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**SURVEY ARTICLE**

# A Survey on Routing Protocols in VANET

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***Abstract-Vehicular Networks are receiving a lot of attention due to the wide variety of services they can provide. Their applications range from safety and crash avoidance to Internet access and multimedia. In this paper we present a performance evaluation study of a simple routing technique in new emerging Vehicular Ad hoc Networks (VANETs). VANETs differ from traditional Mobile Ad hoc NETworks (MANETs) for a high dynamism of the network topology, and for different traffic and mobility patterns. For all these reasons, routing protocol designed for MANETs cannot always be applied in a vehicular environment, and lack of effective network performance. This paper presents the various protocols such as AODV, OLSR, PBR for VANET. These protocols then analyzed and compared based on Packet delivery ratio (PDR), Routing requests ratio, Average end-to-end (E2E) delay.***

***Index terms: VANET; MANET; AODV; PBR; OLSR***

## I. INTRODUCTION

VANETs are a promising technology to enable communications among vehicles on roads. They are a special form of mobile ad hoc networks (MANETs) that provide vehicle-to-vehicle communications. A mobile ad hoc network is a collection of two or more nodes equipped with wireless communications and networking capabilities without central network control, which may be referred to as an infrastructure-less mobile network. Vehicular Ad-hoc Networks (VANETs) represent a rapidly emerging, particularly challenging class of Mobile Ad Hoc Networks (MANETs). VANETs are distributed, self organizing communication networks built up by moving vehicles, and are thus characterized by a very high node mobility and limited degrees of freedom in the mobility patterns. A vehicular network is an environment with high degree of mobility - without a doubt it is a major difficulty.

But on the other side, such network has also some advantages over the classic Mobile Ad-Hoc Network. We are going to use those advantages in our solution. First advantage is that the vehicle movement is topologically constrained by roads, other road users and roadside equipment such as signs and traffic lights. Hence, vehicles follow some traffic patterns. There is also no issue of power saving, which is an important constraint of sensor networks and small mobile devices. Another advantage is that vehicles often move in naturally formed groups, especially on the single lane roads or in case of a high traffic density. Moreover, the majority of vehicles are equipped with GPS devices giving them knowledge about their geographical position. VANETs tend to operate without an infrastructure; each vehicle in the network can send, receive, and relay messages to other vehicles in the network. This way, vehicles can exchange real-time information, and drivers can be informed about road traffic conditions and other travel related information.

We have a number of routing protocols for VANETs. MANET Protocols are not feasible in VANET. The main problem with these protocols in VANETs environments is their route instability. The traditional node-centric view of the routes (i.e., an established route is a fixed succession of nodes between the source and destination) leads to frequent broken routes in the presence of VANETs' high mobility. Consequently, many packets are dropped and the overhead due to route repairs or failure notifications increases significantly, leading to low delivery ratios and high transmission delays.

In VANET, several reliable routing protocols have been proposed such as AODV, OLSR, PBR. The details of each protocol will be discussed in further. In this paper, we then compare these reliable protocols on VANET. We then evaluate these protocols in terms of Packet delivery ratio (PDR), Link failures, Routing requests ratio, Average end-to-end (E2E) delay, Route lifetime by simulation. This paper is organized as follows. In Section II, details of the PBR protocol is described. In Section III, details of AODV protocol is described. In Section IV, details of OLSR protocol is described. In Section V, simulation and performance evaluation are shown. Section VI has a conclusion portion.

## II. PBR PROTOCOL

Two important building blocks of our PBR protocol are obtaining location and velocity information of vehicles on the route to the gateway and the prediction algorithm that uses this information to predict when the route will break. An additional consideration is whether to use routes through vehicles that are not moving in the same direction as the vehicle requiring the route, i.e., the source node.

### *A. Basic Operation*

The PBR protocol's basic operation of creating routes is similar to that of a reactive protocol. When a node needs to communicate to a location on the Internet, it checks its routing table for a route. If none exists, it broadcasts a route request (RREQ) packet with a time-to-live (TTL) value that specifies the number of hops to search for a gateway that would have the required route. A neighbor upon receiving this packet forwards it to all its neighbors after reducing the current TTL value by one if 1) the packet contains a higher sequence number for the same source and destination pair and TTL value in the packet is greater than one or 2) the packet contains the same sequence number as a previously received packet for the same source–destination pair, but this time with all intermediate nodes on the route traveling in the same direction and with the TTL value in the packet greater than one. Once such a packet is received by a node, it drops all further packets unless they have a higher sequence number. When the RREQ packet reaches a gateway with the desired route to the sought destination, a route reply (RREP) packet is sent back to the source node by the gateway . This route through which the RREP packet traversed is stored as the source node's gateway route. The source node then uses this supplied route for sending its application packets. In case that route fails, it discovers a new route to the source as above with the source node as the destination of the RREQ.

### *B. Obtaining Route Lifetime*

After an RREQ packet is sent, the RREP packet from the gateway is used to gather information to predict the lifetime of the route. Initially, the gateway node puts its location and velocity information and sets a *lifetime* field in the RREP packet header equal to some value that is expected to be greater than the minimum of all link lifetimes along the route the parameter max lifetime. Based on the velocity and location information of its predecessor (available in RREP packet) and that of itself, it predicts the lifetime of the link between the two nodes using the prediction algorithm.

### *C. Prediction Algorithm*

Let the range of communication of the WLAN technology used be *R*. If the absolute distance between two nodes *i* and *j* is denoted by $|d_{ij}|$ and their corresponding velocities are given by $v_i$ and $v_j$,respectively, the lifetime of a link between *i* and *j* is predicted as

$$Lifetime\text{link} = \frac{R - |d_{ij}|}{|v_i - v_j|}$$

Since a route comprises of one or more links, the route lifetime is the minimum of all its link lifetimes, i.e.,

$$Lifetime\text{route} = \min_{\forall \text{links} \in \text{route}} \{Lifetime\text{link}\}.$$

## III.AODV PROTOCOL

***The Ad-hoc On-Demand Distance Vector Algorithm:***

The algorithm's primary objectives are:

- To broadcast discovery packets only when necessary
- To distinguish between local connectivity management (neighborhood detection) and general topology maintenance
- To disseminate information about changes in local connectivity to those neighboring mobile nodes that are likely to need the information.

***A.Path Discovery:***

The Path Discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table. Every node maintains two separate counters: a node sequence number and a broadcast id. The source node initiates path discovery by broadcasting a route request (RREQ) packet to its neighbors.

< source addr; source sequence #; broadcast id;
dest addr; dest sequence #; hop cnt >

The pair < source addr; broadcast id > uniquely identi_es a RREQ. broadcast id is incremented whenever the source issues a new RREQ.

***A1.Reverse Path Setup:***

As the RREQ travels from a source to various desti- nations, it automatically sets up the reverse path from all nodes back to the source. To set up a reverse path, a node records the address of the neighbor from which it received the first copy of the RREQ. These reverse path route entries are maintained for at least enough time for the RREQ to traverse the network and produce a reply to the sender.

***A2.Forward Path Setup:***

By the time a broadcast packet arrives at a node that can supply a route to the destination, a reverse path has been established to the source of the RREQ. As the RREP travels back to the source, each node along the path sets up a forward pointer to the node from which the RREP came, updates its timeout information for route entries to the source and destination, and records the latest destination sequence number for the requested destination.

***C.Route Table Management:***

In addition to the source and destination sequence numbers, other useful information is also stored in the route table entries, and is called the soft-state associated with the entry. In each routing table entry, the address of active neighbors through which packets for the given destination are received is also maintained. A neighbor is considered active (for that destination) if it originates or relays at least one packet for that destination within the most recent active timeout period.

***D.Path Maintenance:***

Movement of nodes not lying along an active path does not affect the routing to that path's destination. If the source node moves during an active session, it can reinitiate the route discovery procedure to establish a new route to the destination. When either the destination or some intermediate node moves, a special RREP is sent to the affected source nodes. Periodic hello messages can be used to ensure symmetric links, as well as to detect link failures. Alternatively, and with far less latency, such failures could be detected by using link-layer acknowledgments (LLACKS). A link failure is also indicated if attempts to forward a packet to the next hop fail. Once the next hop becomes unreachable, the node upstream of the break propagates an unsolicited RREP with a fresh sequence number and hop count of 1 to all active upstream neighbors. Those nodes subsequently relay that message to their active neighbors and so on. This process continues until all active source nodes are noticed; it terminates because AODV maintains only loop-free routes and there are only a finite number of nodes in the ad-hoc network. Upon receiving notification of a broken link, source nodes can restart the discovery process if they still require a route to the destination. To determine whether a route is still needed, a node may check whether the route has been used recently, as well as inspect upper-level protocol control blocks to see whether connections remain open using the indicated destination. If the source node decides it would like to rebuild the route to the destination, it sends out an RREQ with a destination sequence number of one greater than the previously known sequence number, to ensure that it builds a new, viable route, and that no nodes reply if they still regard the previous route as valid.

## IV. OLSR PROTOCOL

It is a proactive routing protocol for ad-hoc networks. OLSR protocol is an optimization of a pure link state protocol for ad-hoc networks. First it reduces the size of control packets: instead of all links,it declares only a subset of links with its neighbors who are its multipoint relay selectors. Secondly, it minimizes flooding of this control traffic by using only the selected nodes, called multipoint relays, to diffuse its messages in the network. Only the multipoint relays of a node retransmit its broadcast messages. The technique significantly reduces the number of retransmission in a flooding or broadcast procedure.

***Proactive route discovery:***

Periodic exchange of control messages. Some messages are sent locally to enable a router to discover its neighborhood. Some messages are sent in entire network to distribute the knowledge of topology. The routes are immediately available when needed (no delay is caused by route discovery)

***Multipoint relays:***

Each node selects a subset of nodes in its neighborhood, which retransmits its messages. These selected nodes are named Multi Point **Relays** (MPRs) of that node**.** The selection condition is the following: each two hop neighbor node must have at least one bidirectional link toward a node inside the MPR set**.** So the MPR nodes must permit to reach all the two hop neighbors.

A node retransmits a received message only if it's part of the MPRs set of the neighbor node that has transmitted the message. So each node maintain a list of the nodes from which has been selected as MPR. This set is called **MPR Selectors**. Each node retransmits only the messages received from the nodes inside its MPR Selectors set.

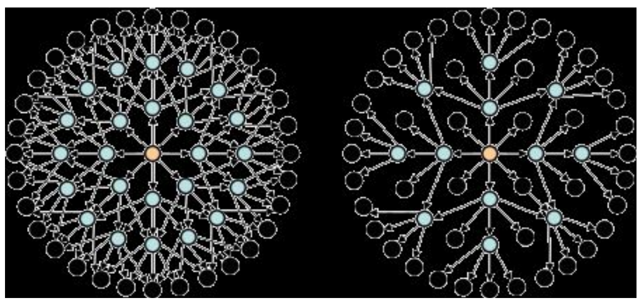

Fig.1 Classical flooding & MPR flooding

***OLSR Packet formet:***

Broadcast UDP packets with port 698. Each router is identified by its main address. Each OLSR packet contains one or more OLSR Messages. There are 4 kind of messages:

- HELLO (Hello)
- TC (Topology Control)
- MID (Multiple Interface Declaration)
- HNA (Host or Network Announcment)

## V. PERFORMANCE EVALUATION

The main objective of this performance evaluation is to identify the impact of the high dynamic topology on the routing process performance.

Three performance metrics will be considered for the simulation experiments.

1) *Routing requests ratio:* It expresses the ratio of the total transmitted routing requests to the total successfully received routing packets at the destination vehicle.

2) *Average end-to-end (E2E) delay:* It represents the average time between the sending and receiving times for packets received.

3) *Route lifetime*: It represents the average lifetime of the discovered route. A longer lifetime means a more stable and more reliable route.

The aim is to investigate the impact of different velocities on the routing performance.

 

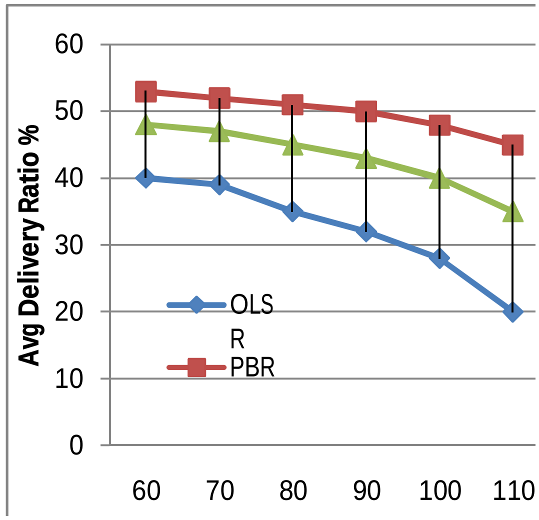


Fig. 2 Avg Delivery Ratio

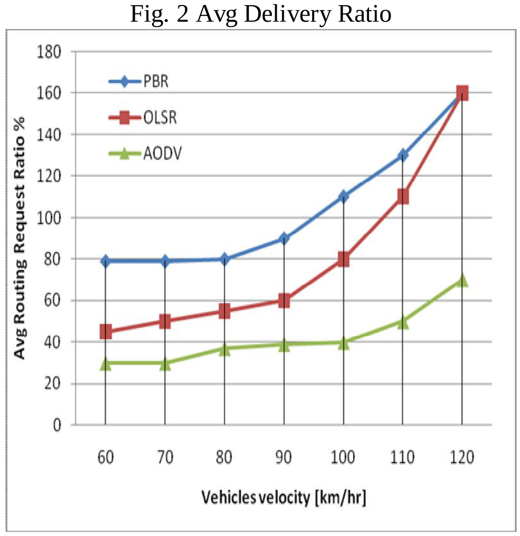


Fig 3. Avg Routing Request Ratio

As shown in Fig. 2, the average PDR reduces for all routing protocols when the average velocity increases from 60 to 80 km/h. This reduction comes from the fact that the routing topology becomes more dynamic and unstable when velocity increases. The decrease of the PDR of AODV and OLSR is much more rapid than that of PBR. To keep the routing tables updated in OLSR, topology control messages are sent to exchange information about the current vehicular status. It is clear that OLSR is not suitable for highly dynamic networks such as VANETs.

In Fig. 3, the average routing requests ratio generated by PBR is high as compared to other protocols. All other routing protocols in this experiment are considerably impacted by the changes of the network topology. In particular, PBR creates the highest routing requests ratio due to the need to process multiple routing requests. As more topology control messages are sent in OLSR when velocity increases, its routing requests ratio increases significantly.

In Fig. 4, OLSR show lower E2E delay values than AODV and PBR. OLSR is a proactive or tabledriven approach that helps achieve a low E2E delay value, although its delivery ratio is the worst among all the considered schemes, as shown in Fig. 2. AODV and PBR cause much higher E2E delay values when the velocity increases.

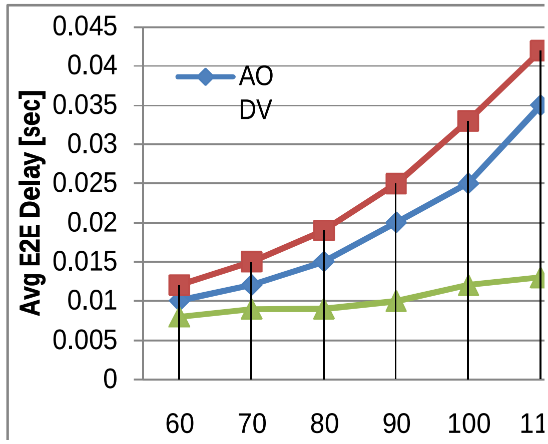


Fig 4. Avg E2E Delay

## VI. CONCLUSION

In this paper the characteristics of the Vehicular Ad-Hoc Networks were discussed and explained how it is differ from the Mobile Ad-Hoc Networks. Then characteristics of some routing protocols used in VANET such as PBR, AODV and OLSR were discussed and their working procedure was explained. In the performance evaluation section, performance of each protocol was discussed and compare these protocols based on Avg delivery ratio, Avg routing request ratio and Avg end to end delay . However, there are many challenges to be faced in the routing protocols of VANETs. A central challenge is the development of the dynamic routing protocol that can efficiently perform the communication between vehicles even though they change their speed, direction frequently. Also, in order to analyze and improve the existing or new VANET routing protocols, it is desirable to examine other metrics such as power vehicle's velocity, speed and direction in various traffic models.

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