Reliable Routing In VANET Using Cross Layer Approach

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***Abstract*— Vehicular Ad hoc Networks (VANETs), a subclass of mobile ad hoc network (MANET), is a promising approach for the intelligent transport system (ITS). Routing in VANET is more complicated then MANET due to unique characteristics like high dynamic nature, predictable mobility, scalability and frequent disconnection. In recent years, A stateless routing turn attention of researchers as it provides promising simulation result. Each stateless routing is based on the multihop forwarding approach, and for that routing protocols like MOPR, R-AOMDV, GPSR-MA uses the cross layer parameter to select the next forwarding hop. Here a novel approach is proposed for selecting a next forwarding hop based on the parameter get from the MAC-PHY layer. In this approach speed and position parameter are carried out from the lower layer (MAC) and used in Routing layer (Network) for promising forwarding hop selection. Here a threshold value is applied over a communication range of node for limiting a packet drops due to unreliable signal strength and within this range a node with highest speed toward destination is selected, as higher speed node can travel more distance towards destination, and this resulting into a lower end to end delay.**

***Index Terms*—Cross layer, RSSI, multi hop, forwarding strategy.**

I. INTRODUCTION

With the sharp increase of vehicles on roads in recent years, driving has not stopped from being more challenging and dangerous. Roads are saturated, safety distance and reasonable speeds are hardly maintained, and drivers often lack enough attention. As there is no sign of improvement in near future, government agencies and leading car company jointly works together for develop solutions. One of the developments has been a novel type of wireless access called Wireless Access for Vehicular Environment (WAVE) dedicated to vehicle-to-vehicle (V2V) and vehicle-to-roadside communications (V2I). VANET uses a dedicated short range communication (DSRC) IEEE 802.11a later it amended for low overhead operation to IEEE 802.11p. Then IEEE standardizes whole as 1609 family referred as WAVE [1].

VANET has special characteristics that distinguish it from other mobile ad hoc networks; the most important characteristics are: high mobility, self-organization, distributed communication, road pattern restrictions, and no restrictions of network size. All these characteristics make VANETs environment a challenging for developing efficient routing protocols. The routing protocols of MANET cannot be directly applied in VANET network because of fundamental difference in between VANET & MANET. Due to highly dynamic nature of VANET existing routing protocol of MANET are not suitable. Hence new routing protocols are required in VANET for the communication that can be implemented and effectively work in VANET environment.

Position based routing is a technique to deliver a message to a node in a network over multiple hops by means of position information. Routing decisions are not based on network addresses and routing tables; instead, messages are routed towards a destination location. With knowledge of the neighbors' location, each node can select the next hop neighbor that is closer to the destination, and then forwards towards the destination in each step. Recently research focused on reliable routing, as the message delivery is must in safety related application in addition to this that message must received by destination within a time. Due to above, various approaches are proposed, such as by measuring the various parameters from the lower layer (MAC) like speed, no of hop, link stability, direction etc. used for selecting a most promising forwarding node on NETWORK layer.

A state less routing like Position based routing provides good performance over topology based routing, and packet forwarding is done by multi hop forwarding, so by considering various parameter form lower layer (MAC) for making routing decision at NETWORK layer can provides a reliable and efficient routing in VANET. Here, this approach uses the RSSI (Received Signal Strength Indication) to find out next hop in multi hop forwarding.

II. RELATED WORK

Most of the stateless routing uses a greedy forwarding strategy as forwarding methods, where a node which is closest to the destination is going to selected as nest node. But sometime this forwarding node situated at the edge of the range of current node and due to high speed, forwarding node may get out of the range, resulted into a packet loss and unreliable communication. Here we study various cross layer parameter obtain from the lower layer (MAC) to make decision at the (NETWORK) layer for better selection of forwarding node.

GPSR [2] , proposed a greedy stateless routing in VANET. Here a next forwarding node is selected based on a closest to destination parameter, so that which next hop is closest to the destination and within a range of the current node is going to selected as a next forwarding node until the destination is reached.

GeoSVR [3] uses a restricted greedy forwarding methodology for routing between junctions. Most of packet drop occurs in greedy forwarding at edge node connection, as edge node may move faster than current node resulted into a packet drop and routing performance decrease. In GeoSVR a greedy forwarding strategy is restricted to maximum signal strength so that packet loss may reduce and reliability increased but end to end delay may increase.

GPSR-MA[4],The mobility aware extension of GPSR protocol, called Greedy Perimeter Stateless Routing with Movement Awareness (GPSR-MA), extends the set of parameters used for taking a routing decision with the inclusion of (I) the speed and (II) the direction of movement of the vehicle. Here a node moving towards a destination and having a speed near to the sending node is selected as a next forwarding hop. Speed and direction parameter derived by neighboring nodes using a history of node's coordinates.

R-AOMDV [5], protocol based on AOMDV protocol. This method makes use of a routing metric that combines hop count and transmission counts at MAC layer by taking quality of intermediate links and delay reduction into consideration. This protocol has been shown to deliver better performance than AOMDV, especially in sparse and dense urban vehicular networks. To measure quality of entire path, it adds two additional fields to RREP packets – the maximum retransmission count (MRC) that is measured in MAC layer and the total hop count that is measured in network layer. When RREP is passed back to the source, each intermediate node compares its retransmission count with the MRC and replaces it if its retransmission count value is greater than the current MRC. Thus, when RREP packet arrives at the source, the source can identify which path contains maximum MRC.

CLWPR [6], cross-layer, weighted, position-based routing protocol is more or less self-described. First of all, it is a position based protocol that uses the distance on the road as a metric instead of the actual geographic (Euclidean) distance. It also keeps track of PHY and MAC layer parameters such as SNIR and MAC frame error rate in order to estimate the link quality. In addition, queuing information is taken into consideration in terms of node utilization to provide some sort of traffic balancing for better QoS. All this information is jointly combined in a weighting function, that calculates the weight for each neighboring node, based on which the forwarding selection is performed.

Cross Layer Optimization of VANET Routing with Multi-Objective Decision Making [7], When GPSR is in its greedy mode it is more likely that the chosen next hop is always in the edge of the coverage area of the forwarding node. Due to this GPSR can have high percentage of packets been lost due to physical layer errors. Existing studies focus more on maximizing or minimizing single criteria for relay selection rather than binding the relaying process effectively to the routing protocol. To address this research gap we propose to integrate path repairing in well established GPSR protocol and optimize the problem further using multi objective decision making.

Improved GPSR [8], in the greedy forwarding scheme of GPSR, the source node or intermediate node forwards the data packet to a neighbor located in the general direction of the destination node, and the next hop neighbor is close to the destination. However, the next hop selection is general and may be appropriate. Under our next hop selection scheme, the principle is defined as follows: the source or forwarder node sets priorities on the one-hop neighbors considering their X, Y coordinate information, speed and direction. Among their one-hop neighbors, the conditions to set priority are: 1) the nodes are in the direction of destination from the current node; 2) the relative speed between the neighbor node and the current one is not more than 10m/s. These conditions are set in a packet and it is sent. Thus, receiving node determines their own priority as the next hop selection depending on whether it satisfies the conditions or not.

III. FORWARDING STRATEGY

Different forwarding strategies [9] are used in position based routing protocols. Each vehicle maintain information about neighbor nodes, normally that table contain information like geographic position, speed, direction of neighbor. Based on table, source forwards packets to next hop. The forwarding strategies are as follows.

Greedy forwarding: Greedy forwarding strategy always forward packet to a node closest to destination. Here source 'S' forward packet to 'A', which is closest node to destination 'D'. [9]

Improved greedy forwarding: source node first consults its neighbor table and computes new predicted position of all its neighbors based on direction and velocity and then selects anode which is closest to the destination .'S' computes new predicted position of its neighbors and suppose at time t2, vehicle 'B' over takes the vehicle 'A', then 'S' selects 'B' as its next hop instead of 'A'. [3]

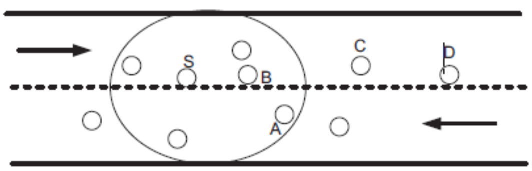

Figure 1 Forwarding strategies [9]

Directional greedy forwarding: Directional greedy approach only considers those nodes which are moving towards destination. Thus, it selects vehicle 'B' as its next hop. [9]

Predictive directional greedy forwarding: In this strategy, forwarding node maintains the information of its 2-hop neighbors. Before forwarding the packet, forwarding node consults its neighbor table and computes predicted position of all its neighbors (one-hop and 2-hop neighbors) and then selects a node whose one-hop neighbor is moving towards the destination and is closest to the destination. In this case, 'S' selects vehicle 'A' because its one-hop neighbor 'C' is moving towards destination 'D'. [9]

IV. ROUTING STRATEGY

In forwarding strategy for multi hop routing a next hop selection play a major role. Here we proposed a cross layer approach to make decision for selecting a next hop. In this we obtain the parameter from the MAC layer and used into the NETWORK layer for routing. In proposed schema a node having a higher speed towards the destination is selected as a next forwarding hop. Position and speed parameter are obtained from the MAC layer.

At MAC layer we can have a RSSI (Received Signal Strength Indicator) value which represents the node's signal strength with current node. So by calculating RSSI value strength value we can determine the node having higher speed from current node as signal strength drop decreasing at higher rate. So node with higher decreasing rate of RSSI value is selected as a next hop. Here we also introduce a position parameter for making a better selection of next hop as node moving towards destination has higher probability of fast communication.

Greedy forwarding strategy selected the next hop which is closest to the destination. But problem occurs when a node is selected which is situated at the edge of the communication range of the current node having a higher speed then current node. When next hop is at edge and at relatively higher speed then packet drop occurs as that node may be gone out of range from the current node resulted into a higher delay and low packet delivery ratio. And for achieving reliable communication we can restrict the communication range, so packet drop occur less. For overcoming a problem of greedy forwarding strategy for edge node we can restrict the communication range for current node so that next hop must have good signal strength to communication take place.

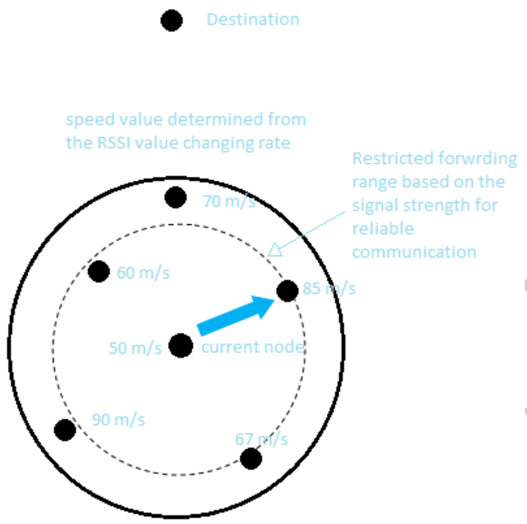

Figure 2 Routing Strategy

Above problem of packet loss due to communication link lost can be reduced by selecting a forwarding node within a strong enough communication range that can be determined by a RSS (Received Signal Strength) threshold value. Though this can increase a delay of routing but it will increased a (PDR) Packet Delivery Ratio. End to End delay can be reduce by selecting a forwarding node with higher speed towards the destination as higher speed node can travels more distance between forwarding packet so delay must be reduce. This direction information is achieved form the position parameter. In this way by combine all this parameter for selecting a nest forwarding node we can improve the performance of the routing in terms of delay with reliability taken into consideration. This scenario is shown in figure 1 where a opposing to selecting a closets node to the destination here we select a node with high speed towards destination within restricted forwarding range.

V. PROTOCOL IMPLEMENTATION AND PERFORMANCE ANALYSIS

Protocol Implementation

For comparative study of the proposed protocol, we compared it with the widely used position based routing protocol GPSR. For generating traffic mobility model we used the SUMO (Simulation of Urban MObility) [10] and its graphical interface MOVE [11]. Random traffic mobility is generated from SUMO on the grid based city layout. And for network simulation we used is NS-2 version 2.34. The simulation performed on the various traffic densities ranging up to 100 vehicles in random movement with 4 different set of source-destination pairs.

For implementing the proposed protocol we modified the source code of the GPSR protocol. Here we fetch the RSSI value from the MAC layer to the Routing layer and by measuring this RSSI value variation a rate of change is calculated for each neighbor. By selecting the neighbor nodes having the highest decreasing rate we can select a next hop towards destination with highest speed and thus improve the end to end delay. For achieving the reliability we restrict the range of communication of current node to 80% so that next hop selection take place within this range and packet loss decrease as edge node disconnection occurs less. Other simulation parameters are given in table 1.

Table 1 Simulation Parameters

Simulation parameter	**Values**
Traffic Simulator	SUMO 17.0.1 MOVE
Network Simulator	NS-2 (Version 2.34)
Propagation model	Two ray ground
PHY/MAC	802.11
Topology	3052 * 3052
Traffic type	CBR
CBR connections	4
Antenna	Omni antenna
Simulation time	300 sec
No of nodes	10-100

Performance Analysis

Average End to End Delay: It is the average delay experienced by all successfully received data packets. Delay can be possible from broken link, local maxima problem, queuing, all account here. Here average end to end delay comparison is shown for GPSR and modified GPSR*. From the result we can see that modified GPSR decrease the end to end delay and provides the better performance.

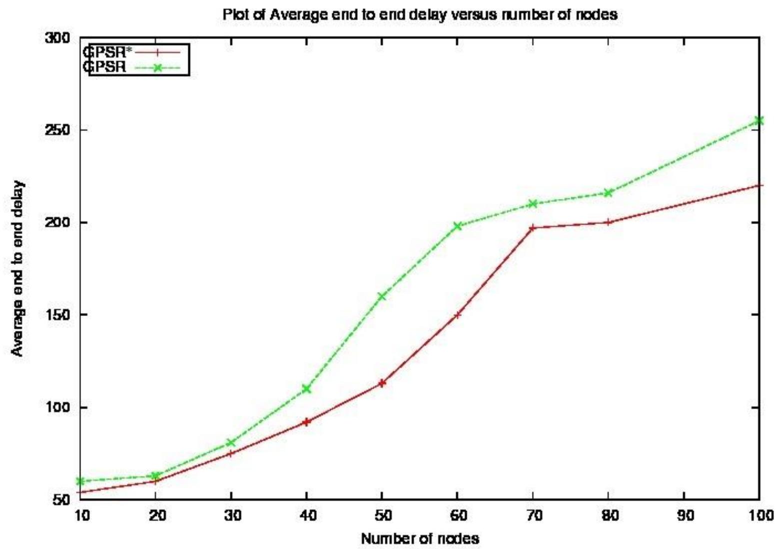

Figure 3 Average End to End Delay

Throughput: Here a throughput of proposed algorithm is calculated based on the average packet delivery ratio with the different vehicle density. A result graph is shown below for GPSR and Modified GPSR* for throughput, and from that we can see GPSR* provides a better throughput.

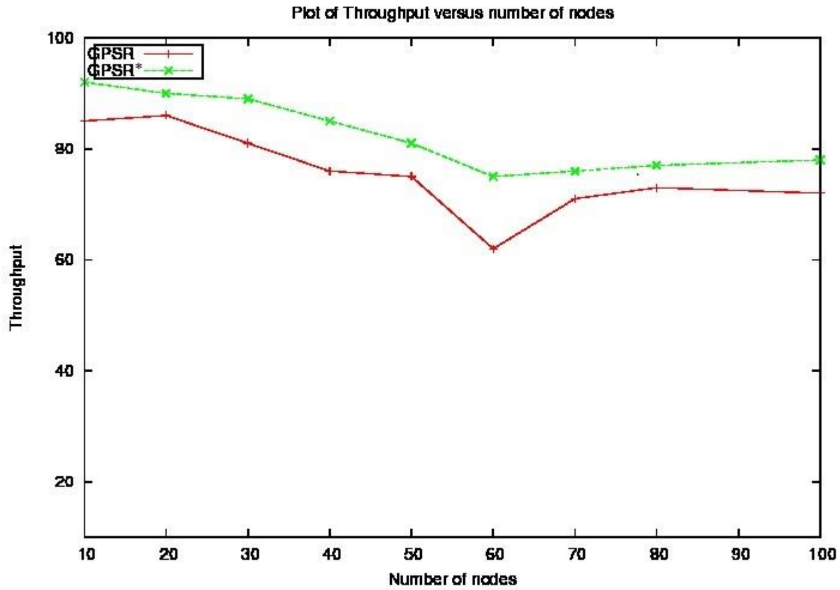

Figure 4 Throughput

VI. CONCLUSION

In the past years, many VANET projects and research have been undertaken and many standards have been developed in VANET. Though much more research is requires, as many fundamental issues like reliability of route, network fragmentation, and delay in routing must address to achieve practical applicability of VANETs. This paper provides review upon fundamental of VANET, various routing strategies and existing reliable routing protocols. We have seen various cross layer approaches for making a better decision at routing layer. Here a novel forwarding schema is shown based on node's speed and direction value to chose a best forwarding node with maintaining reliability by providing a restricted forwarding approach. From result it clearly seen that this novel approach provides better results over the existing protocol. In future we will works on more depth analysis of routing protocol and the routing performance optimization.

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