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An Analysis of Various Routing Protocols in VANET

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Abstract: *Vehicular Ad Hoc Networks (VANET) is a part of Mobile ad hoc networks which provides a well-known approach for Intelligent Transport System (ITS). The survey of routing protocols in VANET is essential and required for smart ITS. This paper discusses about various protocols and routing applications for VANET. This mainly focuses on advantages and disadvantages of VANET applications. It explores the impulse behind the intended, and traces the growth of these routing protocols. The comparison of various type of routing protocols are given in this paper as concluded and given below for the VANET Technology.*
Keywords: *VANET, routing protocols, QoS, V2V, V2I*

I. INTRODUCTION

Vehicular Ad-hoc Networks (VANET) is one of the most and demanding research area in automotive companies and ITS designers. In general, a VANET is formed from several numbers of vehicles which are in the identical road to form ad-hoc network. VANET is derived from mobile Ad Hoc networks (MANETs), is a right approach for future intelligent transportation system (ITS). These networks have no fixed communications on the vehicles themselves to provide network functionality. Although it has high mobility, driver behavior, VANETs exhibit characteristics that are considerably different from many generic MANETs. VANET enable vehicles to communicate each other with roadside system. In 19th Century traffic are controlled and managed by traffic police through their hand signals, and through traffic lights. After a decade the vehicles are increase on road side and not able to manage through hand signals so to avoid.

In the 1930s saw the automation of traffic signals and in the 1940s car indicators were developed widely. Now a day the smart cities mostly focus on observing the traffic pattern and managing traffic accordingly road transportation naturally provides the similar information to all cars, and the amount of information that the drivers can share directly with one another is controlled. In the presence networks opens the way for a broad range of applications such as safety applications, mobility and connectivity between both driver and passengers to develop the transport systems in a smoothly, efficiently and safer way by exchange more information, such as traffic information and directions through phones between each other, the wireless sensor technologies supports in sharing the information between the vehicles and it's also communicated through (WAVE) Wireless Access for the Vehicular Environment, In this paper the terms used as V2I (vehicle-to –infrastructure),I2V (infrastructure-to-vehicle) and V2V (vehicle-to- vehicle) communications.

II. NETWORK ARCHITECTURES

Wireless ad hoc networks generally do not trust on fixed roads for communication and distribution of information. The Network architecture will mainly focus on pure cellular/WLAN, pure ad hoc, and hybrid. as shown in the Figure 1. In VANETs to access the Internet the VANET may use fixed cellular gateways and WLAN / WiMax access points at traffic intersections, it also gather traffic information, and routing information. The network architecture set-up that concentrates on pure cellular or WLAN structure as shown in Fig. 1(a).where the VANETs can combine both cellular network and WLAN to form the networks to access the services on access point where it is avail and other 3G connections.

Figure 1: Network architectures for VANETs (a) Cellular/WLAN (b) Ad Hoc (c) Hybrid

Still the Standard Gateways or fixed gateways roughly on the sides of roads could provide connectivity to vehicles through (mobile nodes) and impossible in considering the communication structure. As blind crossing the goal of vehicle to vehicle communication through Figure 1(b) pure mobile adhoc network it achieves certain goals between the vehicles to vehicle communications. Hybrid Architecture for VANET Safety Message Dissemination provides the combined communication structure between the infrastructure networks and ad hoc networks among the safety upon the roads. In paper [13] proposed such a hybrid architecture, in which it can uses both the WLAN and the cellular to access the network routing. Through multi hope links the vehicles are communicated through WLAN around the globe world. The hybrid architecture can provide better coverage, but also causes new problems, such as the faultless change of the communication among different wireless systems.

III. VEHICULAR NETWORK LAYERED VIEW

The basic 5 aspects of Vehicular networks can be classified as shown in table.

1. Vehicular Networks has the various range of applications that varies safety applications to relieve applications.

Table 3.1. Vehicular Network Layered View.

Vehicular Network	Application Type	Safety application
		Intelligent transport application
		Comfort application
	Quality of Service	Soft-real-time
		Hard-real-time
	Scope	Wide Area
		Local Area
	Network Type	Ad hoc
		Infrastructure-based
	Communication Type	V2I
		V2V

To avoid accidents during driving conditions and give enough time to the driver by applying brakes automatically through safety applications have developed. It also divided as follows:

- Cooperative collision warning
- Incident management
- Emergency video streaming.

The main aim of intelligent transport applications is that to provide a quick delivery of traffic information, and gives the effectiveness and accurateness of traffic finding by allowing shared processing of information between vehicles. These applications focus on observing the traffic prototype and managing traffic as a result. It can be further categorized into the following:

- Traffic Monitoring
- Traffic Management
- Platooning
- Vehicle tracking
- Notification services

Quiet applications are the applications of VANET related to easy level of the peoples moving in the vehicles. It can be further categorized into the following:

- Parking place management.
- Distributed games and/or talks.
- Peer to peer applications

Therefore, the Quality of Service (QoS) required for the network varies from non-real-time, to soft real-time where a timing failure might compromise service quality, up to hard real-time where a timing failure might lead to a disaster. These applications can also be assure by their scope, i.e., where they provide communication over a wide area, or are local only. At last, such applications can vary in their networking approach: ad hoc, where vehicles communicate suddenly, or infrastructure-based, where communication is governed by fixed base stations. VANET has belongs to two different types of communications namely Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I).

IV. VANET CHARACTERISTICS, ISSUES AND REQUIREMENTS

Wireless communication, mainly real-time communication is highly unpredictable. In addition, VANET has firm unique issues that make it different from other wireless networks. Because no central coordination can be assumed, an individual shared control channel is required at the MAC layer. Mobility that is based on knowledge the vehicular network is also very explicit, For example, in the pre defined direction the vehicles are moved on the road. In ordinary mobility models might not address the necessities of VANET. Furthermore, nowadays four wheelers are having very high mobility rates and so change the topology in an in-deterministic method that makes wireless transmission not easy.

In addition, the vehicle density exhibits spatio-temporal variations: it may be very limited (eg. Highway), only few or no vehicles or very dense (eg. city area), with over 500 vehicles per kilometer. Both ends of the compactness spectrum are particularly not easy. The applications of vehicular networks should also fulfill a number of nonfunctional requirements, such as potentially very high consistency, but also provides safety to ensure that safety-critical applications. Vehicles over very large geological area such as cities or countries, it requires large-scale of networks, and mainly a very wide use of equipment if infrastructure-based networks are used. Many VANET applications require the constraints and the QoS needs. Efficient broadcasting of safety messages for getting full coverage and low latency to provide QoS and consistency in VANET routing is still a challenging problem [8].

As mobility of VANETs cannot be captured by common mobility models. Traffic flow both in time and whole need to be learn and incorporated in the design of dependable and high-performance mobility models. Security is also one of the major issues in VANET. Collaboration with inter-vehicular networks and sensor networks placed within the vehicles or along the road need to be further investigated and analyzed. For the development of vehicle growth smooth communication is maintained. In addition to technological challenges, socio-economic challenges have to be solved. The benefits of V2V communication only become major when there are a sufficiently large number of vehicles using the technology. Vehicular applications must operate under initial low accesses.

V. OVERVIEW OF ROUTING PROTOCOLS

In VANET, the five categories in the routing protocols: Topology based routing protocol, Position based routing protocol, Cluster based routing protocol, and Geo cast routing protocol and Broadcast routing protocol. On the basis of area / application these protocols are characterized where all the protocols are most suitable [1].

A) Topology Based Routing Protocols

These routing protocols use links information that exists in the network to forward the packets. They are also divided into Proactive and Reactive.

Proactive routing protocols

The proactive routing means that the routing information will be hopped for the next background communication request. The main advantage of proactive routing protocol is that there is no route finding since the destination route is stored in the background, but the main disadvantage of this protocol is that it provides low latency for real time application. A table is created and maintained within a node. So that, all entry in the table indicates the next hop node towards an assured destination. It also leads to the maintenance of unused data paths, which causes the drop in the existing bandwidth. The different types of proactive routing protocols are: LSR, FSR.

Reactive/Ad hoc based routing

Reactive routing opens for the node communication when it is essential to communicate with each one. It maintains only the current routes in use; as a result it reduces the trouble in the network. Reactive routing consists of route find phase in which the query packets are swamped into the network for the path search and when route is found this phase completes. The various types of reactive routing protocols are AODV, PGB, DSR and TORA.

B) Position Based Routing Protocols

The class of routing algorithm is considered from the Position based routing. In order to select the next forwarding hops they share the property of using geographic positioning information. The packet is transmitted without any map facts to the one hop neighbor, which is closest to destination. Position based routing is helpful since no global route from source node to destination node need to be created and maintained. Position based routing is generally divided in two types: Position based greedy V2V protocols, Delay Tolerant Protocols.

Position Based Greedy V2V Protocols

In greedy strategy the intermediate node forward the message to neighbor nodes in next direction. Greedy approach should posses its position by itself between the intermediate nodes. The main goal of these protocols is to convey the packets to the destination as soon as possible and it will avoid the delay routing protocols. Greedy V2V protocols are GPCR, CAR and DIR.

1. Greedy Perimeter Coordinator Routing (Gpcr)

GPCR is based upon the detail of that city street form a natural planner graph. The External static street map operation is not needed for GPCR GPCR has two components: Controlled Greedy forwarding procedure and repair strategy for routing algorithm. It follows a target based greedy forwarding strategy, it routes messages to nodes at connection. As GPCR have no external static street map so nodes joints are difficult to find the path. So GPCR uses heuristic method for finding nodes where it located each other at coordinates. For make routing decision coordinator has the responsibility. The coordinator uses e two approaches they are

(a) Neighbor Table Approach

(b) Correlation coefficient approach

(a)Neighbor Table Approach:

The nodes transmit signal of messages which contains their position of information about the neighbors, and neighbor's neighbor through intersection.

(b) Correlation coefficient approach:

In this to find the correlation coefficient the node uses its position, proxy. This approach performs better than neighbor approach. By using this approach the algorithm can avoid dependency on external street map.

2. Connectivity Aware Routing Protocols (Car)

CAR protocols get a route to a destination; it has single characteristics that it maintains the reserve of successful route between various source and destination pairs. It also finds the point of destination vehicle repairs route as the position changes. It also contain vector information through velocity vector, which will all the calculate the velocity. By using Beacons it can also be piggybacked on forwarded data packets to reduce wastage of bandwidth and congestion. The distance between nodes exceeds the threshold value. The CAR protocols introduces the data of a security which is a geographic marker message, it is buffered and passed from one vehicle to another to spread the information. A security is a temporary message that has an ID, a TTL (Time to live) counts. Due to communication gap between anchor points routing errors may occur. So CAR protocol has two revival strategies to manage with the problem. The active waiting cycle strategy in Time out algorithm .T he error recovery on second strategy is walk around.

3. Diagonal-Intersection-Based Routing Protocol (Dir)

DIR protocol builds a series of transverse intersections between the source point vehicle and destination vehicle. The DIR protocol forwards the packets towards source to destination by using geographic routing until the packets reaches the destination.DIR vehicle is also allows sub path with poor data packet delay between the neighboring nodes too. The Low sub path delay is selected to reduce the packet delay. DIR protocol can repeatedly adjust routing path for keeping the lower packet delay.

4. Delay Tolerant Protocols

In metropolitan areas the where vehicle are heavily packed locating a node to carry a communication is not a problem but in country highway situation or in cities it is very difficult to establish the point to point routing at night. So to avoid that we considered sparse networks. The various types of Delay Tolerant Protocols are MOVE, VADD, and SADV.

5. Motion Vector Routing Algorithm (Move)

The MOVE algorithm is an algorithm developed for the for sparse VANET setting. In these developed vehicle where the mobile router that have irregular connectivity with other vehicles. Connection may have infrequent topology where the frequent changes occur. The algorithm must expect whether forwarding message will provide progress toward intended destination. M OVE algorithm assumes to that each node has information of its own position, route (source) and destination. Through this vehicle positions are calculate nearer or distanced M OVE algorithm use less buffer space. MOVE algorithm is specially designed for the data transfer from sensor networks to base station through sparse networks.

6. Vehicle Assisted Data Delivery (Vadd)

In Sparse network VADD uses to carry and forwarding approach to allow packets to be carried out when the node arrived then the packets are transmitted to forward on the sparse network. VADD require knowing about its position of the vehicle and also requiring an external static street map. Each packet has three nodes: Intersection, Straight Way and Destination, where each mode are based on location of the packets, or the packets should move only on the specified location or it should move only in the avail direction. In Straight Way node only have the current node is on a road must have only two possible directions for the packet to travel, either from one direction or in the reverse direction. The final destination is that when the packet is close it is to be its final destination.

7. Static Node Assisted Adaptive Routing Protocol (Sadv)

The aim of SADV Protocol is to reduce the message delivery delay in sparse networks. It is also adaptable in all types of traffic system. It also allows finding the density of traffic and measuring the amount of time for delivering the messages in time. SADV also located the vehicle through GPS (Global positioning System) each vehicle has accessed to external static street map. SADV has three special modules; Static Node Assisted Routing (SNAR), Link Delay Update (LDU) and Multipath Data Dissemination (MPDD). The two modes operate on SADV: "In Road Mode" and "Intersection Mode". SNAR make use of optimal paths, which are determined the pre occupied road maps. LDU maintains the delay surrounding substance dynamically by measuring the delay of message delivery between static nodes. MPDD helps in multipath routing.

C) Cluster Based Routing

Cluster based routing is preferred in clusters. A group of nodes identifies and is designated as cluster head will broadcast the packet to cluster. Good scalability but network delay is incurred when forming clusters in highly mobile VANET. In cluster based routing virtual network communications must be created through the cluster of nodes in order to provide scalability. The different Clusters based routing protocols are COIN and LORA_CBF.

D) Broadcast Routing

In networking, broadcasting refers to transmitting a packet received by every device on the network. Broadcast routing is commonly used in VANET for distribution, interchange, climate and disaster, road conditions among vehicles and delivering advertisements and announcements. Broadcasting a message is in compare to unicast addressing in which a host sends datagrams to another single host identified by a unique IP address. The BROADCOMM, UMB, V-TRADE, and DV-CAST are the different Broadcast routing protocols.

E) Geo Cast Routing

Geo cast routing is mainly a position based multicast routing. Its aim is to carry the packet from source node to all other nodes within a particular geographical region (Zone of Relevance ZOR). In Geo cast routing vehicles external the ZOR are not alerted to avoid redundant speedy reaction. Geo cast is considered as a multicast service within a specific geographic region. It generally defines a forwarding zone where it directs the flooding of packets in order to decrease message transparency and network jamming caused by simply flooding packets all over. In the target zone, unicast routing can be used to forward the packet. One drawback of Geo cast is network partitioning and also adverse neighbors, which may delay the proper forwarding of messages. The different Geo cast routing protocols are IVG, DG-CASTOR and DRG.

Table 5.1 Comparison Of Various Protocols

Protocols →	**Proactive Protocols**	**Reactive Protocols**	**Delay Bounded Protocols**	**Cluster Based Protocols**	**Broadcast Protocols**	**Geocast Protocols**
Digital Map Requirement	No	No	No	Yes	No	No
Virtual Infrastructure Requirement	No	No	No	Yes	No	No
Realistic Traffic Flow	Yes	Yes	No	No	Yes	Yes
Recovery Strategy	Multi Hop Forwarding	Carry & Forward	Multi Hop Forwarding	Carry & Forward	Carry & Forward	Flooding
Scenario	Urban	Urban	Sparse	Urban	Highway	Highway

Prior Forwarding Method	Wireless multi hop Forwarding	Wireless multi hop Forwarding	Carry & Forward	Wireless multi hop Forwarding	Wireless multi hop Forwarding	Wireless multi hop Forwarding

VI. CONCLUSION

In this section we have seen that existing routing protocols. Table 2 gives a Comparison of these protocols. To make the decisions routing the node positions and also describes the packets forward Prior forwarding method describes the first routing decision of the protocol when there are packets to be forwarded. The prior forwarding method is used to find the Delay Bounded protocols. While in all other routing protocols wireless multi hop process of forwarding is used. Digital map provide street level map and traffic data such as traffic mass and vehicle velocity on road at different times. Digital map is compulsory in case of Some of Cluster Based Routing Protocols. Fundamental Infrastructure is created from end to end clustering of nodes in order to provide scalability. Every cluster can have a cluster head, which is answerable for secure communication between inter-cluster and intra cluster skill in the network. Revival strategy is the rule, in which is used to review the performance of the protocol.

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