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REVIEW OF ROUTING PROTOCOLS IN VEHICULAR AD HOC NETWORK

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ABSTRACT
VANET (Vehicular Ad Hoc Network) is an emerging technology to achieve intelligent inter vehicle communications. Vehicular Ad hoc Networks is a type of special wireless ad hoc network, which has the characteristics of high node mobility and fast topology changes. The vision of VANET is to improve road safety by providing timely and accurate information to authorities. VANET is one of the influencing areas for the improvement of Intelligent Transportation system (ITS) in order to provide safety and comfort to the road users. But, efficient routing in VANETs remains challenging as due to the varying density of vehicles over time, VANETs size (hundreds or thousands of vehicles), natural obstructions in environments (e.g., buildings, trees, and other vehicles) and wireless channel fading due to high motion. However, many routing protocols for Vehicular Ad Hoc Network have been recently proposed. In this paper we reviewed various routing protocols for VANETs including HyBr(Hybrid Bee swarm Routing protocol).The HyBr combines the features of topology based routing with those of geographic based routing.

***Keywords*—** VANET, Intelligent Transportation system (ITS), HyBr, topology based routing, geographic based routing

I. INTRODUCTION

Vehicular ad hoc networks (VANETs) have been envisioned to enhance road safety and driving comfort, which can support vehicle-to-vehicle and vehicle-to-roadside communication [1, 2]. VANETs are different from mobile ad hoc networks (MANETs), in which mobile nodes (vehicles) are equipped with GPS receivers and move with high velocity along predetermined routes [1].

One of the most important aspects that determine the success of VANET is the reliable message routing from a source node to a destination node. Routing in VANET relies on the presence of a sufficient number of VANET nodes that constitute strong paths to allow the forwarding of messages in the network. These paths can be affected by the vehicles' mobility and traffic density, frequent network topology changes making them unsustainable and unreliable[3].Therefore, the design of an efficient routing protocol for VANET is considered to be a critical issue. Moreover, one of the most important requirements in the routing process is to share integrated data with road safety service in real time in order to provide the information passengers need to help them make safe decisions. Service guarantees are important in delivering messages with a maximum packet delivery ratio on one hand, and on the other hand with a minimum routing overhead and end-to-end delay which have become a challenge for most routing protocols for VANETs.Route discovery and maintenance can affect the requirements of safety applications [4].In VANET, the routing protocols are classified into five categories: Topology based routing protocol, Position based routing protocol, Cluster based routing protocol,Geo cast routing protocol and Broadcast routing protocol. These protocols are characterized on the basis of area /application where they are most suitable [5].In this paper we reviewed the various characteristics of VANET,its applications, various routing protocols including hybrid swarm intelligence routing protocol.

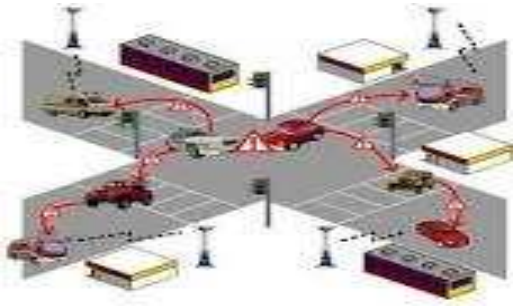

Fig. 1 VANET Scenario

II. VANET APPLICATIONS

VANET application can be categorized into following categories
(a) VANET provides ubiquitous connectivity on the road to mobile users.
(b)It provides efficient vehicle to vehicle communications that enables the Intelligent Transport System (ITS). ITS includes variety of applications like cooperative traffic monitoring, control of traffic flows, blind crossing and collision prevention.
(c)Comfort application is the application to allow the passenger to communicate with other vehicles and with internet hosts, which improves passengers comfort. For example VANET provides internet connectivity to vehicular nodes while on the movement so that passenger can download music, send emails, watch online movies etc [6].

III. VANET CHARACTERISTICS

Though Vehicular network share common characteristics with conventional ad-hoc sensor network such as self organized and lack of central control. VANET have unique challenges that impact the design of communication system and its protocol security [7]. These challenges include:

A. Potentially high number of nodes

Regarding VANETs as the technical basis for envisioned Intelligent Transportation System (ITS) we expect that a large portion of vehicles will be equipped with communication capabilities for vehicular communication. Taking additionally potential road-side units into account, VANET needs to be scalable with a very high number of nodes. [7]

B. High mobility and frequent topology changes

Nodes potentially move with high speed. Hence in certain scenarios such as when vehicle pass each other, the duration of time that remains for exchange of data packets is rather small. Also, intermediate nodes in a wireless multi-hop chain of forwarding nodes can move quickly. [7]

C. High application requirement on data delivery

Important VANET applications are for traffic safety to avoid road accidents; potentially including safety of-life. These applications have high requirements with respect to real time and reliability. An end-to-end delay of seconds can render safety information meaningless. [7]

D. No confidentiality of safety information

For safety application the information contained in a message is of interest for all road users and hence not confidential. [7]

E. Privacy

Communication capabilities in vehicles might reveal information about the driver/user, such as identifier, speed, position and mobility pattern. Despite the need of message authentication and non-repudiation of safety messages, privacy of users and drivers should be respected in particular location privacy and anonymity. [7]

IV. ROUTING PROTOCOLS OVERVIEW

Recently proposed routing protocols for VANETs can be broadly classified into two categories. One category is topology-based and uses network topology data to connect vehicles, and the other category of protocols called Geography-based routing protocols extends Global Positioning System (GPS) services to route the packets in VANETs. [8]

A. Topology-based routing

Traditionally, topology-based routing protocols were initially proposed for MANETs, and were applied to VANETs because they have many common properties such as node mobility, distributed and self-organizing topology, non-existence of central control, etc. [9]. However, VANETs can be distinguished from MANETs because of their specific characteristics such as very high node mobility, limited degrees of freedom in mobility patterns which can be somewhat predictable, since vehicles move in rural or urban areas consisting of roads, highways, buildings, etc.[8] The most common MANET routing protocol that has been applied to VANET is the Ad hoc On-demand Distance Vector (AODV) [10] protocol. The route discovery method of AODV is based on routing tables which store the routes toward multiple destinations. Each destination is indicated using only the next hop node to reach this destination. The source disseminates a Route REQuest (RREQ) to its neighbors which in turn sends the same packet to their neighbors and so on, until the final destination is reached. Once the route request reaches the destination or an intermediate node which knows the path toward the destination, a Route REPlay (RREP) is sent back to the source node through the reverse route. AODV uses a sequence number to discover fresh paths and to prevent routing loops. Abedi et al. [11] extended AODV to apply it to VANET using directions and positions of the source node and the destination node obtained from GPS to find routes. Basically, source and destination directions are used for the next hop selection. To do this, an intermediate node can be selected as the next hop in the requested route if it is located and moves in same direction as the source and/or destination. This modified AODV routing protocol for VANET uses the mobility model of vehicles to support the various characteristics of VANETs. This reactive protocol establishes updated routes only when required. However, the intermediate nodes could indicate inconsistent routes if the sequence number is not updated and, the idea to choose the next hop in same direction of source and destination does not guarantee the optimality of the route found. In addition, the network can be flooded by multiple RREQ and RREP in addition to unnecessary bandwidth consumption due to periodic beaconing. [8]

B. Geography-based routing

Geography-based routing protocols have also been applied to VANET. They are also called position-based routing protocols in which the node positions are used to route data between vehicles. They perform a recovery strategy to overcome the void case when there is no routing progress based on nodes' position data. A strong feature of these protocols is that the packets are routed to the destination without the knowledge of the network topology or a prior route discovery. In contrast, the source should determine its own position in addition to the position of the destination. [8] One of the most commonly used geographic-based protocols is the Greedy Perimeter Stateless Routing (GPSR) [12] proposed for wireless networks. It consists of two methods: the Greedy Forwarding method which is used wherever the forwarding of packets is possible, otherwise, the Perimeter Forwarding method is invoked. To achieve these goals, GPSR uses the positions of vehicles in its transmission range, and the destination to make its packet forwarding decision. In the case of greedy forwarding, the transmitter node chooses the optimal neighbor as the next hop which is the closest geographic node to the destination selected in a greedy manner. In other words, based on the neighbors' positions, the transmitter selects the closest neighbor as its local optimal choice. It will be considered as the next hop to the packet's destination.GPSR also uses a beaconing process to update its neighbors' data (such as positions, etc.). If there is no intersection between the transmitter node and the destination node, the perimeter forwarding method is executed. It is based on the right hand rule in which, each node forwards packet through the perimeter to its first neighbor counterclockwise about itself. It is worth pointing out that under frequent topology changes resulting from the high mobility of vehicles, GPSR can use the local topology information to find the correct new routes quickly. This protocol was simulated over a full IEEE 802.11 and was compared with DSR in terms of routing overhead and the number of data packets delivered. The results showed GPSR's scalability on densely deployed wireless networks. However, its greedy forwarding algorithm can fail if an interior node does not possess a neighbor in 2P/3 angular sector [12]. In addition, the perimeter forwarding algorithm finds a non-optimal route from the source to the destination which takes a longer time and is less efficient. [8]

Routing Protocol	Type	Sub Type	Overhead	Mobility Model	Propagation Model

AODV	Topology Based	Reactive	Path States	IDM on Manhattan grid	Probabilistic shadowing
GPSR	Position based	Non-DTN, Nonoverlay	Beacons	MTS	Probabilistic shadowing

Table1: Characteristics of representative routing protocols that have either been used or specially designed for VANET routing. [7]

V. ISSUES IN VEHICULAR AD-HOC NETWORK

The Vehicular ad hoc network (VANET) is a new model of Mobile ad hoc network for wireless communication between vehicles on road or in between the vehicle to road side unit. Due to the nature of dynamic network topology, routing in VANET play a vital role for the performance of the networks. There are various studies and researches in this field in attempt to propose more efficient routing protocols. However, there is not a routing protocol that can perform efficiently in every situation. The existing routing protocols are effective only when the node population is small. The Reactive routing schemes will fail to discover a complete path due to frequent network partition. The proactive routing protocols will be overwhelmed by the rapid topology changes and even fail to converge during the routing information exchange stage. The Position-based routing schemes generally require additional node physical position information during the routing decision process. A location service is needed as well to provide the position information of nodes. Due to the high node mobility and the movement constraints of mobile nodes the conventional topology-based routing schemes are not suitable for VANETs. [13]

Summary of drawbacks of both Topology-based and Geography-based routing. [8]

Topology-based routing

1. Inadequate for rural scenarios
2. Delayed transmissions
3. Increased routing overhead
4. Frequent broken routes
5. More dropped packets

Geography-based routing

1. Inadequate for urban scenarios
2. Using a longer path to transmit data
3. Inaccurate GPS node coordinates
4. Occurrence of inherent loops
5. Frequent network partitioning

VI. HYBRID SWARM INTELLIGENCE ROUTING PROTOCOL

To address the drawbacks of topology-based and geography based routing approaches, the hybrid routing protocol called Hybrid Bee swarm Routing (HyBR) protocol for VANET has been designed. HyBr is a unicast and a multipath routing protocol which guarantees requirements of VANET safety applications HyBR combines two fundamental routing methods namely; topology-based routing and the geography-based routing in order to reap their benefits on one hand and avoid their drawbacks at the same time.

HyBR is a hybrid protocol which applies a topology-based routing approach when the network density is high (e.g., city-based VANET) and applies a geography-based routing approach when the network is not dense (e.g., highways) . Using GPS devices, outdoors or through other means, each node saves the position information of all VANET nodes in a table called a

positions table which is updated whenever the network topology changes. Moreover, each node possesses its own routing table which contains the various routes toward the desired destination. Only the next hop toward the destination is indicated. [8]

VII. CONCLUSION

This paper discuss about Vehicular ad hoc network is a special form of MANET which is a vehicle to vehicle & vehicle to roadside wireless communication network, including applications and various characteristics of VANET. Also this paper review the various routing protocol categories i.e. topology based routing and geography based routing. The most common MANET routing protocol that has been applied to VANET is the Ad hoc On-demand Distance Vector (AODV) and the most commonly used geographic-based protocols is the Greedy Perimeter Stateless Routing (GPSR).Also this paper discuss the drawbacks of topology based routing and geography based routing and discuss the hybrid swarm intelligence routing protocol which combines the features of both topology based and geography based routing ignoring the drawbacks.

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