DBR-LS: Distance Based Routing protocol using Location Service for VANETs

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Abstract—Vehicular Ad-Hoc Network mainly involves Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication. This communication accelerates in reducing number of accidents, avoiding traffic congestion, enhancing the transport facility with the aid of infotainment and entertainment application. One of the major challenges of VANET application is in routing the packet in efficient manner since the network topology is dynamic. In this paper, proposed solution enhances the efficacy of Distance Based Routing [1] protocol by using Location Service (DBR-LS) which is designed especially for Vehicular Ad hoc Networks (VANET). The proposed algorithm adopts map based location technique. In DBR-LS, a connectivity graph based on the intervehicular distance, the duration of connectivity between neighbouring vehicles, the information from the digital map and location of destination vehicle from location service are collectively used to route the data. In proposed protocol the network traffic is reduced due to the relative position information of the neighbouring vehicles and location servers. The stability of the route path is high due to intervehicular distance based next hop selection technique as implemented in this protocol. The proposed routing protocol is simulated using NS2 simulator to analyse the efficiency and effectiveness of the protocol.

Key word - Ad-Hoc Networks; routing protocol; VANETs.

I. INTRODUCTION

The Vehicular Ad hoc Network technology is of interest to automobile industries to extend the comfort of commuters in terms of safety, entertainment and infotainment. In order to achieve this automobile industries are keen on V2V communication than V2I due to the high cost incurred in maintaining the road side infrastructure. The VANET is a special case of Mobile Ad hoc Network (MANET) with frequent changes in the topology and a highly self organizing form of network [2]. The major challenges associated with VANET are lack of infrastructure and shorter communication session due to rapid change in the network topology. Therefore routing protocols play a significant role in achieving successful intervehicular communication. The routing protocol for VANET can be designed using position based approach and map based approach. The position based approach makes use of GPS technology to fetch position information. The Global Positioning System (GPS) [3] technology provides essential information like longitude (X), latitude (Y), altitude (Z) and time error (At). This positioning system is used in mobile phones, fixed base stations and vehicles to obtain the position information. The GPS requires at least four satellites to provide accurate position information. But in GPS, transmission delay of 1µs gives rise to positional error of 300m. Therefore the position based approach which utilizes such position information will locate the vehicle at wrong position in the digital map. This intern leads to inefficient routing. The map based approach involves dynamic computation of the route map while forwarding the data from source to destination. Since vehicles are highly mobile in nature, it is difficult to dynamically compute and maintain the route map. Furthermore, transmission delay is one of the key parameter used to analyse the routing protocols. The safety application of VANET requires very low transmission delay where as application related to entertainment and infotainment can compromise with transmission delay to a certain extent. Therefore different applications of VANET have different requirements.

The location servers are the vehicles which stores position information of vehicles of its region. The maintenance of location servers are done by different methods like map based and hierarchical techniques. In these approaches the vehicle requests the position information of destination vehicle by sending request message. The location server replies with the most recent position information of the destination vehicle. This position information can be used for locating the destination vehicle and route the packet. But updating and maintaining location servers is also a research issue. In this paper it is assumed that the location servers are ideal in nature.

In this paper, DBR-LS: Distance Based Routing protocol using Location Service is proposed to address the short coming of position based and map based approach. In this protocol real time traffic information is utilized to build a connectivity graph of the vehicles. The connectivity graph depicts distance between neighbouring vehicles. Based on intervehicular distance, the longest duration of connectivity and position information of destination vehicles, an appropriate path for routing the data is selected.

The rest of the sections in the paper are organized as follows: Section II provides overview of the related works on routing in VANET. Section III describes the DBR-LS protocol in detail. In section IV we explain the simulation setup and results thus obtained. Finally, section V provides a
A brief conclusion of the current work and future enhancements.

II. RELATED WORK

In DBR [1] algorithm the route is constructed by making use velocity and time. The intervehicular distance is used to decide the next hop while forwarding the data.

**Figure 1. Calculation of intervehicular distance based on relative speed**

**A. Intervehicular distance**

In DBR, every vehicle uses propagation delay to computes the intervehicular distance between itself and its neighbouring vehicles. The intervehicular distance is determined using Equation 1[4] where $D$ represents the intervehicular distance, $S$ is the velocity of vehicle and $T$ is the propagation delay. It is evident from Equation 1 that the intervehicular distance ($D$) is directly proportional to velocity($S$) of the vehicle and propagation delay ($T$). Therefore the intervehicular distance remains constant as long as there is no change in the velocity or direction of the vehicles.

$$D = S \times T \quad (1)$$

Figure 1 represents the procedure involved in determining the intervehicular distance based on Equation 1. The n1 and n2 represent two vehicles moving on road with velocity v1 and v2 respectively. The vehicle n1 broadcasts position and speed information at time $t_0$ and the vehicle n2 receives this information at time $t_1$. Based on the information received, the vehicle n2 calculates the intervehicular distance with respect to propagation delay, using the Equation 4. The $d_2$ represents the distance between the current position of vehicle n2 and the position of the vehicle n1 at time $t_0$. It is determined using the Equation 2. Similarly $d_1$ as shown in Equation 3 represents the distance covered by the vehicle n1 in time ($t_1 - t_0$).

$$d_2 = v_2 \times (t_1 - t_0) \quad (2)$$

$$d_1 = v_1 \times (t_1 - t_0) \quad (3)$$

$$\text{inter_vehicular_distance} = d_2 - d_1 \quad (4)$$

**B. Propagation of geographical information**

In DBR every vehicle makes use of digital map. The vehicles keep track of velocity and direction information. Whenever there is a change in these parameters, the vehicle will broadcast a hello message [5], [6], [7]. The neighbouring node which receives the hello message will updates its routing table accordingly. The fundamental parameters of hello message are position of the vehicle, speed of the vehicle and destination coordinates. The destination coordinates represent the coordinates of approaching intersection and it is used to determine the direction of travel of the vehicle.

**Algorithm 1 Send Data Packet**

1: Generate data to send
2: Decide the destination vehicle
3: if nodeid is exists in the table then
4: Set destination vehicle as nodeid
5: Send(packet)
6: else if nodeid exists in packet information table then
7: Search the nexthop in the packet table
8: Set the nexthop with nodeid
9: Send(packet)
10: else
11: Set destination with Broadcastid
12: Send(packet)
13: end if
14: The sent packet information is maintained in Data Forwarding

Whenever vehicle receives hello message due to the change in velocity or direction of its neighbouring vehicle, it recomputes intervehicular distance analogous to change in velocity and also updates the vehicle ID, velocity, position information and coordinates of destination in the routing table. The size of the table depends on the traffic congestion of the road. When there is huge traffic congestion, maintaining all the vehicle information will increase the computational load. So the delay of updating and searching while forwarding the data is minimized with the help of varying table size.

**C. Forwarding data packet**

The DBR forwards the data packet using both location information and vehicle ID present in the routing table. In order to forward the data packet, a vehicle selects the nexthop based on the direction if the location of destination is known [8], [9], [10] and [11].

To avoid repeated link failure, the forwarding vehicle selects nexthop based on intervehicular distance and current speed. The velocity of the vehicle is an influencing parameter in selecting the nexthop because, communication link with the vehicle moving at a very high speed are less stable than the vehicle moving at the lower speed. Therefore vehicles moving with high speed are given less priority in forwarding the data packet. The algorithm 1 explains the procedure involved in forwarding the data packet. The data forwarding table is maintained by every vehicle. Before forwarding any data packet the parameters of data
The forwardinopath associated with the data packet are stored in the table. The vehicle searches for necessary information in data forwarding table to select the next hop whenever a data packet is received. The algorithm 2 represents the procedure involved in receiving and processing the data packet.

**Algorithm 2 Receive Data Packet**

1: nodeid: Vehicle identification
2: Read destination nodeid
3: if nodeid is received vehicle id then
4: Read the data packet
5: else
6: Send data(packet)
7: end if
8: The sent packet information is maintained in packet table

### III. DISTANCE BASED ROUTING PROTOCOL USING LOCATION SERVICE (DBR-LS)

The proposed routing algorithm uses location servers, in which the location information of the vehicle is maintained. In this paper map based location service is considered.

**Algorithm 3 Send Data Packet using LS**

1: Generate data to send
2: Decide the destination vehicle
3: Generate a Request packet
4: Send Request packet to LS
5: LS Read Reply packet for destination vehicle coordinates
6: if nodeid is exists in the table then
7: Set destination vehicle as nodeid
8: Send(packet)
9: else if nodeid exists in packet information table then
10: Search the next hop in the packet table
11: Set the next hop with nodeid
12: Send(packet)
13: Send(packet)
14: end if
15: The sent packet information is maintained in Data Forwarding

The DBR-LS routing algorithms uses Map Based Location Service (MBLS) [12], [13]. In this approach the digital map attached each vehicle provides the street and road information for navigation system. The geographical area is divided into a hierarchical square zone. In each square one waypoint position defined which tells the position of location service. The waypoint positions are identified by geographic coordinates and unique IDs. The hierarchy of squares are identified by their levels. Each level associated with one location server. The location server at level-1 updates to level-2 and which updates level-3, the updating process happens frequently and effectively.

The location server updates its information as it receives updates packet from vehicle. The DBR algorithm sends update packet whenever there change is its direction and speed of vehicle. The location server uses this velocity and direction information with digital map to get the geographic coordinates.

In algorithm 3, when node has data to send it will collect the location information from location servers. The source node generates one Request packet which has destination node ID. The request packet processed by nearby location server. Once location server find the location information like geographical coordinates and direction in which vehicle is moving, will send through Reply packet to the source node. The source node uses this information to select the next hop and then forwards to it.

In DBR-LS the next hop selection process became very easy due to the location service. The time taken to find the next hop is just the round trip time taken by source and location server.

### IV. SIMULATION

The proposed routing algorithms DBR-LS is simulated using Network Simulator 2 (NS2) [14] and road map is generated using SUMO & MOVE. The simulation environment is summarized in the Table I. As indicated in the table, the simulation was carried out for duration of 500 seconds over an area of 1000 sq. meters, with a varying traffic density of 100 vehicles to 600 vehicles. Figure 2 shows a snapshot of the road network used for the simulation at t=0s. The DBR-LS is compared with DBR for efficiency of algorithms.

As indicated in Figure 3 the number of messages generated during data forwarding process is less in DBR-LS. In DBR technique source node broadcasts the data packet when node doesn’t have any information in its tables. But in the case of DBR-LS, location servers provides’ all necessary information to select the next hop. From the Figure 4 it is noted that hop count is reduces because the source node collects destination node information from location servers.
and selects proper next hop and forwards towards destination.

<table>
<thead>
<tr>
<th>TABLE I. SIMULATION PARAMETERS</th>
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<tbody>
<tr>
<td>Simulation area (m x m)</td>
</tr>
<tr>
<td>Simulation time (s)</td>
</tr>
<tr>
<td>Number of vehicles</td>
</tr>
<tr>
<td>MAC layer protocol</td>
</tr>
<tr>
<td>Transmission range (m)</td>
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<td>Maximum velocity (m/s)</td>
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Similarly in Figure 5, the route stability is more in proposed routing algorithm. Here it uses location servers and also the data forwarding table information to select the next and decisions are maintained in table for future use.

V. CONCLUSION

In this paper, the proposed a routing protocol which uses both position based and map based technique along with Location service. It is also evident that DBR-LS is not affected by the GPS error, because of the DBR in which algorithm uses relative speed and position of the vehicle. The proposed protocol locates the neighbouring in digital map using information obtained from Location Servers. It also avoids broadcasting of data packet. As part of future work, it is planned to test the DBR-LS protocol for various scenarios of the VANET and refrain the protocol by performing different optimization analysis.

REFERENCES