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Vehicular Ad-Hoc Network: Routing Protocol

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Abstract: ***Vehicular Ad hoc Network (VANET) is a subclass of mobile ad hoc networks (MANETs) and a special type of Intelligent Transport System (ITS), it is an emerging new technology integrating ad hoc network wireless LAN (WLAN) and cellular technology to achieve intelligent inter-vehicle communications and improve road traffic safety and efficiency. To support the smart ITS The design of routing protocols in VANETs play a important role. The key difference of VANET and MANET is the special mobility pattern and rapidly changeable topology. Existing routing protocols of MANET are not suitable for VANET. It is observed that The key consideration for designing all routing protocols in VANETs is carry and forward. In VANET, routing is a difficult task because of the high mobility of nodes, which causes rapid changes of topology and to deliver a packet within a minimum period of time. Existing routing protocols are not sufficient to meet all the issues in routing. To provide best routing protocol, it is necessary to make an analysis of routing protocols in VANET.***

Keywords: Vehicular Ad Hoc Networks (VANETs), Intelligent Transport System (ITS), Routing Protocols, Advantages and Disadvantages

1. Introduction

Vehicular Ad Hoc Networks (VANETs) have gained a lot of popularity in the last few years due to its usage in a number of applications. VANET are emerging new technology to integrate the capabilities of new generation wireless network to vehicles. Vehicular communication is a communication between the vehicles. Vehicles share different kinds of information such as safety information, traffic jams, traveler's related information and entertainment. It provides comfort and convenient journey for passengers and drivers. Applications of VANET are classified into following classes they are safety oriented, non-safety oriented, commercial oriented, convenience oriented and productive applications[1].

Vehicular AD Hoc networks are also called vehicle to vehicle communications (V2V) or inter vehicle communications (IVC). Vehicles can communicate with others in three different ways such as Vehicle to Vehicle communication (V2V), Infrastructure to Vehicle (I2V) communication and Vehicle to Infrastructure (V2I) Communication[2]. In V2V communication, Vehicles can directly communicate with other vehicles.V2I and I2V communication refer to the communication between vehicle and Road Side Units (RSUs).

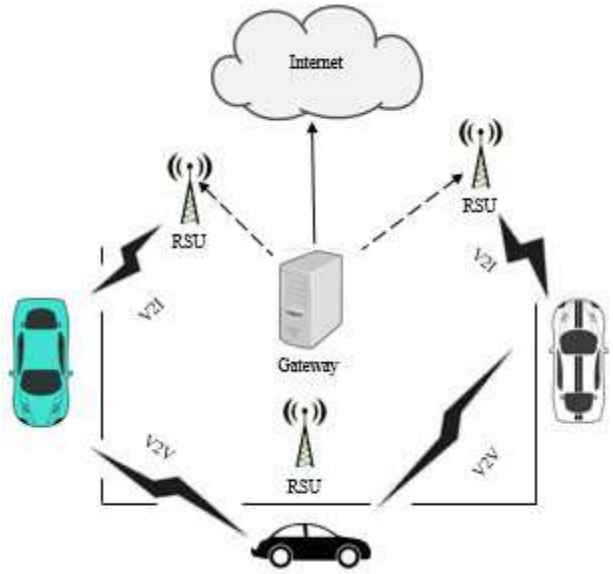

Figure 1: VANET architecture

With the development of vehicle industry and wireless communication technology, VANET are becoming one of the most promising research fields. VANETs use vehicles as mobile nodes are a subclassof mobile ad hoc networks (MANETs) to provide communications among nearby vehicles and between vehicles and nearby roadside equipment [3] but apparently differ from other networks by their own characteristics. Specifically, the nodes (vehicles) in VANETs are limited to road topology while moving, so if the road information is available, we are able to predict the future position of a vehicle; what is more, vehicles can afford significant computing, communication, and sensing capabilities as well as providing continuous transmission power themselves to support these functions [4]. Intelligent Transport System (ITS) is one of the important application of VANET. VANETs is providing Internet connectivity to vehicular nodes while on the move, so the users can download music, send emails, or play back-seat passenger games. Other application are co-operative traffic monitoring, control of traffic flows, blind crossing, prevention of

collisions, nearby information services, and real-time detour routes computation.

VANET has its unique characteristics which pose many challenging research issues, such as data sharing, data dissemination and security issues Because of the unreliable channel conditions and high nodes mobility. Finding and maintaining routes is a very challenging task in VANETs, So we mainly focus on a key problem i.e. routing protocol for VANETs. Many routing protocols have been developed for Mobile Ad Hoc Networks (MANETs), and some of them can be applied directly to VANETs. One of the main requirement of the routing protocols is to achieve minimum consumption of network resources with minimal communication time. VANET are different from those of MANETs Because of the characteristics of fast vehicles movement, dynamic information exchange and relative high speed of mobile nodes simulation result showed that they suffer from poor performances.

The rest of this paper is organized as follows. Section 2 introduce the classification of routing protocols and taxonomy of vehicular adhoc networks, it also explain the merit and demerit of routing protocol. Then in section 3 , we discuss the performance of existing routing protocol. Finally the paper is concluded in section 4.

2. Classification of Routing Protocol

Several routing protocols have been constructed for communication between the vehicles in adhoc environment but Because of the dynamic nature of the mobile nodes in the network to deliver a packet within a minimum perios of time and maintaining and finding routes Is very challenging task in VANETs. The existing routing algorithm in MNAETs are also not available for most scenarios in VANETs. Routing protocol can be divided in geocast based, broadcast based, cluster based, position based and topology based protocols [5]. Classification of routing protocols in VANET has been shown in figure 2.

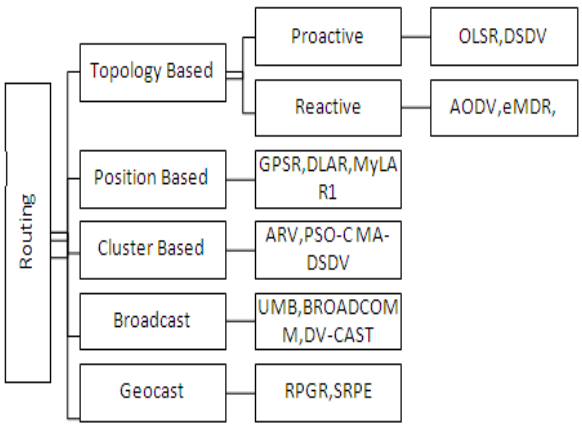

Figure 2: Classification of routing protocol.

2.1 Geocast routing protocol

It is basically a location based multicast routing because of the requirement of distributing messages to unspecified/ unknown destinations the geocast protocols are necessary in VANETs. Joshi et.al [6] had proposed a distributed robust geocast protocol for inter-vehicle communication. The goal of distributed robust geocast multicast routing protocol is to deliver packets to vehicles located in a specific static geographic region. A vehicle need to receive or drop packets only depended on its current location. If a vehicle is located within this specific geographic region, this vehicle receives packets. Otherwise this vehicle drops packets [7].

2.2 Broadcast routing protocol

Broadcast routing is one of the used technique in VANET periodically. Here the messages are broadcast among vehicles and between V2I/I2V. The implementation of broadcast routing is done using the technique flooding. Flooding guarantees that the message will eventually reach all nodes in the network. Flooding performs relatively well for a limited number of nodes and is easy to be implemented. This routing mainly shares safety information, such as weather, traffic, emergency and road conditions[8].

2.3 Cluster Based routing protocol

In cluster based routing entire geographic area has been divided in to clusters. Closed Vehicles form a group for communication. Each cluster can have a cluster head which is responsible for inter and intra cluster communication[9]. Nodes inside a cluster communicate via direct links.

2.4 Position Based Routing Protocol

Position based routing has been identified as a more promising routing paradigm for VANETs. It is based on the geographic location information of nodes in the routing process. GPSR (Greedy Perimeter Stateless Routing) [10] is one of the best known position based protocol. It combined the greedy routing with face routing by using face routing to get out of the local minimum where greedy fails. It works best in a free open space scenario with evenly distributed nodes[11].

2.5 Topology Based Routing

It is used to store source to destination information in the routing table. There are two types of routing protocols: proactive routing protocols and reactive routing protocols.

Proactive routing protocols are mostly based on shortest path algorithms. It is used to store all the network nodes routing information in the table. They routing table keep information of all the connected nodes in form of a table because these protocols are table based. Each node maintains the absolute image of a network until it receives the new one.

A Reactive routing protocol is also known as the on demand routing protocol. It starts the route discovery process when it needs. This protocol does not know about the entire network.it is convenient for large sized ad hoc networks which have dynamically changing topology.

VANETs has also been classified in to three broad categories: unicast, multicast and geocast, and broadcast approaches.

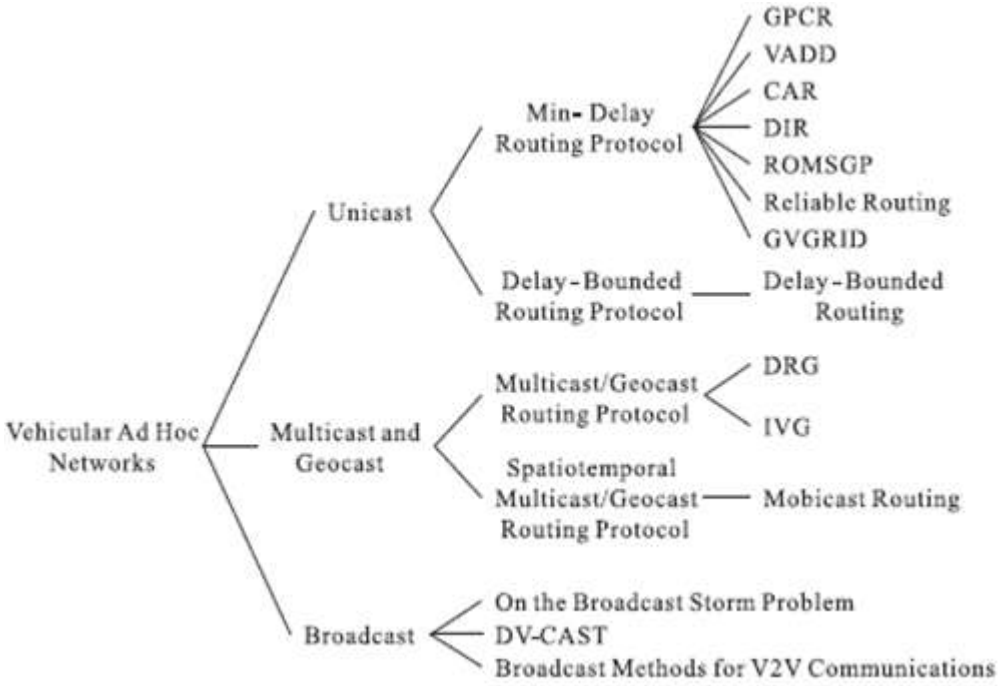

Figure: Vehicular Ad-Hoc Network Taxonomy

Table 1: Routing Protocol Advantages and Disadvantages

Routing protocol	Advantages	Disadvantages
Proactive Routing Protocol	The delay is avoided. The routes are predefined. No route discovery takes place	Maintenance of unused nodes leads to high network load. Bandwidth utilization is high. Frequently update the routing table because of the high dynamic topology. All these three factors degrade the network performance.
Reactive Routing Protocol	With the help of the routing table the route from sender to receiver is maintained. Network traffic is decreased and bandwidth is saved.	If communication exceeds, flooding of the network causes suspension of nodes. Searching delay is high for route.
Position based routing protocol	Route discovery delay is avoided. No routes and routing tables are maintained.	Failure and deadlock may occur in the location server. There is a need for the GPS, Position and location finding services. Satellite signal does not reach in the tunnel.
Cluster based routing protocol	It has high scalability. It is suitable for large networks.	Increases the delay in formation of clusters.
Broadcast based routing protocol	It is easy to implement. Well suited for a small amount of network.	Each node in a network receives the flooding message at the same time, so collision and congestion occur. When the network size is large, the bandwidth utilization is high.
Geocast based routing protocol	In this routing collision is reduced	Satellite signal does not reach in the tunnel. There is a need for the GPS, position and location finding services.

3. Study of Existing Routing Protocol

Omar sami oubbati et al. [12] proposed an Efficient Traffic Light Aware Routing Protocol (ETAR) for VANET. This protocol finds the most stable route for exchanging data packets based on traffic lights and traffic density of vehicles. By exchanging modified hello packets, it determines the density and connectivity of the vehicles. To ensure delivering the data packets to their destinations three steps are used, they are Path Selection, Greedy Forwarding and Carry and Forward method. ETAR is compared with topology based AODV and position based GyTAR. The proposed protocol is evaluated by two parameters, Packet Delivery Ratio (PDR) and End-to End Delay (EED) using NS2.34 simulator. A simulation result shows that ETAR outperforms in terms of PDR and EED.

David Chunhu Li et al. [13] proposed Bipolar Traffic Density Awareness Routing Protocol [BTDAR]. The authors proposed two protocols BTDAR-R for dense traffic density, BTDAR-P for sparse traffic density. BTDAR-R protocol uses multi-hop packet forwarding method. It finds optimal path selection based on the computation of path quality matrix and comparison. BTDAR-P protocol uses carry and forward method and hello beacon packets for discovering neighbour nodes. Simulation shows that the proposed protocol showed good performance with a rise in PDR and decrease Packet Delivery Delay.

Road Perception Based Geographical Routing Protocol (RPGR) is proposed by Kashif Nasear et al. [14]. It considers mid -range node, distance and direction as metrics to select the next hop node in the network. To overcome the disconnectivity problem it uses Carry and Forward mechanism. The proposed RPGR has been analyzed in simulation with three existing routing protocols GeoSVR, SDR, GMGR. A simulation result shows that RPGR

outperforms all the three existing protocols in terms of PDR, EED, Path Length (PL) and Packet Size (PS).

Xinming Zhang et al. [15] designed a Street-Centric Opportunistic Routing Protocol Based on ETCOP (SRPE). A link model with a wiener process is used to conclude the probability of link availability, which considers the unstable and stable vehicle states according to the activities of the vehicles. To transmit a packet with less resource network and higher throughput, different link combinations are used. Performance is evaluated by varying number of vehicles and a varying number of CBR connection pairs.

Po-Jen Chuang and Ming-Chun Liu [16] designed a Routing Table Learning and Maintenance (RTLM) Protocol for junction based V2V communication in VANET. This protocol is mainly focused on effective routing table learning and maintenance. It avoids unnecessary packet dropping. RTLM provides better stable route and lower transmission cost. A simulation result shows that RTLM outperforms GPCR, JBR, JMSR in terms of PDR, Average Delay Time (ADT) and Packet Drop Ratio.

Kashif Nasear et al. [17] proposed Beaconless Packet Forwarding Protocol (B-PFP) for urban environment. In this proposal, the authors use a beaconless packet forwarding method for packet transmission. At the time of packet transmission vehicle direction and link quality are considered. The protocol has two modes of data forwarding, one is at the intersection and other is between the intersections. B-PFP is compared with two beacon based protocol such as CAIR, IGRP and two beaconless protocols are BRAVE and LIATHON. The proposed protocol is evaluated by two parameters PDR and EED using NS2.34 simulator. A simulation result shows that BPFP outperforms in terms of PDR and EED.

Dynamic Vehicle Ontology Based Routing protocol (DVOR) was proposed by Sourav Chhabra et al. [18]. In this protocol, the shortest path routing that reduces the waiting time for vehicles at traffic jams is found. It uses RSU based scheme and activity file for finding the optimal path. DVOR mainly focused on Trip Duration time, so automatically waiting time is decreased. DVOR is compared with two proactive routing protocols OLSR and DSDV. The proposed protocol is evaluated by three parameters PDR, Mean Delay (MD) and Trip Duration using NS 3 simulator.

Neha Garg et al. [19] proposed an improved AODV routing protocol for VANET. In this, the protocol is optimized by using various parameters such as Hello Interval, Hello Message Loss and Active Route Timeout. Using these parameters is found the optimal route for data transmission. The proposed protocol is evaluated by three parameters PDR and EED and Throughput using OPNET Simulator V14.5. Simulation result shows that proposed AODV outperforms than the normal AODV.

Samira Harrabi et al. [20] proposed a PSO-C MADSDV cluster based protocol. In this protocol, multi agent approach and PSO optimization algorithm were combined. It improves the stability of links. This protocol effectively reduces the average number of dropped packets and decreases the unused path number. It increases the throughput. The proposed protocol is evaluated by three parameters Packet Drop Ratio, Throughput and Average Routing Overhead using MATLAB.

Aggregate Relative Velocity (ARV) backbone Cluster based protocol is proposed by Jaskaran Preet Singh et al. [21]. Cluster formation and Cluster head selection are based on a number of links and vehicular mobility in the network. A node with minimum ARV is selected as Cluster head. It reduces communication cost and increases stability. ARV protocol is compared with ALM protocol using NS2 simulator.

Mary Valantina and S.Jayashri [22] proposed QLearning based point to point data transfer in Vanets. This protocol is based on fuzzy constraint Q-learning algorithm. By taking multiple metrics such as available Bandwidth, Delay and Packet collision probability it determines whether the link is good or not. Simulation result shows that the proposed protocol is the best performance with a rise in PDR; decrease EED and low overhead.

Manuel Fogue et al. [23] proposed a novel scheme called enhanced Message Dissemination based on Roadmaps (eMDR) for VANETs. This protocol mainly focused on increasing the number of informed vehicles and reducing the notification time. Vehicles operate in two modes normal and warning mode. The default one is normal mode. If it detects any dangerous condition it acts as a warning mode. At the time of sending, if the vehicle is in warning mode then the message priority is set accordingly and the message is broadcasted. In case of receiving, the warning message and if the distance between sender and receiver is greater than the threshold distance, then the message is rebroadcasted. The simulation is performed and results are compared with existing protocols. It is shown that eMDR outperforms the compared protocols.

Aakash Jasper et al. [24] proposed a location based reactive routing protocol MYLAR1. It uses three packets for data transfer from one node to another and maintains a connection, they are route request, route reply and route error packets. Two types of route request packets are used by the author. Modified route request packet is used initially when there is no information about the destination. The original route request packet is used when route breakage has taken place. The redundant fields, flooding variable field and zone variable field are removed by the author in the modified route request packet. While reducing the size of modified request packet the network performance is increased and the overload is decreased. LAR1 protocol is compared with MYLAR1 protocol using Qualnet6.1 simulator.

R. S. Raw et al. [25] proposed Analytical Evaluation of Directional-Location Aided Routing Protocol for VANETs. D-LAR protocol combines location aided routing and directional routing methods. In this protocol, the selection of next-hop node is based on greedy approach. Through analytical analysis, the authors have given the relationship among the link lifetime, average number of hop counts and

path throughput metrics for the protocol. This protocol is simulated by using MATLAB tool.

4. Conclusion

In VANET, a vehicle can leave or join the network in very small period of time, which causes numerous changes in the topology. Routing protocols must respond quickly to the changes in order to send the proper routing of packets to their final destinations. This paper provides a classification of routing protocols and discusses its advantages and disadvantages. In future, a new routing algorithm will be created and its performance over the other schemes of the category will be explained.

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