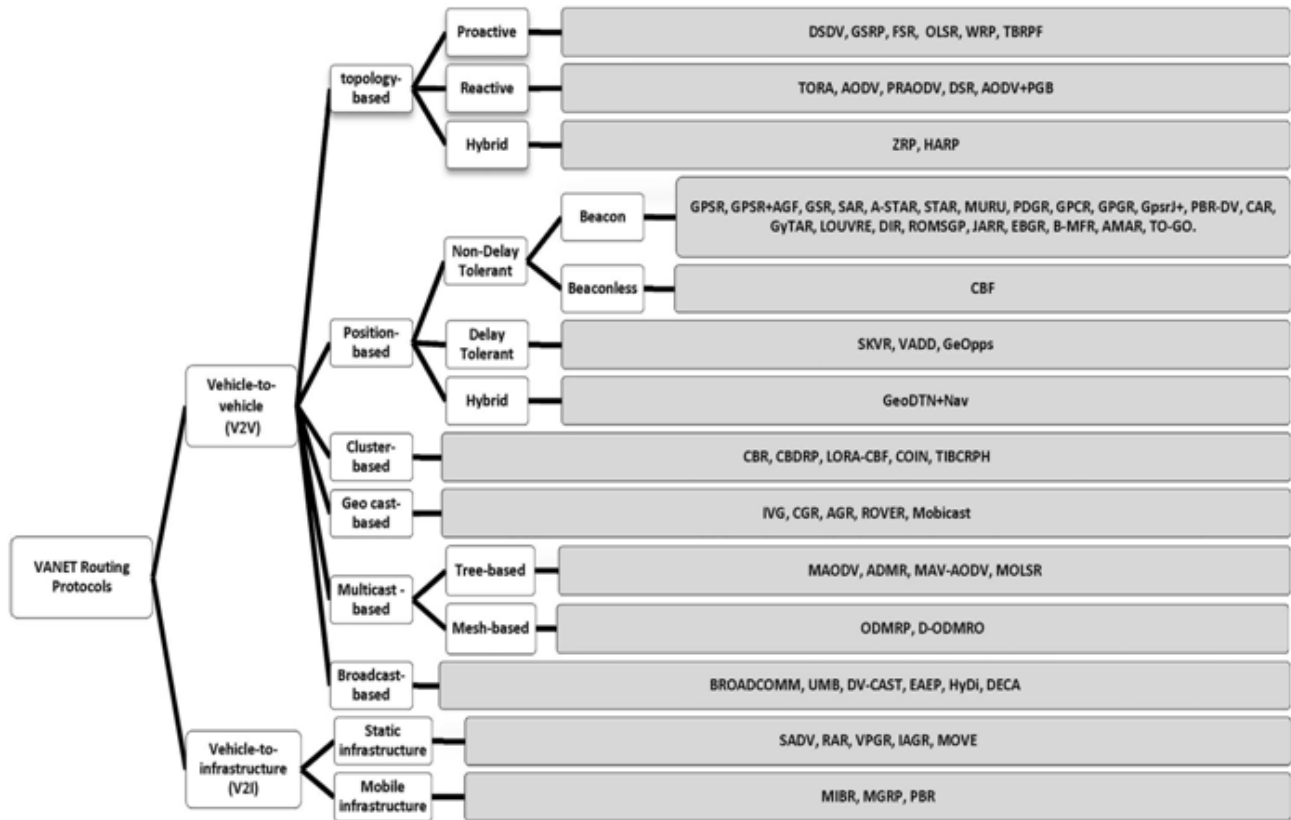
Figure 2.Various routing protocols in VANET

A. Vehicle-to-vehicle Infrastructure:

The classification under vehicle to vehicle architecture includes static and mobile infrastructure.

i) Static infrastructure based routing protocol:

These protocols use road-side units (RSU)along the roads to route the packets to vehicles within the range of transmission. The number of RSUs depends on the protocol to be adopted. Certain protocols may require RSU to be placed uniformly along the entire roadside. Whereas some may require only at border zones. Major benefits of RSUs are that higher the size of antenna higher is the range. The major static infrastructure based routing protocol include SADV, PAR, VPGR, and MOVE.
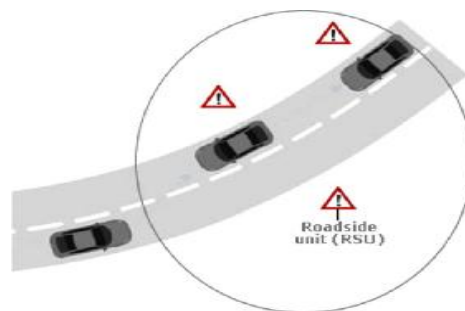

Figure 3. RSU's in Static Infrastructure Routing Protocol

ii) Mobile Infrastructure Routing Protocol:

RSUs in static infrastructure protocol minimize the delay.Yet cost and the number of RSU needed is an issue. In mobile infrastructure protocols mobile vehicles are used as mobile gateways instead of RSUs. These protocols include MIBR,MGRP and PBR which revolve around mobile infrastructure for their routing.

B. Vehicle to Infrastructure Routing:

This includes unicast, multicast and broadcast routing protocols. Unicast routing protocols [7] includes both position based routing and topology based routing.

i. Position Based Routing Protocol:

In this protocol, node's position information is used to send and receive packets between source and destination[15].In these protocol, information regarding route discovery and maintenance and topology need not be maintained. The major fields in the packets being transmitted includes location and packet forwarding.

Some of the position based routing protocols include Distance Routing Effect Algorithm for Mobility(DREAM) and GPSR(Greedy Perimeter Stateless Routing)

ii. Topology based routing protocols:
Topology based protocols use the link information in the network for forwarding the packet.
categories of topology based routing protocols:
1. Proactive Routing (Table-driven)
2. Reactive Routing (On-demand)
3. Hybrid Routing.

1. Proactive (Table-driven) Routing Protocols:
The information of a node and its associated node is recorded and its associated node is recorded in the tables as they are table-driven. These tables are distributed among all the neighboring nodes. When the topology of the network changes, routing tables has to be renewed by the nodes. Various proactive routing protocols include Destination Sequenced Distance Vector, GSRP, FSR, OLSR.

Basically nodes (automobiles) in MANET are highly mobile. So the category of proactive routing protocols may not be the correct choice because the table has to be transmitted for large amount of data and bandwidth requirement is also more.

2. Reactive Routing Protocols:
Reactive protocols are On-demand protocols. These protocols use broadcasting of the messages for route discovery which causes overhead. These protocols update the routing information constantly and so they fit to be used in VANET.
Various Reactive routing protocols[13] include TORA, AODV, PROAODV, PSR.

3. Hybrid Protocols:
Hybrid protocols coordinates the functionalities of both Proactive and Reactive protocols. Most of these protocols are Zone-based which greatly helps in route discovery process and reducing overhead.
These types of protocols are not designed for highly dynamic environment. The zone-based techniques in these protocols helps to minimize the overhead which is caused by the proactive routing and also reduce the time for discovery of route in reactive protocol routing. Zone routing protocol comes under Hybrid routing.

iii. Multicast Routing Protocols:
These routing protocols transmit from single source to multiple destinations. VANET favors multicast routing protocols for, they have wireless nature which enables transmission of messages to many nodes.

1. Tree Based Multicast Routing Protocols:
This is a variant of multicast routing protocol which establishes a routing tree to transfer data from source to other nodes in the group. Free band multicast routing protocols are MAV-AODV.

2. Mesh-Based Multicast Routing Protocols.
Mesh based protocol maintains a mesh which has the network components connected together containing all the receivers in a single group. Examples of mesh-based multicast routing approaches are ODMRP, D-ODMRP.

iv. Broadcast-Based Routing Protocols:
These protocols are generally used to share information regarding road condition for advertising. Broadcast protocols follow simple process of flooding. These protocols include BROADCOMM, DECA, HYDI, and EAEP.

v. Geo Routing Protocols:
In these routing protocols, packet forwarding is done in multicast manner based on position. The main idea is to transfer the packets to the nodes based on the zone of relevance (ZOR)[2]. The zone of relevance in the region where automobiles receive the geo cast[8] message.
The major drawback of these protocol is the partitioning of the network [11]which will hinder the proper forwarding of messages .Some of the geo cast routing protocols include ROVER, MOBICAST, AGR.

vi. Cluster Based Routing Protocol:
In this protocol, vehicles which are nearby form a cluster. Each cluster has a cluster header and every time node selects the best neighbor cluster to forward the data.
The common cluster based routing protocols include CBR, COIN, LORA-CBF.
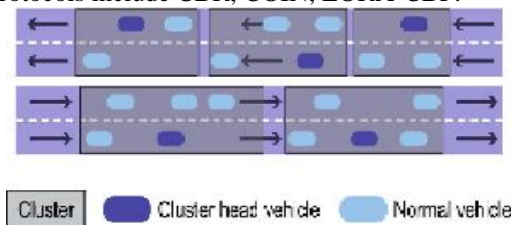

Figure 4. Cluster Based Routing protocol

VII. CONCLUSION

Due to advancement in telecommunication industry motivation for research on various challenges on VANET has also increased. One such challenge is routing in VANET. In this paper VANET characteristics and the predominant issues in vehicular network in day to day life is elaborated. The difference of VANET from MANET is provided in this paper. Further the classification of various routing protocols under VANET routing is explained in a concise manner. The future work would be to concentrate on the techniques of securing the VANET [12] and finally to compare the performance of the various protocols based on the various performance metrics.

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