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Survey on Location-based Routing Protocols in Vehicular Ad-Hoc Network

Kshitiz Singh[1], Gauri Mishra[2], Abdul Raheem[3]

[1,2,3]*Department of Computer Science and Engineering*
[1,2,3]*Galgotias College of Engineering and Technology Greater Noida, Uttar Pradesh, India*

Abstract—Vehicular ad-hoc network (VANET) is a wireless ad-hoc network created by short range communicating mobile vehicles where vehicles exchange traffic related information over a wireless link. Due to the mobility nature of the vehicles, the vehicles change their network topology frequently that turns into link breakage among vehicles. Link breakage cause delivery of the data packets from the source node S to the destination node D is a very difficult task. There are many challenging issues to be addressed when employing VANET which have not been addressed efficiently yet. The aim of this paper is to compare the various concepts used in the field of VANET and provide an efficient solution for Location-based Routing in VANET by comparing various algorithms so that an efficient reliable connection can be made in VANETs.

Keywords—VANET, Routing, dynamic, reliable connection, efficiency

I. INTRODUCTION

A vehicular ad hoc network (*VANET*), a type of wireless network, is able to provide many communication services via the collaboration of the vehicles in the network. It has only been less than a century since the first automobile came to the world. The various innovations in safety, comfort, and convenience have made the modern vehicles a very complex machine than it was in the past century. Recently another innovation was made by characterizing of low-cost wireless connections and distributed peer-to-peer cooperative systems, is changing the advancement of cutting-edge vehicle. All the aforementioned applications rely on the metropolitan-wide *VANETs* which involve moving vehicles and fixed roadside units. The *RSUs* or the road side unit comes in many forms and perform different functions, such as information broadcast station to announce roadside services, data collection hubs to collect real-time traffic information, Wi-Fi access point and metro mesh node to provide internet access. Data are disseminated in the network by employing all possible connectivity including vehicle to vehicle communication, vehicle to roadside communication and roadside to roadside communication.

Vehicular ad hoc network's (*VANET*) applications are safety applications in VANET system design and implementation. This paper will focus on routing problem in directional location routing in vehicular ad hoc network (VANET) by discussing about the various. The objective of routing protocol is to give ideal paths between network nodes via minimum overhead. Many routing protocols have been developed for VANETs environment, which can be classified in many ways but in this paper, we have only focused on location-based routing protocols.

II. LITERATURE SURVEY

In VANETs, nodes are movable so they change their network topology frequently, at first in 2007 Menouar et. al. suggested routing protocol named *Movement Prediction-Based* Routing Concept based on movement prediction of vehicles [1]. In this protocol mobility model, depending upon the nodes' lifetime at the particular place determined for routing. Due to the dynamic nature of the nodes, it is very difficult to deliver data packets from the source to the destination node. Therefore, *VANET* requires customized and efficient location-based routing protocols for better performance of the network [2].

Location-based routing protocol uses current location information of the neighbour nodes within the transmission range of any forwarding node [3]. Therefore, in any location-based routing protocol global topology information is not required. Its because of this that location-based routing protocols give low routing overhead of route creation and maintenance. The location-based routing protocols forward data packets in the network following the greedy forwarding technique. The greedy forwarding approach is guarantees of loop-free operation [4, 5]. The current physical local information of the nodes is obtained by the global positioning system (*GPS*) mounted in the nodes.

In location-based routing protocols, each node transmits data packets that cause loads in the network increases so that for better performance of the network should be balanced. Authors in [6] have proposed a protocol uses current location information of nodes to balance the network. To balance the network nodes, make only one copy of the data packet and send data packets to their selective neighbour nodes. In this to take routing decision nodes use a utility or probability-based routing mechanism. Authors assumed in this movement pattern of the nodes is not only random and their future contact depends on the previous information.

In location-based routing protocols as the size of request zone increases with the increase in the route discovery overhead. Therefore, partitioning of the large size requested zone limits the search process of the neighbour nodes in the request zone that results in reduced routing control overhead. Rana et. al. [7] proposed a location-based improved directional LAR (I D-LAR) to minimize the average number of next hops and end to end delay. In this request, zone is divided into a number of sub-request zones to reduce control flooding in the network. establish the best route from the source to the destination node.

III. COMMUNICATION TECHNOLOGIES IN VANET

Vanet is a broad concept which comprises of basically three important areas governing the layout and type of communication to be established in the network. These are:

A. In Vehicle Communication

In-vehicle communication (IVC) enables the information exchange between different components within a vehicle and is widely used in any modern car. In general, two application areas for in-vehicle communication can be distinguished: The first is the in-vehicle network of sensors, actuators and controllers, and the second is high rate multimedia communication for comfort applications. Since in most cases the number of communicating entities will not change over the lifetime of the vehicle, in-vehicle communication networks have a stable topology, a clearly defined limited set of possible communication partners and rely on wire line communication. Typical are ring and bus topologies. Particularly controller networks have stringent requirements on delay and integrity, whereas in case of comfort applications consequences of violations of the maximum allowed delay or data corruption are less serious but higher data rates are required. Example and standards: With the increasing number of electronic components integrated in vehicles, standardized communication systems for in-vehicle communication became necessary. Currently, the dominant standard in Europe for controller communication in vehicles is the Controller Area Network (*CAN*).

B. Vehicle-to-Roadside (V2R) Communication

The term Vehicle-to-Roadside Communication (VRC), also known as vehicle to infrastructure communication, is used for any kind of communication from the vehicle to a fixed infrastructure or vice versa. This communication can be unit or bidirectional. Broadcast systems support unidirectional transfer of information from a broadcast station to the vehicle. In contrast, in systems allowing bidirectional communication, the vehicle communicates point-to-point with a base station or access point. In this case, the base station is usually responsible for coordinating the communication, e.g. physical layer synchronization and medium access. Furthermore, the base station can provide access control and avoid excessive load. Bi-directional VRC technologies can be divided further into cellular mobile phone systems and short range/WLAN-like systems. The former employs the existing cellular infrastructure, e.g. of GMS and UMTS networks, and can provide information wherever the required infrastructure is available. The latter cover only a small local area but can provide high data rates at a low cost. It depends on the type of infrastructure and air interface, the range in which VRC is possible varies from tens of meters for wireless local area technologies to hundreds of kilometres for public radio systems.

Examples and Standards: A simple form of broadcast systems are public radio stations, e.g. utilizing the FM radio system which allows the transmission of Travel and Traffic Information (TTI) to vehicles via the Traffic Message Channel of the Radio Data System (RDS TMC).

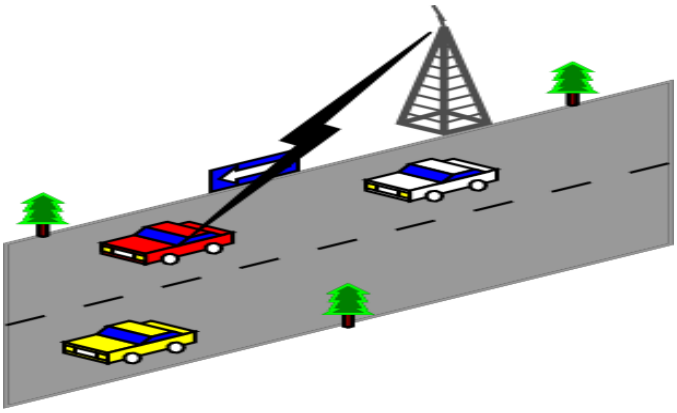

Fig. 1 V2R Communication

In the above figure 1 Vehicle-to-Roadside Communication (VRC) is demonstrated. The car is communicating to the roadside tower to benefit from the information shared about it.

C. *Vehicle-to- Vehicle (V2V) Communication*

Direct communication between vehicles, so-called Inter-Vehicle Communication (IVC)1, allows information exchange without requiring any fixed infrastructure. While a similar form of communication has recently been deployed on a large scale in maritime traffic with the Automatic Identification System (AIS) and in aeronautics with the Automatic Dependent Surveillance - Broadcast (ADS-B) system, it is not yet in wide use in the automotive sector. A basic requirement for any kind of IVC is an air interface capable of ad hoc communication: In contrast to VRC, synchronization and medium access cannot be coordinated by a base station. The network has to be self-organized and allow spontaneous peer-to-peer communication between any two vehicles which are within mutual transmission range. Thus, medium access and synchronization have to be solved in a decentralized way. Two types of IVC can be distinguished based on the relative positions of information source and destination:

Single-hop: In single-hop IVC information source and destination are within transmission range of each other and communicate directly. Multi-hop: Information exchange over distances larger than the transmission range of a single vehicle can be achieved using multi-hop IVC. Information source and destination are connected by one or more intermediate vehicles which forward the information. IVC is the foundation for vehicular ad hoc networks, which allow a wide range of applications in the areas of comfort and safety.

Examples and Standards: In the automotive sector, there is not yet an established and widespread standard for IVC. Studies have shown that for some comfort applications, even conventional one also known as Car-to-Car Communication.

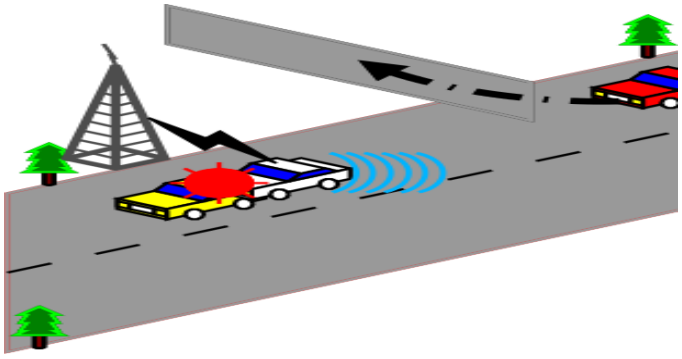

Fig. 2 V2V communication

In the above figure 2 V2V Communication is demonstrated. A car is sending messages to other vehicles telling them about the accident and its location so that others can benefit from it

IV. VANET ROUTING PROTOCOLS

Vehicular Ad-hoc Networks are self-configuring wireless network used to create a wireless ad-hoc network, on demand and uses mobile vehicles, these mobile vehicles work as host as well as a router to transmit data Packets in the network. For communication between two nodes, they should lie within the transmission range of each other. If receiving node is within Transmission range of the sending node, the sending node will communicate directly with the receiving node otherwise intermediate nodes will be required for the communication. For a successful communication in the network all vehicles should coordinate and cooperate with each other and this Cooperation process known as routing in the network. In VANET, the vehicles are highly mobile on the road so that they change their location, which in turn Changes the road networks frequently. Due to this links may be broken the data delivery may fail; it may be recovered if alternative links can be Re-established immediately. If there is any change in the network topology, it Must be updated in the routing table. The overall performance of a network Depends on the efficiency of a routing protocol, the VANET routing protocols are classified into two types such as position-based and topology-based routing protocols.

A. Position Based Routing protocol

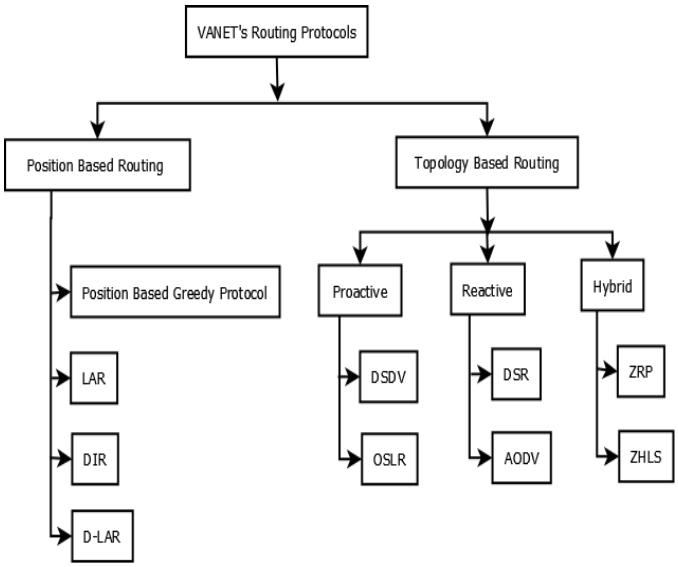

Fig. 3 Classification of routing protocols

Position-based routing protocol is one of the most popular routing protocols that uses current location information of the nodes in the network. Therefore, the measure advantage of position-based routing protocol is that it does not need global information of the network. The packet is sent without any map knowledge to the one hop neighbour, which is closest to the destination. It is also profitable as no route from source node to destination node need to be made and maintained after it.

1) Position Based Greedy V2V Protocols: In greedy strategy, intermediate node in the route forward message to the neighbour which is most distant toward the following goal (new destination). Greedy approach requires that intermediate node should possess its own position, its neighbour's position and destination position. The fundamental objective of these protocols is to transfer information packets to destination at earliest possibility which is why it's known as min delay routing protocols. Various types of position based greedy V2V protocols are GPCR, DIR and CAR.

2) Diagonal-Intersection-Based Routing Protocol (DIR): DIR protocol makes many diagonal intersections between the source and destination vehicle which make a series. This protocol is based upon the geographic routing protocol here the source vehicle geographically transmits the data/information packets in the direction towards the first diagonal intersection, second diagonal intersection and so on until the last diagonal intersection and finally geographically reaches to designation vehicle.

DIR vehicle is auto adjustable, auto adjustability means that the one sub path which has low data packet delay between two neighbouring diagonal intersections and is selected dynamically to forward data packets. To lessen the data packet, delay the route, it automatically selects sub path with the lowest delay. DIR protocol can automatically change routing path for keeping the lower packet delay.

3) Location Aided Routing (LAR): Location Aided Routing is a position-based routing protocol reduces route discovery overhead using position information of the destination node. In reactive routing protocols if the destination node is out of the reach of the Source node, source node floods RREQ message to find out the best next- Hop forwarding node and it will continue until the data packets reached at the destination node.

4) Directional-Location Aided Routing (D-LAR) Protocol: It is a combination of DIR and LAR routing protocol. In D-LAR protocol, basic purpose of using LAR protocol concept is to restrict the routing search are a and concept of DIR routing protocol used to select a next-hop forwarding node in the forward area. Selection mechanism of next-hop forwarding node in D-LAR protocol is quite different from DIR protocol. D-LAR protocol selects next-hop forwarding node among the neighbour nodes present in the request zone with the transmission range of source node. In the D-LAR protocol, selection Mechanism of next-hop forwarding node is a fusion of selection mechanism of both DIR and LAR protocols. In D-LAR, sending node broadcast data packets to its all neighbour nodes these data packets carry information current position information of node and coordinates values of the request zone. When neighbour nodes of sender node receive data packets, they match Its position with the packet information. If the node lies within the request Zone as per data stored in the data packet the node processes this information either to forward the data packet further or to discard it.

B. Topology Based Routing Protocols

These routing protocols use the existing links information in the network perform packet forwarding. It is further classified into Proactive, Reactive and Hybrid.

1) Proactive routing protocols: The proactive routing means that the routing information processes the next forwarding hop in the background independent of the communication requests. Because the destination route is stored in the background so there is no route discovery and this is the benefit of proactive routing protocol, but its disadvantage is that it gives low latency for real time application. Within it a node a table is constructed and maintained such that each field in the table points to the next hop node towards the required destination. The different types of proactive routing protocols are: FSR, LSR.

2) Reactive Ad hoc based routing: Reactive routing opens the route provided it is necessary for a node to communicate among themselves. It maintains only the current routes and so it reduces the unnecessary strain on the network. Reactive routing has a route discovery phase in which in order to search for a path the query packets are flooded when route is found this phase completes. The various different types of reactive routing protocols are AODV, PGB, DSR and TORA.

3) Hybrid routing protocols: It combines the advantages of both reactive and Proactive routing protocols. Initially proactive routing protocols establish connection and after these reactive routing protocols take care of remaining operations. Hybrid routing protocols eliminate disadvantages of both routing Protocols as it reduces control overhead in proactive routing protocols and Delay in reactive routing protocols.

TABLE I
COMPARISON OF VARIOUS PROTOCOLS

Protocols	Forwarding method	Digital map required	Infrastructure needed	Scenario	Realistic traffic flow
Greedy	Heuristic	No	No	Urban	Yes
Proactive	Wireless multi hop forwarding	No	No	Urban	Yes
Reactive	Wireless multi hop forwarding	No	No	Urban	Yes

V. CONCLUSIONS

Routing in vehicular ad-hoc network is an efficient next hop as it is a multi-hop routing, therefore, an efficient next hop node selection mechanism needs to select the remarkable next hop node in the forward direction. In this paper we have compared different location-based routing protocols (Greedy, LAR, DLAR, DIR Proactive and Reactive) and we have listed the differences between them.

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