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Simulated Analysis of Location and Distance Based Routing in VANET with IEEE802.11p

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Abstract

A new sub-category of MANET is vehicular ad hoc network where vehicles communicate with each other. Because of constraint roads and very high speed of vehicles, routing is an issue in VANET. Most of the papers analyzed the performance of topology based routing protocols. This paper analyzed the performance of distance-effect routing algorithm for mobility (DREAM) and location aided routing (LAR) location-based protocols for city and highway vehicular environment. Metrics for analysis of performance like PDR, routing overhead, delay, throughput and lost packet ratio are evaluated using ns2 with IEEE802.11p. The simulation results are analyzed using AWK programming script.

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1. Introduction

In vehicular network systems, VANET plays an important role, which is formed by vehicles like car, bus, truck, cab etc. to convey some information to neighbour vehicles and road-side units. It is assumed that these vehicles have devices for computation, event recording, transceiver and GPS system. On the road VANET make possible for vehicles to use applications like, safety application [1], collision control warning, Internet surfing and advertisement while moving. Because vehicles move on predefined roads, they have a restricted mobility path [2]. In VANET environment mostly topology-based protocols AODV [3], DSR [4] are compared with location-based protocol LAR [5] and distance effect protocol DREAM [6].

In this paper performance analysis of DREAM and LAR in city as well as in highway environments with different metrics are presented. In order to provide realistic vehicular traffic movements, an extended version of intelligent driver model (IDM) [7] is used. The left over work is presented as: section 2 present the review on related research, section 3 describe the brief concept of DREAM and LAR protocols. In section 4 simulation environment is given and section 5 analyzed the simulated results. At last, section 6 presents the conclusion and further research work.

2. Related research review

Routing protocols in ad hoc network for VANET applications are categorized in topology and location based [8]. In topology based routing link information between nodes is stored in a table, which is used to transmit packets in the network. Geographic location of neighbours and destination nodes is used at each and every node to forward the packets to destination.

The routing performance of GSR, AODV and DSR protocols studied with a city vehicular network by Lochert et al in [9]. GSR is a hybrid concept combining topology and location based routing protocols. With delivery ratio and delay metrics GSR outperforms DSR and AODV. Authors in [10] did analysis of TORA, FSR, DSR and AODV in city scenario with IDM mobility model. On the basis of analysis AODV is best protocol in vehicular environment and TORA is not suitable at all. Husain et al.[11] analyzed the performance of topology as well as location based protocols in VANET for city and highway network. Bakhouya et al.[12] did simulation of DREAM protocol using MOVE[13] with traffic simulator TraNS[14] and found that it is suitable for VANET but showing average performance. Ko et al. [15] perform the simulated study of LAR routing protocol with IDM and it shows that LAR is reasonably good candidate for VANET, because it uses geographical location of the nodes.

Nidhi and D.K. Lobiyal[16] consider the JNU real map and divide into smaller routes to study the mobility impact in VANET . In this paper, AODV protocol with clustering of traffic light is used at road intersections for regularization of the traffic in various directions. C. Tee and A. C. Lee [17] analyzed the routing performance of GPSR, AODV and DSR using NS-2 and IDM. From this research article authors concluded that GPSR performed better in VANET. Multi-path doppler routing protocol (MUDOR), DSR and DSDV has been simulated by S.Xi et al.[18] and found that MUDOR is best in VANET environment. Simulation of position and topology based protocols done by M. Azarmi, M. Sabaei, and H. Pedram[19] and position based routing protocols found better.

3. Various location based routing protocols for VANET

To enable position-based routing, a node must be able to discover the location of the node it wants to communicate with. Position-based routing depends upon the forwarding decisions. This task is typically accomplished by a location service such as predictive hierarchical location service (PHLS). In PHLS, the entire network is partitioned into a hierarchy of smaller and smaller regions. For each node, one node in each-level region of the hierarchy is chosen as its local location server. When network initializes or nodes attach the network, nodes contact their local location server with their current location information (position and velocity). Nodes query their location servers and get exact or predicted location of nodes to communicate with. Greedy perimeter stateless routing(GPSR), geographic source routing(GSR),greedy perimeter coordinator routing(GPCR), anchor-based street and traffic aware routing(A-STAR), greedy traffic aware routing(Gytar), distance-effect routing algorithm for mobility(DREAM), location aided routing(LAR),distance-based routing protocols(DBR),distance-based routing protocol using location service(DBR-LS) etc. are some examples of location-based routing protocols for VANET. In this paper DREAM and LAR are considered for the analysis of performance in VANET.

3.1 Distance-effect routing algorithm for Mobility (DREAM)

DREAM [12] routed the data packets in the network by the use of distance and geographical location of the nodes. This geographical location is used to discover the route and bound the flooding in a small limited region. A proactive scheme is used in the routing process of DREAM. Each node of the network store the location of all the nodes of the network in a table, called location table and a control or location packet is flooded frequently to update the location by neighbouring nodes. Every location packet generated by a node contains the coordinates of the node, current time and the speed with direction to be stored by neighbour nodes.

Location table updating frequency is affected with distance of nodes; if a node is near to a source node then more location packets are sent to this node. When a node want to send a data packet to a destination node, it first check its own location table for the geographical position of the destination, if the location of destination found there, then it send the packet to one-hop neighbours in the direction of destination. If the location of destination was not found there, protocol starts the discovery process.

3.2 Location aided routing (LAR)

The main objective of LAR [15] is to lower the overhead caused by routing process, for which this protocol uses information about location of the nodes with the help of GPS or some other location service. By the use of location of the nodes, flooding is bounded to a limited region called request zone due to that route request packets are reduced. When finding the location of destination, LAR limit the search to a small area called expected zone where chances of being destination nodes are high, which reduces the overhead packets required for discovery process.

4. Simulation and evaluation setup

Mostly routing protocols are simulated using network simulators like ns-2 [20], OMNeT++[21], J-SIM [22], and JiST/ SWANS[23]. Movements of vehicle patterns are generated using traffic simulators like CORSIM, VISSIM, SUMO and VanetMobiSim. VanetMobiSim is most suitable for vehicular network because it integrated with components for intersection management (IDM_IM), lane changing (IDM_LC) and traffic lights. Simulation process steps of routing protocols in vehicular ad hoc networks are shown in Fig.1. Analysis of DREAM and LAR in this paper is done using the network simulator ns-2.33 with IDM_IM based VanetMobiSim [24-26] traffic simulator in VANET environment.

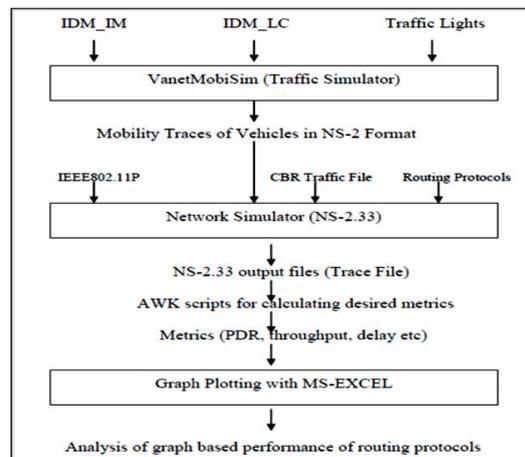


Fig.1: Simulation of routing protocols in vehicular ad hoc networks

4.1 System model

The parameters for vehicles mobility of VanetMobiSim simulator are shown in Table1. IEEE 802.11p AC/PHY protocol is implemented in ns-2.33 for the vehicles to communicate with other vehicles.

Table 1. Mobility model parameters

PARAMETER	VALUE
Threshold acceleration	0.2 m/s ²
Politeness factor of driver	0.5
Safe deceleration	4 m/s ²
Safe headway time	1.5s
Recalculating movement step	1.0 s
Jam distance	2m
Comfortable deceleration of movement	0.9 m/s ²
Maximum acceleration of movement	0.6 m/s ²
Vehicle length	5 m

The parameters used in vehicular ad hoc network simulation in ns-2 are shown in Table2. Vehicles are able to communicate with each other using the IEEE 802.11p DCF MAC layer. The transmission range is taken to be 250 meters. The traffic light period is kept constant at 60 seconds. Simulations are repeated varying the speed, that is, 25 km/h (city) and 120 km/h (highway) and varying the node density.

Table 2. Network simulation parameters

PARAMETER	VALUE
Simulation tool	NS-2 version 2.33
MAC protocol	IEEE802.11p
Mobility model	IDM_IM
Transmission range	250 m
Simulation area	1100m x 1100m
Channel	Wireless
Antenna	Omni-directional
Simulation time	1000s
Packet length	512 Bytes
Data rate	8 packets/s
Pause duration	15s
Bandwidth	2 Mbps
Type of Traffic	CBR
Vehicle speed	25km/hr(city), 120km/hr(highway)
Type of Interface queue	Drop Tail/CMU Priority Queue
Size of Interface queue	50 packets
Number of vehicles	5 to 40
Routing protocols	LAR and DREAM
Maximum connections	65%

5. Results and discussions

The following performance metrics are considered to evaluate and analyze the performance of DREAM and LAR routing protocols:

5.1 Packet delivery ratio (PDR)

PDR is the ratio of the total number of data packets successfully delivered divided to the total data packets transmitted by all the nodes in a network. Mathematically, packet delivery ratio (PDR) = S_a / S_b

Where, S_a = Sum of the data packets received by each destination

S_b = Sum of the data packets generated by each CBR source

Fig.2 represents the ratio of packets that are transmitted during simulation by ns-2.

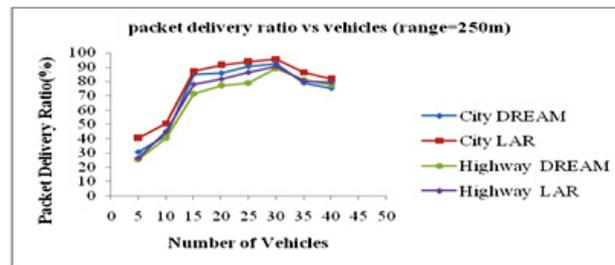


Fig.2. Packet delivery ratio in city and highway scenario

It has been shown that in starting PDR increases with the increase in number of nodes. It is because when number of nodes is very low, it may not be possible to establish a communication path from the source to destination. As number of nodes increases, the connectivity in the network is better; therefore protocols show good performance for medium density of the nodes. As node density further increases, PDR drops because now higher and higher numbers of vehicles share the same communication medium. It can be observed that the performance of LAR is slightly better than DREAM in city as well as in highway scenario. When node density is less than 15 nodes, packet delivery ratio of all the protocols is below 60% and for the density between 20 to 30 nodes it is above 70%. For node densities beyond 30 nodes, the PDR starts to decrease.

5.2 Throughput

Throughput is the sum of bits received successfully by all the vehicles. It is represented in kilo bits per second (kbps). Mathematically,

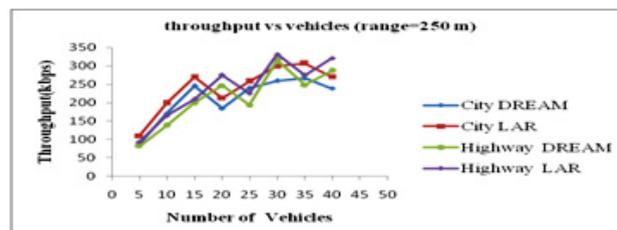


Fig.3. Throughput in city and highway scenario

Throughput= Sum of the packets transmitted successfully / the time of the last packet transmitted

From Fig.3, it is observed that when node density is up to 15 the throughputs of LAR in city scenario is higher than DREAM in both scenario and LAR in highway scenario. However when density is increased from 15 to 30 nodes, LAR in highway scenario is higher than DREAM in both scenario and LAR in city scenario. The reason behind this is that at low density the connection between vehicles is easily maintained but due to the obstacles such as buildings prohibits some vehicles to maintain the connection when node density is increased.

5.3 End2End delay (EED)

EED is the time between arrival times of the packet at the destination vehicle to the same packet transmission time at the source vehicle. It is the sum of buffering time, queuing time, MAC layer retransmission time of packets and delay in propagation.

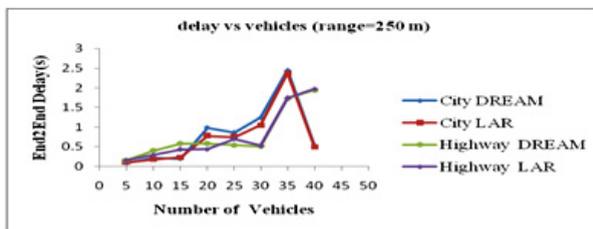


Fig.4. End2End delay in city and highway scenario

Mathematically, average end-to-end delay = S / N

Where,

S = Sum of time spent to deliver packets for each destination, and

N = Number of packets received by all the destination nodes.

Fig.4 summarizes the variation of end to end delay by varying node density. It is also evident that average delay increases with increasing the number of nodes. At low node density, DREAM in highway scenario consistently presents the highest delay. This may be explained by the fact that its route discovery process takes a relatively more time. LAR in city scenario has the lowest delay compared to DREAM in both scenarios. For densities from 5 to 30 nodes end-to-end delay caused by DREAM and LAR is very different, but for the densities beyond 30 nodes there is a sharp increase in the delay in city scenario

5.4 Routing overhead load (ROL)

Routing overhead load includes the number of route request packets transmitted, number of route reply packets transmitted, number of route error packets transmitted, number of route errors resent packets.

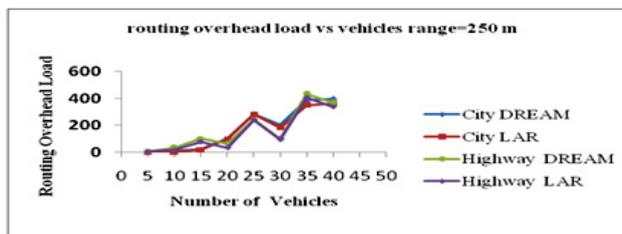


Fig.5. Routing overhead in city and highway scenario

Mathematically,

$$\text{Routing overhead load (ROL)} = St / Sr$$

Where,

St = Sum of routing packets transmitted by each source and destination

Sr = Sum of data packets received by each destination.

As shown in Fig. 5, DREAM in highway scenario causes the highest routing overhead as compared to LAR in both scenarios and DREAM in city scenario. It is observed from the Figure 5.4 that routing overhead load increases as the wireless channel is shared by more and more nodes. For node densities from 20 to 35 nodes, LAR in highway scenario showed the lowest overhead in comparison to DREAM in both scenarios. It shows that LAR outperforms in highway scenario.

5.5 Lost packet ratio (LPR)

The number of lost packets is the sum of the packets lost or dropped by all the nodes in the network. Lost packet ratio (LPR) is defined as the number of lost packets to the packet generated by CBR sources. Mathematically,

$$\text{Lost packet ratio (LPR)} = Sa / Sb$$

Where,

Sa = Sum of lost packets by all routes

Sb = Sum of packets generated by all CBR sources

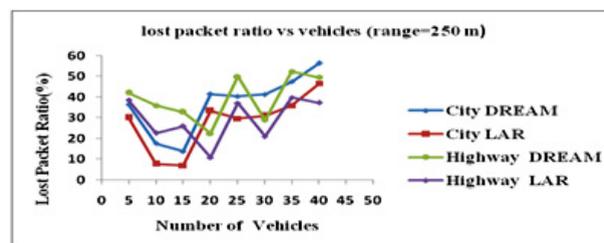


Fig.6. Lost packet ratio in city and highway scenario

Fig. 6 shows the LPR with varying number of vehicles. It is observed that initially LPR increases with increase in the number of nodes. At very low density the nodes are not able to communicate among themselves, which shows high LPR. As number of nodes is increased more and more nodes are able to successfully communicate which results in low LPR. When nodes are increased further the LPR increases. This is due the fact that as number of nodes is increased more and more packets are transmitted in the network and competing for access to the channel and more collisions would be there. DREAM in highway scenario has the highest LPR, while at low node density LAR in highway have lowest LPR but at high density of nodes LAR in city scenario shows the lowest LPR. The analysis of LPR shows that LAR performed better than DREAM.

6. Conclusion and future work

This research paper, analyzed the DREAM and LAR routing protocols in vehicular ad hoc considering various metrics in city and highway scenarios. For the analysis, ns-2.33 with an advanced intelligent driver

model (IDM_IM) of VanetMobiSim which is a traffic simulator is used to generate realistic mobility patterns in VANET. It is observed that LAR performs better than DREAM protocol in VANET for most of the metrics. In future, VANET research to analyze the impact of traffic lights with traffic signals and variation in transmission range for the performance of the routing protocols considered. In future, the work will be extended to evaluate the location based geocasting protocols in vehicular ad hoc networks.

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