Survey and Analysis of DREAM Protocol in the Vehicular Ad-Hoc Network

Manoj Kumar Singh  
Department of CSIT  
Moradabad Institute of Technology  
Moradabad, U.P. INDIA  
Email: manojaswal1982@yahoo.com

Anil Kumar Singh  
Department of CSIT  
MJP Rohelkhand University  
Moradabad, U.P. INDIA  
Email: anilbisht_20@yahoo.com

Brajesh Kumar  
Department of CSIT  
MJP Rohelkhand University  
Moradabad, U.P. INDIA  
Email: sainibrajesh@gmail.com

ABSTRACT

Vehicular Ad-hoc Network (VANET) is a kind of new class of mobile ad-hoc networks, which can be used to provide better road safety and comfort to the passengers inside vehicles. Routing is a more challenging task in VANETs due to mobility constraints and high dynamics. A lot of studies on ad-hoc routing protocols in inter-vehicular environment are available in literature, but mostly topology-based protocols were studied and position-based protocols necessitate more consideration. Thus, in this paper Distance Routing Effect Algorithm for Mobility (DREAM), which is geographical position-based routing protocols, have been discussed and analyzed for VANETs by computing its performances in the city scenario. Mobility model has significant effects on the simulation results. Conventional mobility models are unsuitable for VANET simulations. We used Intelligent Driver Model (IDM) based tool VanetMobiSim to generate realistic mobility traces. Performance metrics like delay, throughput, routing load and packet delivery ratio are taken and evaluated using ns2.

Keywords: Vehicular Ad-Hoc Network (VANET), Position Based Routing Protocols, DREAM, IDM, NS-2.

1. INTRODUCTION

These days’ wireless-communication technologies become more and more popular in our daily life. Presently wireless communications turn out to be the new paradigm used for establishing communication between the mobile users. The wireless communication turns out to be more in style than ever before because of its easy deployment. Wireless service is mobile and can be deployed almost everywhere faster than the fixed service. Scalability and flexibility are the two well known characteristic of wireless networking. Wireless networking provides users with network resources and connectivity irrespective of their locations.

There are two broad categories of wireless networks: infrastructure wireless network and infrastructure less wireless network also known as ad-hoc network [1]. The infrastructure network contains Base Stations (BSs) or Access Points (APs). Data sent between a wireless client and other wireless clients and nodes on the wired network segment is first sent to the wireless AP or BS. The wireless AP then forwards the data to the appropriate destination. On the other hand, Ad-hoc is used to connect wireless clients directly together, without the need for a wireless AP or BS or a connection to an existing wired network. An ad-hoc network consists of different wireless clients, which send their data directly to each other. In these network no communication infrastructure, no wires and no central controller is required.

If the carriers in wireless network are mobile [2] like cell phone, laptops or Personal Digital Assistant (PDA) then this type of network is called “mobile ad-hoc network” (MANET). A MANET is a type of wireless ad-hoc network consisting of autonomous mobile nodes and supporting no fixed infrastructure and no central controller. The nodes in such networks can organize themselves in an arbitrary fashion.

If the carriers are moving vehicles then this type of network is said to be “Vehicular Ad-Hoc Network” i.e. (VANET). A vehicular ad-hoc network (VANET) is a hastily emerging new class of mobile ad-hoc networks that uses moving vehicles as nodes in a network to create a mobile network. It’s a promising paradigm in wireless communication that aiming to enable road safety by providing driving support services and convenience by providing user’s interest oriented information services. It’s a special type of MANETs where vehicles are participating in the wireless ad-hoc network for establishing communications among vehicles or vehicles to roadside units or base stations. To accomplish this type of communication each vehicle in a VANET must be equipped with radar systems, Geographic Positioning Systems (GPS), sensors, computer system, cellular technologies, bluetooth etc. that allow them to act as network node.

Both MANETs and VANETs share some characteristics like movements of nodes, low bandwidth as well as self organizing feature of nodes with no controlling authority. But
few factors are there which clearly distinguish both concepts like nodes in a VANET have higher mobility, restricted mobility pattern along the predefined highway infrastructure, extremely dynamic topology, frequent network partitioning, good availability of resources (especially energy) compared to small mobile devices and finally the totally new application state of affairs. VANET will likely be an essential part of future Intelligent Transportation Systems (ITS) [3].

The Vehicular Ad-hoc Network structure is comprised of various nodes (vehicles), roadside infrastructure (base stations). There exist two types of communications vehicle to vehicle communication (V2VC) i.e. inter-vehicle communications as well as vehicle to roadside-infrastructure communication (V2RIC) using Dedicated Short-Range Communications (DSRC) [4] operating in the 5.9 GHz band as shown in figure.1. In 1999 the Federal Communications Commission (FCC) allocated a new 75 MHz band DSRC at the 5.9 GHz frequency for ITS applications in North America. The IEEE 802.11p standard and WA VE (Wireless Access for Vehicular Environment) suite were recently released for trial use [5].

Several applications in VANETs require data routing protocols for establishing these two types of communication. The Routing approaches adopted in the network characterize performance of the communication. Routing is the most important and challenging issue to be handle in VANETs because of high mobility of vehicles. Thus routing protocols for VANETs must cope with the partitioning of networks due to connectivity problem.

Data routing protocols plays an important role for establishing these two types of communication in VANETs. Routing is the most important and challenging issue to be handled in VANETs because of high mobility of vehicles. Ad-hoc routing protocols can be classified into two major categories [2]: first one is the topology-based routing protocols and the second one is the geographic position-based routing protocol. In topology-based routing protocols for packet forwarding, the protocols rely on the links information that is present in the network [6] i.e. it utilizes the topology itself of the network for routing decisions.

Topology-based routing protocols have difficulties in dealing with the characteristics of vehicular networks. The position-based routing protocols are more convenient for dynamic networks[7][9]. A number of routing protocols have been proposed and evaluated for ad-hoc networks few of these are also evaluated for VANET environment, but most of them are topology-based protocols. Position- based protocols which require information about the physical position of the participating nodes, have not been studied that much and require more consideration of authors.

In this paper the performance analysis of DREAM (Distance Routing Effect Algorithm for Mobility) protocol is presented. The performance metrics such as Packet Delivery Ratio (PDR), throughput, end-to-end delay and routing overhead are evaluated using ns2. The realistic vehicular mobility traces are generated using Intelligent Driver Model (IDM) based tool called VanetMobiSim. For simulation purpose the selection of the road topology is the most important and critical issue in order to map realistic vehicular mobility traces [10]. So for obtaining practical results the real world map for city of Arlington, Texas is being taken into account and a state from this map is generated by defining road topology in terms of user-defined graph considering the city scenario. The remaining portion of this article is structured in four sections. In section two related work is presented. Section three covers the overview of the DREAM protocol. In section four we present simulation methodology and give performance analysis of DREAM protocol using the simulation results. Finally section five concludes the work.

2. RELATED WORK

The topology-based routing protocols suffers from various limitations[7]: these protocols require establishment and maintenance of routes with an additional overhead of storing the routing tables and their periodical updating, inefficient to handle highly dynamic topology and frequent network breakdown in VANETs and finally with increasing number of nodes it does not scale well in dynamic networks[11]. So in order to overcome all these drawbacks the position based routing protocols[7] [16] came into existence. In these protocols the routing decision is not based on a routing table instead the routing decision is based on geographical positions of current node which is the sender, neighbor’s position towards the destination and the position of the receiver. Now each vehicle is aware of its position information by GPS (Global Positioning System), so position based routing is feasible in VANETs [12].

The authors Miguel Garcia de la Fuente et al. [13] presents a performance analysis between two location-based routing protocols: SIFT (Simple Forwarding over Trajectory), a trajectory-based scheme, and DREAM (Distance Routing Effect Algorithm for Mobility), a position-based scheme. Authors adopted Omnet++ Simulation Engine and its Mobility Framework [15] for performing the simulation. They concluded that the position-based routing methods cut down the control overhead as they are based on restricted flooding concept. However the simulation results point out that the position-based techniques (DREAM) not always perform efficiently in some highly dynamic scenarios, like VANETS. Instead the Trajectory-based protocols (SIFT) perform more efficiently in VANETs since they are spatial-aware. Hence the authors obtained the result that SIFT performs better than DREAM.

Authors Akira Takano et al. in [12] gave a classification of Position-Based routing protocols into two categories. First is the Next-Hop Forwarding method and second one is the Directed Flooding method. Then they compared these two types of methods by analyzing their performances through simulation using QualNet 4.0 [18] as simulator. They came to the result that the criteria for selection of any one of the
two methods is totally depend on the density of the nodes as well as their distribution. The reason for this conclusion is that the Next-Hop Forwarding method achieved higher packet delivery ratio than the Directed Flooding method when node density is low.

Bakhouya et al. presented a simulation study of DREAM protocol in [1][8][9] for inter-vehicle communication using MOVE and TraNS[18] simulation tools. Their results show that the DREAM protocol is more sensitive to traffic load than vehicles speed which is more suitable for dynamic ad-hoc networks like Vehicular Ad-hoc Networks.

3. OVERVIEW OF DREAM ROTOCOL

Dream [8] (Distance Routing Effect Algorithm for Mobility) Protocol is a directional, restricted flooding position-based routing approach [13]. Each node maintains a location table to store the position information of other nodes which belong to the network. Each node regularly floods the position or location packet, called control packet, to update the position information maintained by its neighbors. Two algorithms are implemented in DREAM protocol. In first the location information packets are distributed and in second the data packets (messages) are disseminated. The first scheme is based on restricted flooding idea. To restrict the flooding the maximum distance is defined that a position packet can travel. Principle of ‘distance effect’ is also used in which the location table update frequency is determined by the distance of registered nodes. In other words, the closer the node, the more updates sent to it. Thus nodes departing far away normally have a more stable relative location relationship. As a result when a node maintains the location information of another node that is far apart, less frequent updates are used. In second algorithm the data packets are disseminated using directional flooding where the source S forwards the packet to all one hop neighbors that are lying in the direction of destination D. To determine the forwarding zone in the direction of D, the source node S calculates the region that is likely to hold D, called the Expected Region (ER) as shown in Figure 1. [7].

![Figure 3: Real Map – 1000 x 1000 m, City of Arlington, Texas for simulation as road topology](image)

The radius of this expected region is set to the value \((t_f - t_0)v_{\text{max}}\), where \(t_0\) is the timestamp of the position information that S has about D, \(t_f\) is the current time, and \(v_{\text{max}}\) is the local known speed that the node D may travel in ad-hoc network. The line between S and D with the angle \(\phi\) represents the direction towards D. When the source node S wishes to send a message to a destination node D, the position table is checked to retrieve information about its geographical position. If the direction of D is valid, the message is forwarded by S to the all one hop neighbors in the forwarding zone using that direction. If case no one hop neighbor is found in the required direction i.e. no location information is available for D, then a recovery procedure is started by flooding partly or totally the network in order to reach D. When any node receives the data packet and it itself a destination D, an acknowledgement is replies back to the source node regarding message receiving otherwise all other nodes except D replicate the same method by sending it to all one hop neighbors that are in the direction of D. This method is replicated by each of these nodes, until destination D is reached.

4. SIMULATION AND RESULTS

This section presents the simulation and results for analyzing the performances of DREAM routing protocol. Extensive simulations have been carried out to evaluate the performance of DREAM protocol in VANETs by using the network simulator ns-2 [17] in its version 2.33 and 2.34. It is freely available and widely used for research in mobile ad-hoc networks. The movement traces of nodes are generated using VanetMobiSim tool. It is assumed that every vehicle is equipped with GPS using which it can obtain its current geographical location.

4.1 Mobility Model

In simulating mobile systems, it is important to use a realistic mobility model. Mobility model has major effects on the simulation results. Random waypoint (RWP) model, which is broadly used for MANET simulations, is unsuitable for VANET simulations [14], as the mobility patterns underlying an inter-vehicle network are rather different. In order to model realistic vehicular movement Advanced Intelligent Driver Model has been used. It is the extension of Intelligent Driver Model (IDM) and part on VanetMobiSim tool. VanetMobiSim developed by J. Harri et al., extends IDM and adds two new microscopic mobility models Intelligent Driver Model with Intersection Management (IDM-IM) and Intelligent Driver Model with Lane Changing (IDM-LC).

4.2 System Model

For simulation purpose the selection of the road topology is the most important and critical issue in order to map realistic vehicular mobility traces [10]. Therefore, for obtaining practical results the real map for city of Arlington, Texas as
shown in Figure 3. is being taken into account and a scenario from this map is generated by defining road topology in terms of user-defined graph. We performed a set of experiments for simulation area which is a square of 1000 m × 1000 m using ns 2. Vehicles are able to communicate with each other using the IEEE 802.11 MAC layer. The simulations are carried out taking the city scenario and varying CBR i.e. (Constant Bit Rate) against various performance parameters. The simulation parameters are given in Table 1.

### Table 1. Simulation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC type</td>
<td>IEEE 802.11</td>
</tr>
<tr>
<td>Channel type</td>
<td>Wireless</td>
</tr>
<tr>
<td>Simulation time</td>
<td>1000 seconds</td>
</tr>
<tr>
<td>Simulation area</td>
<td>1000m × 1000m</td>
</tr>
<tr>
<td>Transmission range</td>
<td>250m</td>
</tr>
<tr>
<td>Node speed</td>
<td>30 km/hr.</td>
</tr>
<tr>
<td>Traffic type</td>
<td>CBR (Constant bit rate)</td>
</tr>
<tr>
<td>No. of CBR sources</td>
<td>10 to 40</td>
</tr>
<tr>
<td>Packet rate</td>
<td>8 packets/sec</td>
</tr>
<tr>
<td>Data packet size</td>
<td>512 bytes</td>
</tr>
<tr>
<td>Mobility model</td>
<td>IDM</td>
</tr>
<tr>
<td>No. of node (vehicles)</td>
<td>50 (constant)</td>
</tr>
<tr>
<td>Routing protocol</td>
<td>DREAM</td>
</tr>
</tbody>
</table>

### 4.3 RESULTS AND DISCUSSION

The protocols are evaluated for end-to-end delay, throughput, routing overhead, and packet delivery ratio by considering varying CBR (Constant Bit Rate) under IDM model. The number of CBR sources taken from 10 to 40.

#### 4.3.1 End-to-End Delay

End-to-End delay is the average delay between source and destination node for all such data packets which are delivered successfully i.e. the delay suffered by packets before reaching their destinations. This includes all possible delays caused by buffering during route discovery, queuing at the interface queue, retransmission delay at MAC, and propagation delay. It is clearly concluded from the Figure 4 that average delay increases with increasing the number of CBR sources because traffic increases with increasing number of source nodes.

#### 4.3.2 Throughput

It is the total number of bits delivered successfully from per second from source to the destination. It is observed from Fig. 5 that the throughput is clearly increasing with the increasing number of CBR sources. This behavior results from improvement in the connectivity.

#### 4.3.3 Routing Overhead

It signifies the ratio of total number of overhead packets propagated by every node in the network over the total number of packets sent. Figure 6. illustrate routing load increases as the wireless channel is shared by more and more traffic sources.

#### 4.3.4 Packet Delivery Ratio (PDR)

PDR is defined as the ratio of of those packets that successfully reach the destination. Figure 7 expresses that PDR is continuously decreasing with increase in the number of CBR sources.
5. CONCLUSION

In this paper we analyse the performance a geographical position-based routing approach i.e. DREAM protocol for vehicular ad-hoc networks using Advanced Intelligent Driver Model (IDM) by considering the city scenario and modelling the real map of city of Arlington, Texas as road layout for obtaining the realistic vehicular traces through simulation using ns 2. For analyzing the behaviour of DREAM protocol we carried out its performance evaluation using various metrics against varying constant bit rate (CBR). It is concluded from the simulation results that the throughput is clearly increasing with the increasing number of CBR sources. This behaviour results from improvement in the connectivity but at the cost of increased overheads.

REFERENCES


