Performance Evaluation of Beaconing Schemes in GPSR for VANETs

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Abstract— In VANETs or Vehicular ad hoc Networks, vehicles represent the nodes, which communicate wirelessly. Every node sends the beacons (data packets) to update its position using GPSR protocol. The packets are forwarded through the best-effort delivery technique called Geographic Forwarding. In this paper, APU or Adaptive Positioning Routing has been used to evaluate the distance-based and speed based beaconing schemes on the basis of variation in number of nodes and in transmission range using NS-2 simulator.

Key words: VANET, GPSR, APU, Beaconing Schemes

I. INTRODUCTION

Vehicular ad hoc networks are self-configured networks in which vehicles, which are assembled with on-board computer, wayside infrastructure, sensors and pedestrian devices represent the nodes. Wi-Fi (IEEE 802.11) technologies are used in these networks. The IEEE group is completing the IEEE 802.11p and IEEE 1609 final version, called as WAVE (Wireless Access in Vehicular Environments) which is mainly used for VANETs. This technology can be used to develop powerful car systems capable of aggregating, processing, and distributing information [1]

A. How VANET Works?

VANET System consists of a number of nodes. These vehicles are governed by an authority, and communicate with other vehicles by Short Radio Signals or DSRC (5.9 GHz). Within the range of 1 KM, such communication is called an Ad Hoc communication in which every connected node can move freely and wirelessly. Road Side Unit or RSU works as the router between mobile nodes. All vehicles have on board units, which connect the vehicle to the RSU through DSRC signal, and the other device is the Tamper Proof Device, which holds all the information of a vehicle such as drivers' identity, keys, speed, trip details and routes, see figure 1. [2]

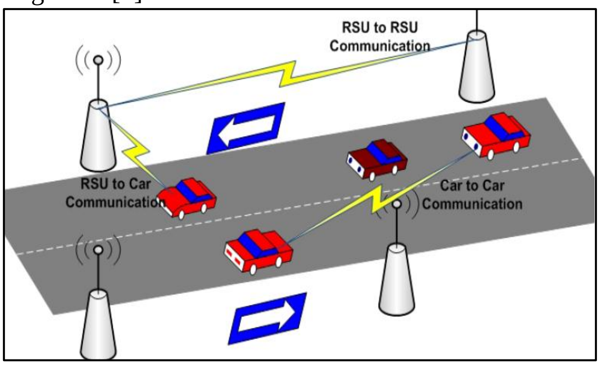

Fig.1 VANET Structure [2]

B. Components of VANET

VANET is a self-governing wireless network. It includes following components:

1) Vehicles

Vehicles represent the nodes of VANET. VANETs include the wireless communication among vehicles i.e. V2V and among vehicles & infrastructure access points i.e.V2I.

2) Infrastructure

Infrastructure consists of road-side base stations. Base stations are situated at specific locations such as junctions, close to parking areas etc. They are set up to improve the communication area of any network by reallocation of the data to nodes and to carry security applications such as accident warnings or low bridge warnings etc.

3) Communication Channels

Radio waves are the electromagnetic rays having wavelength in the frequency spectrum more than the infrared light, and possessing frequency in the range of 190 GHz – 3000Hz. Radio wave propagation model is an important model to calculate the number of nodes in a collision domain [3]

C. Greedy Perimeter Stateless Routing (GPSR) Protocol

It is a position-based protocol, which transmits data packets through the "greedy algorithm". In this algorithm, it is assumed that the packets are greedily forwarded to the neighbour, which is closest to the destination. If the node itself is the closest node, the GPSR uses a recovering technique— through the Right Hand Rule to solve the issue of the local optimum. The GSR or Geographic Source Routing uses the Dijkstra algorithm in order to find the shortest distance between source & destination on a digital graph or map, and sends the data packets via this route. The GPCR or the Greedy Perimeter Coordinator [6]

D. Geographic Random Forwarding or GERAF

It is a new kind of transmission technique that considers geographical routing process, in which the packets are forwarded on the basis of best-effort delivery, i.e., the node which actually relays the packet is not known in prior to the sender, but it is decided only after the transmission. [1]

The technique is as follows. When a node has one packet to transmit, it uses some type of broadcasting address to send the packet. It specifies the location of itself and of the required destination. All active nodes in the coverage range receive this packet and will determine their priority to relay the packet, on the basis of distance from the destination. The message may be a full packet, or a RTS message (if a collision avoidance technique is used). [5]

E. Adaptive Position Updates

A new beaconing mechanism used in the geographic routing protocols is known as the Adaptive Position Updates or APU strategy. It removes the drawbacks of the periodic beaconing through adapting to the system changes.

The APU is based on the two rules for triggering the beacon updation process:

1) Mobility Prediction (MP)-It uses a motion prediction scheme and estimates when the broadcasting of

location information in the previous beacon is inaccurate. The next beacon is broadcasted only when the estimated error in estimating the location is greater than some threshold. It tunes the update frequency to the vitality inherent in the motion of the node.

2) On-Demand Learning (ODL)-It is used to improve the efficiency of the topology along the links between the communicating nodes. It uses an on-demand learning mechanism, in which a node will broadcast the beacons when it hears the transmission of the data packet from a new neighbour in the network. Thus, the nodes which forward the data packets will maintain an updated view of the local topology. In contrast, the nodes which are not in the range of the forwarding path remains unaffected by the rule and hence do not broadcast the beacons very often. [4]

II. Related Work

1) A sequence of representative metaheuristic algorithms like PSO, DE, GA, and SA are studied to find automatically optimal configurations of OLSR. Additionally, a group of realistic VANET scenarios have been defined to precisely evaluate the performance of the network through automatically optimized OLSR
2) In this paper, several types of security challenges and problems of VANETs been analysed and discussed; also a group of solutions to solve them is mentioned.
3) Several routing protocols have been designed considering the major challenges involved in VANETs. This paper gives a survey of such routing protocols for VANET . It includes application areas, challenges and security issues existing in VANETs.
4) The Adaptive Position Update i.e., APU is proposed. The theoretical analysis, which is confirmed by NS2 simulations of Greedy Perimeter Stateless Routing Protocol i.e, GPSR, viewed that APU can significantly decrease the update cost and improve the routing performance in comparison with periodic beaconing.
5) A new forwarding method based on geographical location of the nodes involved and random selection of the relaying node via contention amongst receivers is proposed. An idealized approach, in which the best relay node is selected, is discussed, and its performance is calculated by means of both simulation and analytical methods
6) A routing protocol annexing the vehicle density, moving direction and speed into the GPSR protocol in making packet forwarding judgements is proposed here. Important data structures were designed and MOVE was required to make traditional Grid map urban simulation scenario. This protocol was simulated by using NS-2 in the urban environment and was compared to AODV and GPSR protocols.

III. Problem Formulation

On the initialization of broadcasting, every node broadcasts a beacon informing its neighbors about its presence and its current location and speed. After this, in most of the geographic routing protocols such as GPSR, every node periodically broadcasts the present location information. The position information received from neighbouring beacons is stored at each node. On the basis of the position updates received from its neighbours, every node continuously updates its local topology, which is represented in the form of neighbour list. Only those particular nodes from the neighbour list are considered as possible candidates for forwarding of the data. Thus, the beacons play an important part in maintaining an accurate representation of the local topology. The beacon interval affects network connectivity.

IV. Proposed Work/ Methodology

Simulation based comparison of performance of Distance-based Beaconing and Speed-based Beaconing on the following parameters:

A. Impact of Number of Nodes on Beaconing Schemes

B. Impact of Transmission Range on Beaconing Schemes

In the distance-based beaconing, the node transmits the beacon when it has moved a given distance 'd'. The node removes an outdated neighbor if it does not receive any beacons from the neighbor while the node has moved more than kth multiple of the distance d, or after a maximum time-out of 5 sec. This approach is, hence, adaptive to the mobility of the nodes, e.g., a faster moving node sends beacons more frequently and vice versa.

In the speed-based beaconing, the time interval of the beacon is dependent on the node speed. A node decides its beacon interval from the pre-defined range with the accurate value selected being inversely proportional to its speed.

V. Simulation

Ns-2 is a discrete event simulator aiming at networking research, which provides substantial support for the simulation of TCP, routing, and multicast protocols over wired or the wireless (the satellite) networks.

Various parameters which form the basis of simulation are given below:

S. No.	Parameter	Value
1.	Number of Nodes	100, 150
2.	Simulation Area(m^2)	1500*1500
3.	Transmission Range(m)	20, 40, 50, 100
4.	Packet size (kb)	1460
5.	Routing Protocol	GPSR
6.	Simulation Time(msec)	250

Table 1: Simulation Parameters

We have studied the impact of

- Variation in number of nodes, and
- Variation in transmission range on the following performance metrics:

1) Average Delay
2) Maximum Delay
3) Minimum Delay
4) Load
5) Packet Delivery Ratio
6) Throughput

VI. RESULTS

- NS-2 simulator has been used to evaluate the two types of beaconing schemes: distance-based and speed-based.
- The combined effect of Number of Nodes and the Transmission Range on Beaconing Schemes are as follows:

A. Average Delay

It is the average time taken by any data packet to reach the destination. It also consists the delay caused by route discovery process & queue in the data packet transmission.

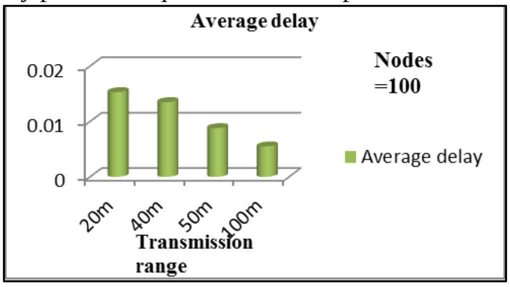

Fig. 2: Average Delay for 100 nodes

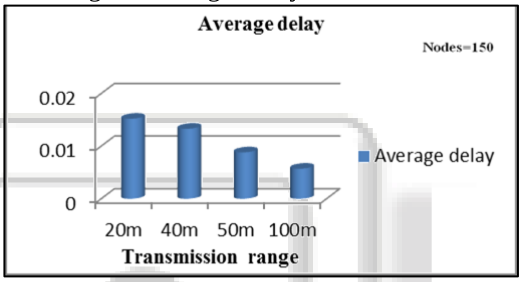

Fig. 3: Average Delay for 150 nodes

As shown in graphs,

- Average Delay remains approximately same as the number of nodes increases.
- Average Delay reduces as the transmission range increases.

B. Maximum Delay

It represents the maximum of all the possible values of the end-to-end delays.

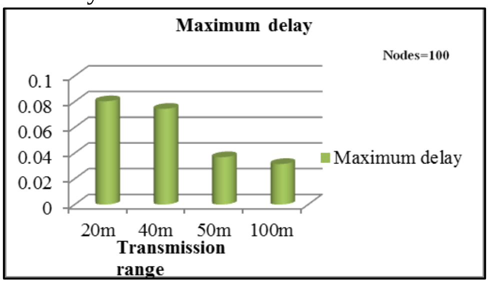

Fig. 4: Maximum Delay for 100 Nodes

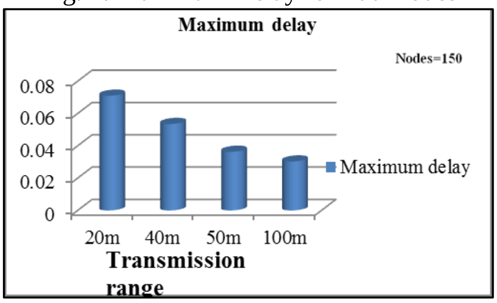

Fig. 5: Maximum Delay for 150 Nodes

As shown in graphs,

1) Maximum Delay remains approximately same as the number of nodes increases.
2) Maximum Delay reduces as the transmission range increases

C. Minimum Delay

It represents the minimum of all the possible values of the end-to-end delays.

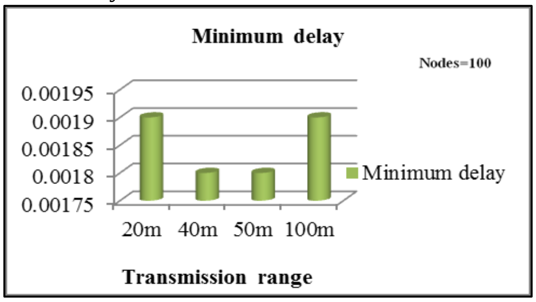

Fig. 6: Minimum Delay for 100 nodes

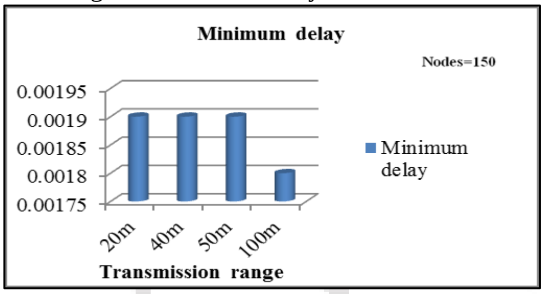

Fig. 7: Minimum Delay for 150 nodes

As shown in graphs,

1) Minimum Delay remains approximately same as the number of nodes increases.
2) Minimum Delay reduces slightly as the transmission range increases

D. Load

It represents the volume of the traffic that is being carried by the VANET.

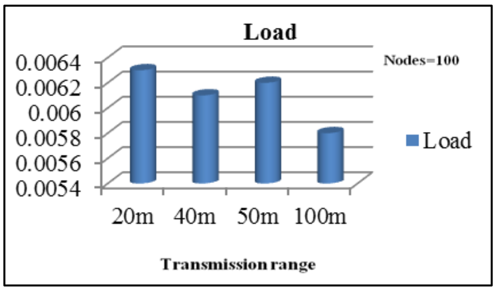

Fig. 8: Load for 100 nodes

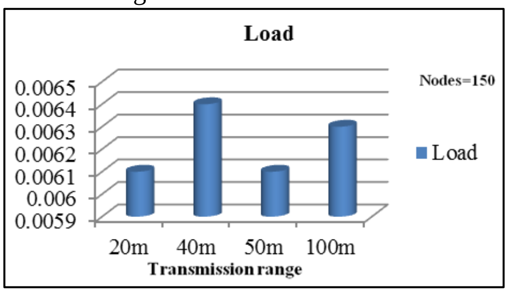

Fig. 9: Load for 150 nodes

As shown in graphs,

1) Load remains approximately same as the number of nodes increases.

2) Load does not depend on the transmission range.

E. Packet Delivery Ratio

It represents the ratio of the number of delivered data packets to the destination to the number of packets actually sent.

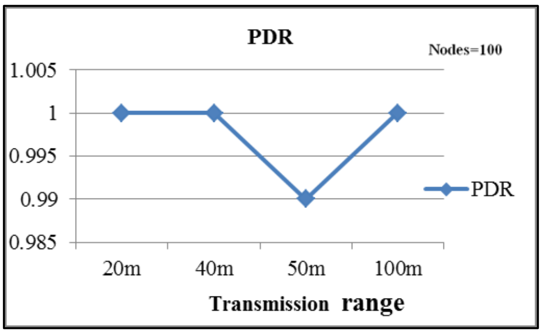

Fig. 10: PDR for 100 nodes

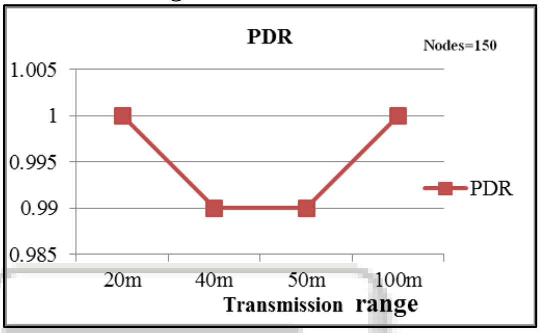

Fig. 11: PDR for 150 nodes

F. Throughput

It is the rate of successful messages delivered over any communication channel, i.e. the number of messages delivered per unit simulation time.

Fig. 12 & 13 represents the throughput for different transmission ranges in case of 100 and 150 nodes, for the starting node (0th) and the concluding node (90th) respectively.

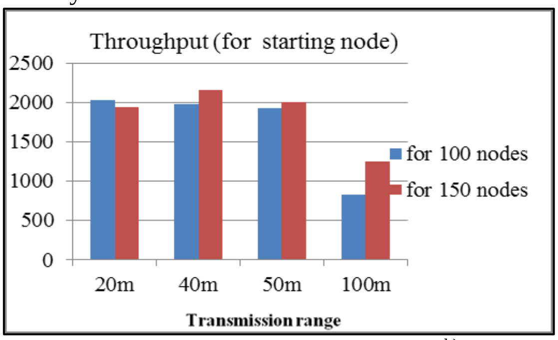

Fig. 12: Throughput for the starting (0th) node

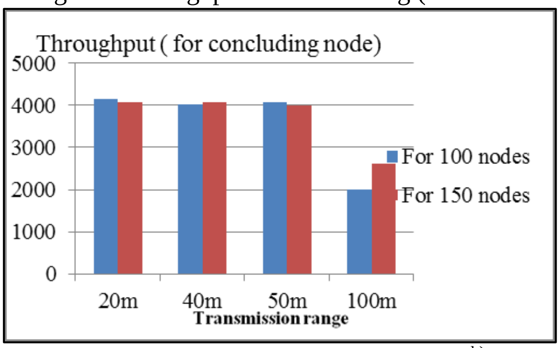

Fig. 13: Throughput for the concluding (99th) node

VII. CONCLUSION

In this paper, distance-based and speed-based beaconing schemes have been evaluated by varying the number of nodes and the transmission range. We have used APU strategy for the forwarding of packets. Two major parameters used for evaluation are Packet Delivery Ratio and the Throughput. It is shown that PDR increases with the increase in number of nodes, and remains constant within the transmission range of 20 to 50m. The throughput also remains constant within the range 20 to 50m, but it increases with the increase in number of nodes.

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