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Performance Evaluation of Geographical Routing Protocol under Different Traffic Scenario

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***Abstract*— Vehicular Ad-Hoc Network (VANET) has attracted lot of research effort due to its applicability in the areas of road safety, infotainment and driving experience obtainable at a very low cost. Being a wireless network, issues in VANET domain include random packet loss in transport layer and in data link layer for a given end to end connection. The losses are dependent on the speed at which the nodes are moving within the network, the routing protocol used and the available channel. In this paper it is proposed to investigate the performance of Geographical Routing Protocol (GRP) under random mobility with voice and traffic.**

***Index Terms*— VANET, MANET, Mobility models, Throughput, End to End Delay**

I. Introduction

PROGRESS in wireless communication technologies enabled mobile ad hoc networks (MANET), which has no fixed infrastructure and depends on nodes to perform routing of data packets. Vehicular ad hoc network (VANET), are a form of MANET, wherein, moving vehicles form the nodes of the mobile network. VANET uses the participating vehicle as wireless router or node, allowing vehicles to connect and create a network with wide range. VANETs differ from typical MANET due to characteristics like high speed of vehicles, mobility constraints and driver behavior. Thus, VANETs are characterized by rapid topology changes, frequent fragmentation, limited temporal and functional redundancy [1]. VANET is used as on-board safety systems, for communicating between vehicles and for communication between vehicle and roadside infrastructure. Police and fire vehicles were the first to integrate VANET for communication with each other for safety purposes.

The success of VANET applications depends upon the routing for efficient handling of rapid topology changes and fragmented network. Topological routing and geographical routing are the two types of routing protocols in VANETs.

Topological routing uses the information in the routing tables about links that exist in the network to perform packet forwarding. Geographic routing decisions are based on self location awareness and neighboring location information for forwarding packets [2]. With the progress of Global Position System (GPS) and self-configuring localization mechanisms, geographic routing are providing better solutions for message delivery.

Geographic routing protocol (GRP) also known as position-based-routing, is a well researched approach for ad hoc routing [3], [4], [5], [6]. GRP is based on two assumptions; nodes are aware of their own geographic locations and also of its immediate neighbors and source node are aware of position of destination. The nodes update its immediate neighbor's locations periodically by beaconing. The data packets are routed through the network using the geographic location of the destination and not the network address. GRP operates without routing tables and routing to destination depends upon the information each node has about its neighbors. Under the assumption of bidirectional connectivity, geographic routing can be efficiently implemented on a planar sub-graph of the one-hop connectivity graph. The most commonly used geographic routing algorithms are greedy routing and face routing. In greedy forwarding, the data packet is brought closer to destination in each step by the nodes forwarding it to the most suitable neighbor.

The suitable neighbor is the one which reduces the distance to the destination in each step. In face routing, the regions are considered to be separated by the edges of a planar graph. The algorithm takes a way around the face; it returns to the point closest to the destination and explores the next face closer to the destination. Face routing always finds a path to the destination. Greedy forwarding fails if there is no next hop among the neighbors which is closer to the destination. On failing to find the next hop, the greedy forwarding switches over to perimeter mode where the next-hop is selected to traverse the perimeter of the region where greedy forwarding fails. Perimeter mode forwarding continues as long as there is no better greedy next hop neighbor. Geographic routing is simple and efficient. The state required at each node depends only on the node density.

In this paper it is proposed to study the performance of GRP under video traffic and voice traffic. The performance is compared with AODV routing protocol. This paper is organized into the following sections. Section II discusses available literature, section III describes the methodology adapted with results obtained and section IV concludes this paper.

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II. LITERATURE REVIEW

Pathak et al., [7] presented the design of the GSPR secure geographic routing protocol for authenticating the routing paths taken by the data packets. The proposed protocol protects location privacy and location authentication for anonymous node. Associative cryptographic hash functions are used for securing the routes. The overhead of location authentication is studied under various scenarios through NS2 network simulator. Simulation results show that data delivery rate of larger than 80% is sustained even if 40% of the nodes are malicious though the routing path length is increased.

Xue et al., [8] proposed Passive Geographical Routing protocol (PGR), a routing mechanism for VANET. The proposed routing mechanism uses GPS devices and embedded digital city road map for geographical location. Node's position prognostication and route message propagation is available from city road map. Beacon messages are used by nodes for sending geographical information to its neighbors along its velocity to the four orthogonal directions. PGR algorithm is based on forwarding application packets towards destination position. Valid duration of the node's location information is prolonged depending upon the node's velocity information. The proposed protocol was evaluated with large realistic traffic data in Shanghai. Experiments results show that the proposed PGR offers a high packet delivery ratio comparing with the traditional routing protocols with additional advantage of having good scalability for high dynamic topology.

Braga et al., [9] presented an overview of geographic routing strategies in VANET. The benefits of location-aware routing are shown. GRP available in literature are presented and its strength and weakness are discussed. In addition, the main challenges of using geographic routing protocols in VANETs are discussed.

Kuhn, et al., [10] proposed a geometric routing algorithm GOAFR+. The proposed algorithm combines greedy routing and faces routing. In greedy routing, the message is forwarded through node to the closest neighbor to the destination. But this forwarding fails when it reaches a node without any 'better' neighbor. Face routing is used to overcome this dead end scenario. The proposed algorithm returns to greedy routing as soon as possible using an early fallback technique. In average case graphs, the proposed method performs more efficiently than any other algorithm. And theoretically it was shown that in worst case scenario the proposed method is asymptotically optimal.

Roa, et al., [11] proposed a scalable coordinate-based routing algorithm that does not require location information. The proposed method assigns virtual co-ordinates to all the nodes and uses these co-ordinates when applying standard geographic routing. The virtual co-ordinates must reflect the underlying connectivity. A proposed relaxation algorithm is used to associate virtual coordinates to each node. Simulation results show that in presence of obstacles, greedy routing performs better using virtual coordinates.

III. METHODOLOGY

The proposed setup was implemented using OPNET. 19 vehicular nodes with specifications shown in Table I was implemented in a 4 square kilometer area.

TABLE I. SPECIFICATIONS USED IN THE EXPERIMENTAL SETUP

Data rate of each node	11 mbps
Transmit power	0.005 W
Packet reception threshold power	-95Db
Routing protocol	GRP, AODV
Buffer size	256k
Packet types	Video conferencing, Voice data using PCM
Video data details	9 bits / pixel with 10 fps
Voice data details	PCM quality speech
Mobility pattern	Random

The experimental setup is shown in Fig. 1. In the first scenario the network used Geographical Routing Protocol (GRP) with low resolution video traffic. In the second scenario GRP with PCM quality voice traffic is investigated and in the third scenario AODV with low resolution video traffic is investigated.

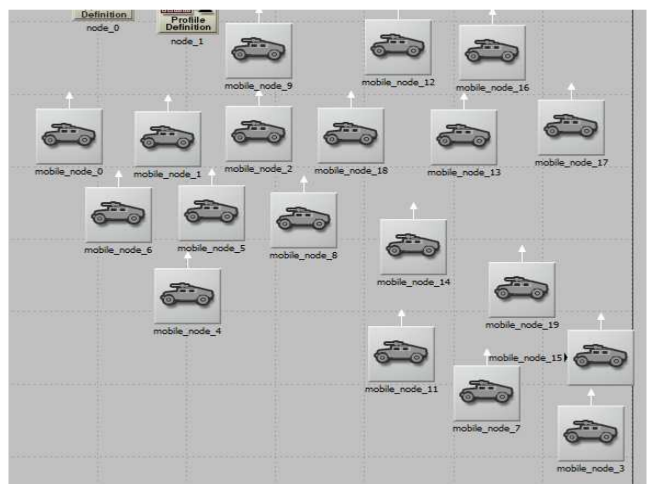

Fig. 1: Experimental setup used in OPNET

Since it is important to maintain uniform packet delay variation for multimedia traffic, the data dropped and packet delay parameters were measured in the first two experiments. However the throughput is also measured when comparing GRP and AODV routing protocol.

IV. RESULTS

Simulations were carried out for six minutes in each of the mentioned scenarios. Fig. 2 shows the packet delivery variation when video and voice traffic is used.

From Fig. 2 it is observed the packet delay for voice data is extremely high compared to video data. This shows that GRP can be used for video streaming operations where uniform delay provides better QOS. The packet dropped and

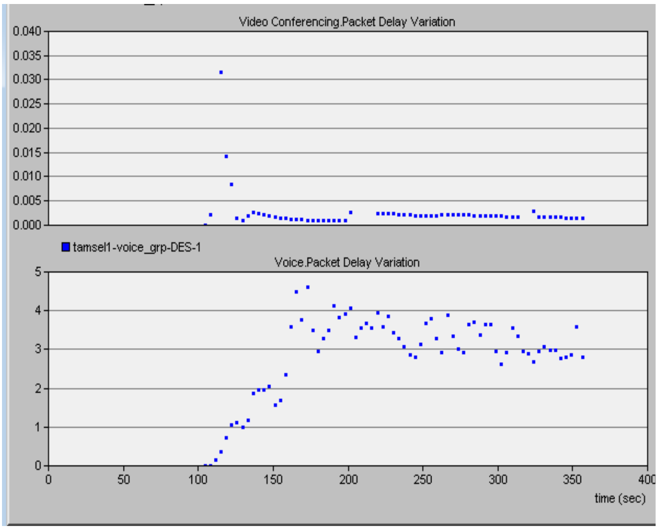

Fig. 2: Packet delay variation under GRP

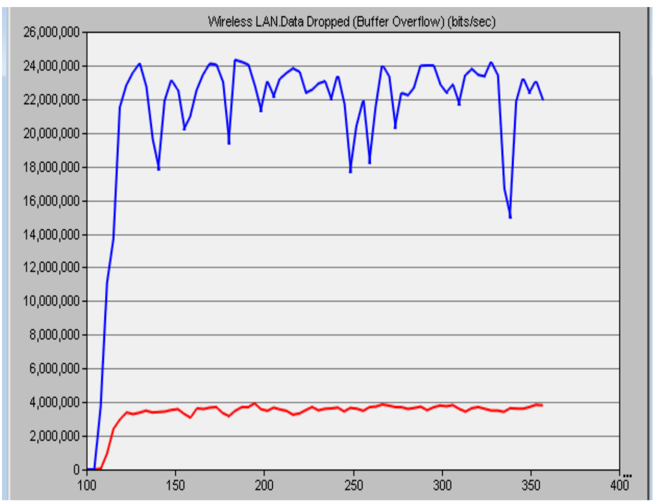

Fig. 3: Data dropped due to buffer overflow

retransmission attempt for video and voice data is shown in Fig. 3 and Fig. 4.

The blue graph indicates the data dropped for video data and red graph indicates the voice data. It can be seen that packet drop is higher in case of video data compared to voice based data. The retransmission attempt is relatively higher for video based data compared to voice data.

From Fig. 4 it is seen that the retransmission attempts coincide with the packet delay variation. For video transmission the data drop directly affects the packet delay variation. Fig. 5 and Fig. 6 show the performance of GRP compared with AODV. The traffic condition and the mobility condition of the nodes remain the same in both the cases.

From Fig. 5 it is seen that the end to end delay between packets is higher with AODV (blue graph) compared to GRP. This shows that GRP is better suited for VANET's compared to AODV for streaming data. Similarly the throughput is higher when GRP is used as shown in Fig. 6.

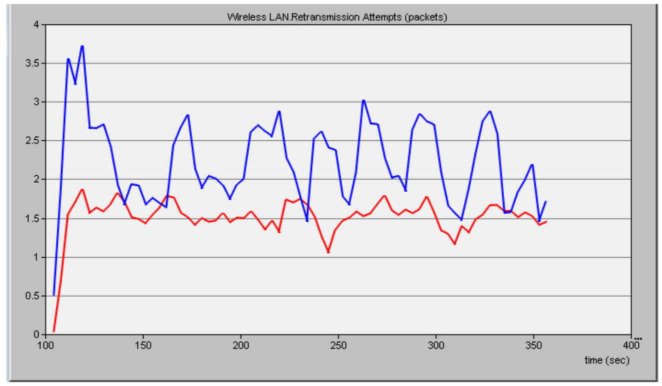

Fig. 4: The retransmission attempts under video and voice loads

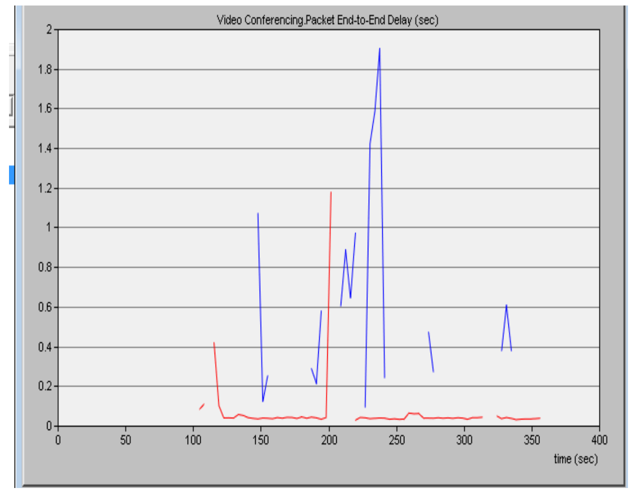

Fig. 5: End to End delay on video traffic for AODV and GRP

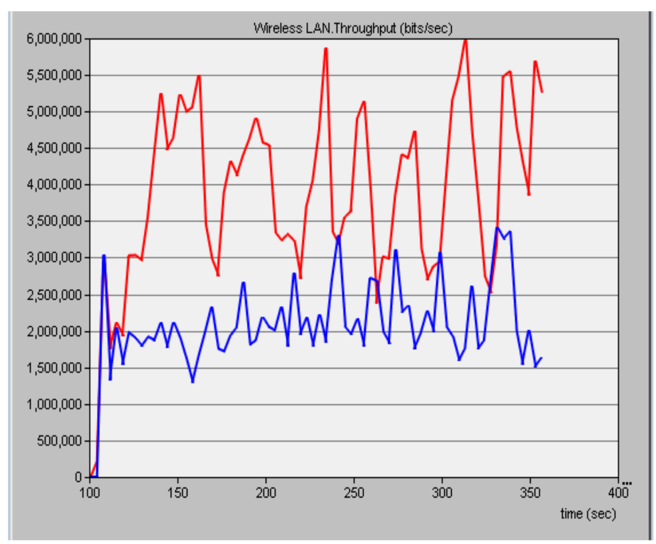

Fig. 6: The throughput of video traffic compared with AODV

V. Conclusion

In this paper it was proposed to investigate the performance of Geographical Routing Protocol (GRP) under different types of multimedia loads including voice and video data. It was observed that end to end delay is relatively lower for video traffic compared to voice traffic. However the data dropped in the network is higher compared voice data by a factor of more than 5.5. However GRP performs well compared to AODV for video data in terms of end to end delay and throughput. Future work in the direction of reducing the data dropped needs to be investigated.

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