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RESEARCH ARTICLE

Vehicular Ad-Hoc Network a Comparative Study and Simulation

Niranjan Singh[a], Sunil Kumar[b], Rajdeep Singh[c], B S Rawat[d], Devendra Singh[e]

[ae] School of Engineering & Technology, IFTM University, Moradabad, U.P, India

[bcd] School of Social Sciences & Computer Applications, IFTM University, Moradabad, U.P, India

[a] niranjansinghcs2010@gmail.com; [b] skiftm@gmail.com; [c] singh.rajdeep1@gmail.com

Abstract— Here we present performance evaluation of different routing protocols such as SIFT, GPSR and GOSR using different mobility models like Fluid Traffic Model (FTM), Intelligent Driver Model and Random Waypoint Model (RWM) with Intersection Management (IDM-IM). We present simulation results that demonstrate the importance of choosing a mobility model in the simulation of a Vehicular Network Protocol. Here, we Simulate the performance of Simple Forwarding over Trajectory (SIFT), Greedy Perimeter Stateless Routing (GPSR) and Geographical Opportunistic Forwarding (GOSR) in Vehicular Ad-Hoc networks metropolitan environments. The performance evaluations are important to improve the routing efficiency in metropolitan Vehicular networks environment. We will simulate the protocols against node speed. We will find that SIFT is better than GPSR and GOSR for most of the performance metrics used in this Simulation.

Key Terms: - Mobility Models; GOSR; GPSR; SIFT; VanetMobiSim

I. Introduction

In Vehicular Ad-Hoc network topology and communication conditions may differ heavily which greatly affects the network performance and making routing of data packets a difficult task. The pace of the nodes and their positions in the topology are represented by a Mobility Model which is one of the most initial parameters in simulating VANETs. Using simple random-pattern, graph constrained mobility models are a common practice among researchers working on VANETs [1, 2]. Such models cannot describe vehicular mobility in a rational way, since they ignore the irregular aspects of vehicular traffic. For instance, vehicles smooth rushing and announcement in presence of nearby vehicles since vehicles do not rapidly break and move, queuing at roads intersections as every vehicle needs to decide a rotating direction at the intersection (e.g., turn left, right or go straight), clustering of the vehicles caused by traffic illumination, and traffic congestion or traffic squash. All these situations greatly effect on the network performance, since they have a huge impact on network connectivity and this makes vehicular specific performance assessment fundamental when studying routing protocols in VANETs. A realistic mobility model should have also consisted of a realistic topological chart which reflects different solidity of roads or path and different categories of streets with different speed restrictions. In this paper, we discuss how these facts affect the network topology and hereby the performance of VANET in the simulation environment. We evaluate the effects of mobility models in VANET routing protocols simulation study. Specifically, we clearly understand that how the reality of traffic lights and stop symbols, driver route choice and car clustering at meeting point activities may heavily affect the connectivity of VANETs, and therefore the performance of VANET network protocols. We evaluate GOSR [5], GPSR [4] and SIFT [3] in realistic metropolitan traffic environment. We use of Fluid traffic Model (FTM) [7], Random

Waypoint Model (RWM) [6] and Intelligent Driver Model with Intersection Management (IDM-IM) [8], the most generally used mobility model which are part of the VanetMobiSim [9, 10] tool.

II. MOBILITY MODELS IN VANET

A. Intelligent Driver Model

In sequence to model realistic vehicular movement Advanced Intelligent Driver Model has been used. It is the addition of Intelligent Driver Model (IDM). This section discusses the clustered integrated approach to this Intelligent Driver Model.

This model is a macroscopic car-following model that adapts a vehicle speed according to other vehicles driving ahead, thus falling into what so-called car following models category. IDM-IM model uses a quite small set of parameters, which can be calculating with the help of real traffic measurements. This model extends the IDM model, in order to include the management of intersections regulated by traffic lights and of broads with multiple lanes [8]. It borrows the car-to-car interaction description of the IDM model and provides intersection handling capabilities to vehicles driven by the IDM model. It can manage crossroads regulated by both stop signs and traffic lights. In both suitcases, IDM-IM only acts on the first vehicle on every road, as IDM automatically adapts the behaviour of cars following the leading one.

B. Fluid Traffic Model (FTM)

This Model instead part of the second class, as they description for the being there of close to vehicles when calculating the speed of a car. This model illustrates car mobility on Single Street, but it does not consider the case in which various vehicular movements have to interact, as in presence of connections. Here the FTM describes the speed as an elementally decreasing function of the vehicular density, emphasizing a lower bound on the speed when the traffic congestion achieves a significant state, is calculated by the following equation:

$$S = \max[\ S_{min}\ ,\ S_{max}(1- K / K_{jam})\ ]$$

Where both S_{min} and S_{max} are the minimum and maximum speed respectively, The vehicular density is represented by K_{jam} for which a traffic jam is identified, and K is the present vehicular density of the street the node, whose speed is being calculates, is moving on. The last parameter is given by k = n=l, where n is the number of cars on the road and l is the length of the road component itself.

C. Random Waypoint Model (RWM)

Random Waypoint (RWP) model is a generally used synthetic model for mobility in Ad Hoc networks. It is basic models which illustrate the movement pattern of autonomous nodes by simple provisions.

In short, RWP model is specified as below:

- Every node moves along a Zig - Zag line from one waypoint Pi to the next Pi+1.
- The waypoints are homogeneously distributed over the given convex area.
- Optionally, nodes may have called "thinking times" when they reach every waypoint before enduring on the next path, where durations are independent and identically dispersed random variables.

III. ROUTING PROTOCOLS IN VANET

A. Greedy Perimeter Stateless Routing (GPSR)

Greedy Perimeter Stateless Routing (GPSR) [4], GPSR, is a responsive and proficient routing protocol for mobile. Unlike established routing algorithms before it, which is use graph theoretic notions of shortest paths and transitive reachability to find paths, GPSR utilize the correspondence between connectivity and geographic position in a wireless Ad hoc network, by using the positions of nodes to make packet forwarding judgment. This uses greedy forwarding to forward packets to nodes that are always increasingly closer to the destination. In area of the network where such a greedy route does not exist (*i.e.,* the only path requires that one move temporarily farther away from the destination), this recovers by forwarding in perimeter mode, in which a packet pass through successively closer *faces* of a planar sub graph of the full radio network connectivity graph, pending reaching a node closer to the destination, where greedy onward resumes.

It works best in a free open space scenario with evenly distributed nodes. It is argued that geographic routing get better results than topology-based routing such as AODV and DSR in a highway scenario because there are fewer obstacles compare to city circumstances and is fairly suited to network requirements. On the other hand, when applied it to city circumstances for VANETs, GPSR suffers from several problems [3]. Firstly, in city scenarios, greedy forwarding is often restricted because direct communications between nodes may not exist due to obstacle such as building and trees. Secondly, if apply first the planarized graph to build the routing topology and then run greedy or face routing on it, routing performance will be degrade, (i.e., packets need to travel a bigger path with higher delays). Thirdly, mobility can also bring routing loops for face routing, and finally, sometimes packets may get promoted to the wrong direction leading higher delays or even network partitions.

B. SIFT: Simple Forwarding over Trajectory

Different from previously proposed trajectory based forwarding schemes, SIFT [3] uses broadcast instead of point to point transmissions. Wireless transmissions are broadcast in nature and allow reaching possibly all active neighbours at the similar time. Moreover, the forwarding decision is shifted from the transmitter to the receiver. Every node that receives the packet takes the decision whether to forward it or not based only on it's possessed position, the transmitter position and the trajectory. This greatly reduces control overhead introduced by the protocol and energy consumption. Once received a packet, every node sets a timer according to its current position with respect to the trajectory and the transmitter. If a reproduction or copy of the packet, forwarded by another node, is received previous to the timer expires, the timer is bunged and the packet is deleted from the forwarding queue. Otherwise, the packets are approved or pass to the Medium Access Control (MAC) layer for transmission when the timer expires. Consequently, the node with the minimum timeout value will forward the data packet. It is the node in the finest position since it is far from the last node and close to the trajectory. Packets contain into the header the trajectory and the coordinates of the last node that forwarded the packet. The innovative source identifier, a hop count, and a sequence number are included as well. Every node sustains a list of recently received packets (i.e., source ID and sequence number) to avoid cycles.

C. GOSR: Geographical Opportunistic Source Routing

The GOSR [5] protocol is composed of two parts, namely geographical source route selection and geographical opportunistic forwarding. They are discussed in the following.

1) Geographical Source Route Selection

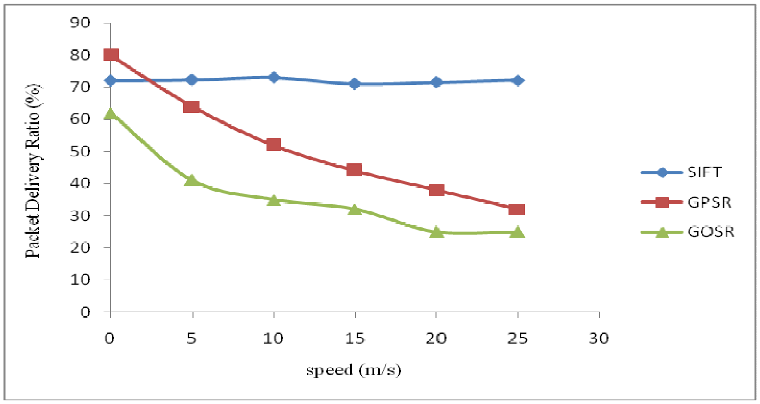
Geographical source routes are computed in an on demand manner. A graph is extracted from the e-map. The positions of the destination and source nodes are represented as road segment and vertices between junctions are mapped as edges. Every edge is joined with a weight, whose value is relative to the length of the road segment. Once the graph is ready, with the help of Dijkstra algorithm, find a shortest path from the source to the destination.

2) Geographical Opportunistic Forwarding

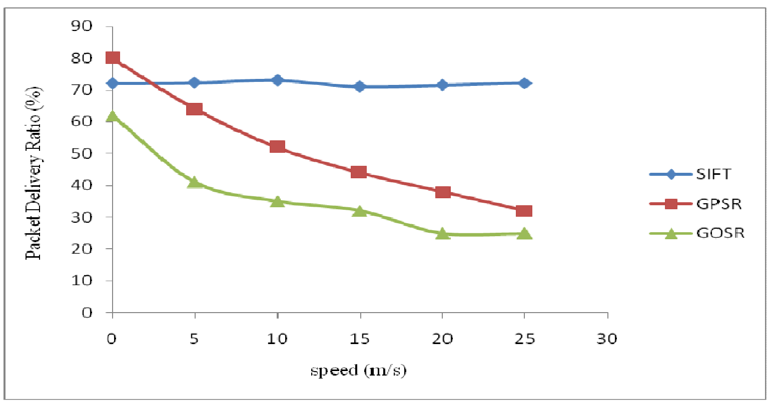
Once the geographical source route is chosen by the source node, GOSR enters the geographical devious forwarding stage. The data packet of GOSR contains the following fields: a list of junction position, scope, and the last hop position. The value of the scope is vital for minimizing the notification cost. For this paper, we simply set the scope twice the distance between the current forwarder and its best-known neighbour as described in [5]. When receiving a packet, the node checks whether it is within the designated scope by using the last hop position and the scope information in the packet. If yes, it compares itself with the best-known neighbour. If it is closer to the next junction than the best-known neighbour, it becomes a candidate. Since there might be multiple candidates, GOSR uses defer timers to shun simultaneous transmissions (i.e., candidates snoop the media in the defer phase). The postpone time of the best known neighbour is the highest value and the defer time of the node at margin of the scope is 0. In this approach, GOSR ensures that better forwarding opportunities are given higher priorities.

IV. EVALUATION AND SIMULATION

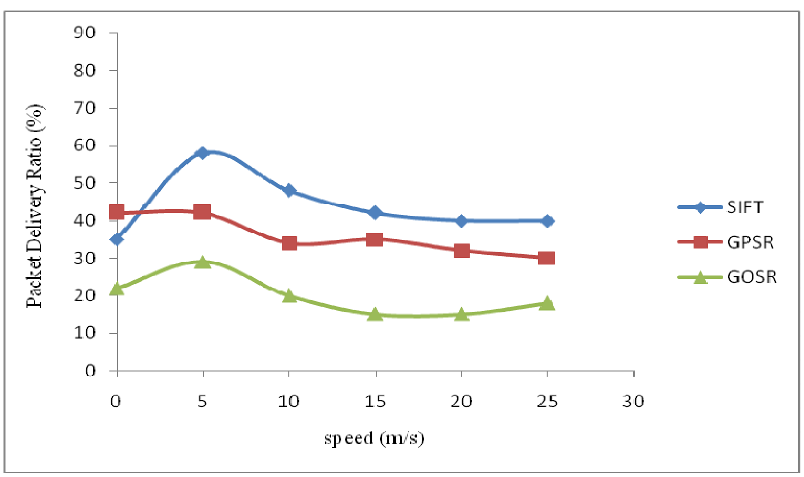
In this section, we calculate the impact of mobility models generated by VanetMobiSim on the performance of VANETs routing protocols. The following experiment set involves the investigation of the impact of nodes speed on routing protocols with the average speed between 0 and 25 m/s and vehicle density fixed at 30vehicle/km. The destination node was placed 2 km away from the source node. As shown in Fig. 1, GPSR and GOSR experience a drastic decrease in their performance affected by nodes speed, since their position information diffusion procedure completely depends on nodes speed. As depicted in Fig. 1, the faster nodes move, the more frequent nodes new positions must be disseminated during the network. When speed surpasses a sure value, the channel gets overloaded and transmission errors happen. When nodes speed increases delivery ratio decreases. It is important to note that delivery ratio in SIFT increases with speed in case of FTM model until it reaches the steady state (i.e., speed is more than 15 m/s). This is because nodes have a better (uniform) distribution when they move faster as the FTM model does not consider intersections or stop signs. In this experiments set, average end-to-end delay remains constant as this parameter depends, merely, on network density and distances between sources and destination nodes, which is stable in this set of experiments. However, SIFT incurs high delay values in case of RWM model since nodes are placed far from the trajectory. In general, nodes speed is a parameter that has a negative impact on location table-driven routing protocols for mobile ad hoc networks because the information kept in the location table is completely linked to nodes speed. From this observation, the most important assertion that can be obtained is that SIFT performance remains completely constant in terms of speed. This is because of the special routing technique implemented by SIFT, which is not location table- driven.



(a) RWM Model



(b) FTM Model



(c) IDM-IM Model

Figure 1. Packet delivery ratio vs speed

V. CONCLUSIONS

Our findings show that the RWM and FTM models fail to provide a realistic movement pattern. Consequently, the use of these models can result in misleading or incorrect conclusions, and thus they cannot be applied to all simulations of vehicular networks urban scenarios. While, the IDM-IM model proved to be more realistic as it is capable of modelling detailed vehicular movements in different traffic conditions. In this paper, we have appraised the performance of GPSR, GOSR and SIFT in vehicular ad hoc networks urban situations. These performance assessments are important to improve the routing efficiency in urban vehicular networks environment. We have tested the protocols against node speed. We found that SIFT outperforms both GPSR and GOSR for most of the performance metrics used in this paper.

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