ABSTRACT

Due to high mobility and unpredictable movement of nodes, Vehicular ad hoc networks (VANETs) are distinguished from mobile ad hoc networks (MANETs). This paper tests routing protocols namely Ad hoc On Demand Distance Vector (AODV), Ad hoc On Demand Multipath Distance Vector (AOMDV), Dynamic Source Routing (DSR) and Destination Sequence Distance Vector Routing (DSDV) in a real world traffic scenario capable of intelligent driver model with intersection management (IDM-IM) and intelligent model with changing lane (IDM-LC) using MOVE (Mobility model generator for Vehicular networks) and SUMO (Simulation of Urban Mobility). The feature of IDM is that the vehicles respond as per the traffic environment i.e. they stop if there is a red light, change their lane and slow down if the vehicle in front of them is slowing down. MOVE is used to create a rapid realistic model for simulation in VANETs. Our simulation performances are evaluated by varying the number of vehicles and their speed considering various performance metrics such as average throughput, normalized routing load, end to end delay and packet delivery ratio. The simulation is conducted following the V2V (vehicle to vehicle) communication. The simulation results show that DSR performs comparatively better than AODV, AOMDV and DSDV.

Keywords: MOVE, SUMO, VANET, performance, routing.

1. INTRODUCTION

Vehicular Ad-Hoc Networks (VANETs) are wireless ad hoc networks formed among vehicles on the roads equipped with short range wireless communication devices [1]. Such networks are useful because they help to improve comfort and safety of people on the highway situations[2]. As the number of people using the cars is increasing, VANETs have the potential to optimize traffic conditions, and to reduce congestions. VANETs provide communication among the vehicles and the nearby road side units. The dynamic nature of VANETs is the cause for complex routing problems. The test of routing protocols in an ITS (Intelligent traffic system) can test the efficiency in terms of the routing load. The mobility of vehicles in VANETs is determined by predefined roads and buildings.

The speed range of Vehicle could be from 0 to speed limit [3]. SUMO is an open source, microscopic road traffic simulator that supports ITS and IDM. MOVE [4] is used to rapidly generate realistic simulation for VANETs. The network simulation is done using NS-2.35[5].

The objective of this paper is to evaluate routing protocols namely Ad hoc On Demand Distance Vector (AODV) [6], Ad hoc On Demand Multipath Distance Vector (AOMDV) [7], Dynamic Source Routing (DSR) [8] and Destination Sequence Distance Vector Routing (DSDV) [9] in real world traffic scenarios of VANETs that supports Intelligent traffic system and Intelligent driver model and to compare their performances.

This paper is organized as follows. Related works are described in section II, section III discusses the traffic model used, protocols are discussed in section IV, section V discusses the Methodology followed by Simulation and Performance evaluation in section VI. Conclusion and future works are discussed in section VII.

2. RELATED WORKS

Many researchers have analyzed the performance of routing protocols through simulation [10-14]. In [15], the authors have done the performance evaluation of reactive routing protocols in VANET using VANET Mobisim. As per our knowledge, earlier works do not use a realistic mobility model capable of Intelligent driver model with intersection management (IDM-IM) and intelligent model with changing lane (IDM-LC).

3. VEHICULAR MOBILITY MODEL

MOVE comprises of four main components: the Map editor, Vehicle Movement Editor, Simulation of Vehicle
and the Traffic Model. Map editor allows the user to create his own traffic scenario by creating traffic lights, lanes and obstacles in the road. The Vehicle Movement Editor lets the user to create the flow of vehicles, specify their speed, determine the probability of turning of a vehicle at a particular red light in a particular direction and also specify the trips of vehicles and the route that each vehicle will take for one particular trip. The scenario so created is fed into SUMO in the simulation component [4]. Here we can visualize the traffic model. SUMO generates a mobility trace which is used by a simulation tool such as ns-2 or qualnet to simulate realistic vehicle movements in the Traffic model component. During this simulation we have created our own realistic traffic model which comprises of traffic lights and multiple lanes. The vehicle stops at the traffic light if the light is red and moves ahead after it gets green. The vehicle can also change its lane at certain points. This has been designed to follow the (IDM-IM) and (IDM-LC) model. Figure 1 shows the traffic model used for the simulation. Figure 2 shows the vehicles responding to the traffic light.

Figure 1: Mobility Model used for Simulation

Figure 2: Scenario at a Traffic Light

4. ROUTING PROTOCOLS

In this paper we have simulated one Proactive routing protocol named DSDV and three reactive routing protocols. Proactive protocols [16] keep track of all destinations in the ad hoc network while reactive protocols have been designed so that routing information is acquired only when it is actually needed. The DSDV protocol transmits the packets between the nodes of the network using routing tables stored at each node. Each route table, at each of the nodes, lists all destinations and the number of hops to each. Each route table entry is tagged with a sequence that is originated by the destination node [9].

In DSR protocol network nodes cooperate to forward packets for each other to allow communication over multiple “hops” between nodes not directly within wireless transmission range of one another. AODV uses route tables to store pertinent routing information. The route table is used to store the destination and next-hop IP address as well as the destination sequence number. When a node wishes to send a packet to some destination node, it checks its route table to determine whether it has a current route to that node. If so, it forwards the packet to the appropriate next hop toward the destination. If the node does not have a valid route to the destination, it initiates a route discovery process. The source node broadcasts a route request packet (RREQ) and then sets a timer to wait for a reply. [9]. AOMDV extends the AODV protocol to discover multiple paths between the source and the destination in every route discovery. Multiple paths so computed are guaranteed to be loop-free and disjoint. In AOMDV, RREQ propagation from the source towards the destination establishes multiple reverse paths both at intermediate nodes as well as the destination [17]. Multiple RREPs traverse these reverse paths back to form multiple forward paths to the destination at the source and intermediate nodes. AOMDV also provides intermediate nodes with alternate paths as they are found to be useful in reducing route discovery frequency [17, 18].This mechanism reduces route discovery latency and the routing overheads.

5. METHODOLOGY

This section briefly describes the framework used for simulation.

5.1. Selection for Network Simulation

Creation of real time traffic scenario for VANET are very expensive and to some extent not possible. By using simulators we can create real time traffic scenarios and do performance analysis in well known conditions. We have used NS-2.35 to simulate the traffic model. NS2 is an open-source event-driven simulator designed specifically for research in computer communication networks [19]. It is written in C++ and OTCl.
5.2. MOVE Process

MOVE runs atop an open-source micro-traffic Simulator SUMO. MOVE allows the road map to be generated manually, automatically or imported from a real world map. The movements of vehicles can be generated automatically or manually using the Vehicle Movement Editor. The mobility trace generated by SUMO is used by a simulation tool such as ns-2 or qualnet to simulate realistic vehicle movements [4]. The simulation process model of MOVE is shown in Fig. 3.

![Figure 3: MOVE Simulation Process Roadmap](image)

5.3. Performance Metrics

In our simulation we have focused mainly on four important performance metrics. These are as follows.

- **Average throughput**: Average throughput is the total number of successfully delivered data packets on a communication network (1).
  
  \[
  \text{avgthrp} = \frac{((\text{total number of received packets at destination node}) \times \text{packet size})}{\text{observation duration}}
  \]  
  (1)

- **Average end to end delay**: Average end to end delay as in (2) is an average end to end delay of data packets that is average time needed to transfer a data packet from source to destination. Once the difference between every CBR packets sent and received is found, it is divided by the total number of CBR packets received. This gives the average end to end delay for received packets. The lower is the end to end delay, the better the application performs [15].
  
  \[
  \text{e2edelay} = \frac{\Sigma (\text{CBRrecvTime} - \text{CBRsentTime})}{\Sigma \text{CBRrecv}}
  \]  
  (2)

- **Packet Delivery Ratio (PDR)**: It is the ratio of total data packets received over total data packets sent by the source during the simulation period (3). This metric shows how successfully a protocol delivers data packets from the source to destination. PDR characterizes the completeness and correctness of the routing protocol.
  
  \[
  \text{pdr} = \left(\frac{\Sigma \text{CBRrecv}}{\Sigma \text{CBRsent}}\right) \times 100
  \]  
  (3)

- **Normalized routing load**: It is defined as the total number of routing packets transmitted per data packet. It is calculated by dividing the total number of routing packets sent (includes forwarded routing packets as well) by the total number of data packets received (4).
  
  \[
  \text{nrl} = \frac{\Sigma \text{RTPkts}}{\Sigma \text{CBRrecv}}
  \]  
  (4)

6. SIMULATION AND PERFORMANCE EVALUATION

This section describes how to find the effect of node mobility and node density on AODV, AOMDV, DSDV and DSR routing protocols using the above discussed performance metrics.

6.1. Simulation Model

We have used NS-2.35 over ubuntu11.10 environment to simulate the real world traffic model. The framework follows V2V (vehicle to vehicle) communication. In NS-2.35, the RREQ packets are treated as broadcast packets in the MAC. RREP and RRER packets are all uni-cast packets with a specified neighbor as the MAC destination [15].

6.2. Simulation Parameters

To do the simulation following simulation and network parameters were kept fixed.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Simulation and Network Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>Simulator</td>
<td>NS-2.35</td>
</tr>
<tr>
<td>Number of Nodes</td>
<td>10,20,30,40</td>
</tr>
<tr>
<td>Speed of Node</td>
<td>0-20,0-30,0-40 (m/s)</td>
</tr>
<tr>
<td>Simulation Area</td>
<td>652 x 552</td>
</tr>
<tr>
<td>Transmission Range</td>
<td>250 m</td>
</tr>
<tr>
<td>Traffic Type</td>
<td>CBR (Constant Bit Rate)</td>
</tr>
<tr>
<td>Packet Size</td>
<td>1000 Bytes</td>
</tr>
<tr>
<td>Packet Rate</td>
<td>64Kb/s</td>
</tr>
<tr>
<td>Queue Length</td>
<td>50</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Intelligent Driver Model</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Antenna/OmniAntenna</td>
</tr>
<tr>
<td>MAC Type</td>
<td>Mac/802.11</td>
</tr>
<tr>
<td>Channel Type</td>
<td>Channel/WirelessChannel</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>500s</td>
</tr>
<tr>
<td>Lltype</td>
<td>LinkLayer</td>
</tr>
<tr>
<td>ifqType</td>
<td>Queue/Droptail/PriQueue /CMUPriQueue</td>
</tr>
</tbody>
</table>

6.3. Performance Under the Varying Number of Vehicles

In these simulations, we vary the number of vehicles from 10 to 40 and keep maximum speed of vehicles to 40m/s. Results for the simulation are given in Fig. 4.
From the figures we found that DSR has better Average throughput (Kbps) than AODV, DSDV and AOMDV. In case of end to end delay the DSDV has lower delay values, and thus performed better. DSR outperforms others in case of Normalized routing load as it has the minimum normalized routing load value. In case of Packet delivery ratio DSDV has better results than AOMDV, AODV and DSR.

6.4. Performance Under the Varying Vehicles
Maximum Speed

In these simulations, we vary the speed of vehicles at 20m/s, 30m/s and 40m/s and keep the number of vehicles fixed to 40. The simulation results are given in Fig. 5. Here also we found that the average throughput of DSR is better than others. In case of average end to end delay DSDV performed better than others as it steadily maintained lower delay values. The Normalized routing load of DSR was found to be low than others. In case of packet delivery ratio DSDV outperformed others.

7. CONCLUSION & FUTURE WORKS

From the simulation results using different factors and performance metrics, we conclude that DSR has better average throughput and lesser routing overload than others. In case of packet delivery ratio DSDV is performing comparatively better than AODV, AOMDV and DSR. The average end to end delay of DSDV is less than others.

In VANET we need to tradeoff among various performances metrics. To select a routing protocol that is efficient for VANETs we can emphasize on average throughput, normalized routing load and average end to end delay. From the simulation we found that packet delivery ratio is a metric where the routing protocols did not mark any significant difference. Hence, we can conclude that in VANETs, DSR is more appropriate than AODV, AOMDV and DSDV.

In this paper we have simulated the routing protocols using V2V communication by creating real world traffic model in MOVE. In our future work, we will use V2I (Vehicle to Infrastructure) communication model in MOVE to simulate the routing protocols.

REFERENCES


