QoS Driven Routing Protocol in VANETs

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Abstract—Vehicular Ad Hoc Networks (VANETs) arespecial type of Mobile Ad hoc NETworks (MANETs). It is an effective new technology to forward packets or sharing messages between vehicles (V2V) or vehicle to infrastructure (V2I). VANETs are considered as one of the most emerging technologies for enhancing the efficiency and the safety applications of transportation systems. The main use of VANET is to exchange traffic related information between the vehicles and prevention of accidents in transportation system. In VANETs vehicles move with the high mobility so it can be considered as the major concern. The challenge in VANETs applications is to send the Emergency Message (EM) to all the vehicles which are available in the communication range. But, because of the wireless communication medium, sharing of the packets and broadcasting of traffic information may lead to frequent altercation and collision, this problem called "broadcast overhead problem". In this paper, a QoS driven protocol is proposed to utilize the network bandwidth efficiently by reducing the broadcast overhead and forwarding the urgent or emergency messages first compared to other messages. This new protocol first finds the Minimum Connected Dominating Set of Vehicle (MCDSV) to reduce the broadcast overhead and the MCDSV acts as a virtual backbone for communication within the Network. After finding the MCDSV, we use the concept of a priority Queue for emergency broadcast scheme (VDEB) to resolve the issue of high overhead in senderoriented schemes and long delay in receiveroriented schemes. For the safety applications the broadcast protocol has to guarantee the performance and the reliability context. This combined method of Minimum Connected Dominating Set and Priority Queue demonstrate the good performances and the robustness of such protocol compared to other Routing protocols.

Keywords—*VANETs, Priority Queue, Minimum Connected Dominating Set, Ad hoc Network and Emergency Message Broadcast.*

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I. INTRODUCTION

Vehicular ad hoc networks are the special class of MANETs. The VANETs aim is to provide inter-vehicle Communication and roadside to vehicle communication to safer and more efficient roads by providing accurate information to drivers and roads. VANETs aim to support wide range application including but not limited to broader safety application such traffic contestant notification, emergency notification peer to peer communication, commercial application for advertising a few projects.In VANETs, all the vehicles are treated as a wireless router or node, allowing the vehicles approximately 250 to 1000 meters of each other to connect. VANETsare self-organized network that can be formed by connecting vehicles aiming to improve driving safety and traffic management with internet access by drivers and programmers. In VANET,every vehicle connected through the wireless network and forwards the message by the intermediate vehicle. To transferemergency message in the VANETs for emergency vehicle (i.e. ambulance, fire engine, police vehicle etc.,) the priority should be high. The communication in VANETs can be done by one hop communication or multi-hop communication. In one hop communication source vehicles directly communicate with destination vehicle but in multi hop communication source vehicles indirectly communicate with destination vehicle using the relay nodes.

By researchers and automobile manufacturing company VANETs applications are considered as effective safety applications. There are some distinct features in VANETs context like dynamic network topology, high mobility, road restrictions and scalability.These features differentiate it from MANETs.

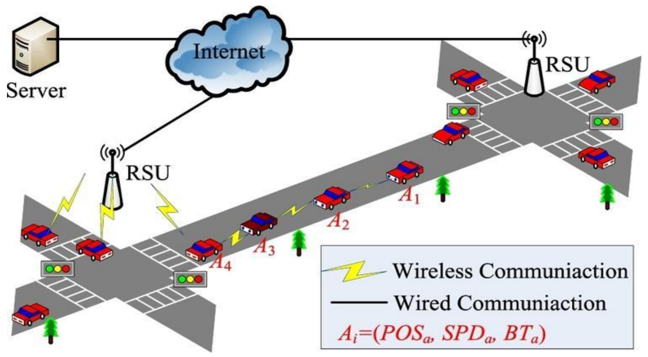

Figure 1. Basic VANET communication scenario.

The classification of vehicular ad hoc networks (VANETs) applications can be categorised into two main parts: first is general data routing services and another is safety applications. In the VANETs context general data routing for the services provide one-to-one or one-to-all data broadcasting, the general data routing can be seen as communications, route planning and entertainment. Reliability is the requirement for the data transmission of this type of service; to say that by the receivers the packets should be received successfully. In a predefined region for receivers the Safety applications provide one-to-all emergency message broadcasting, the Safety applications can be seen as electronic Brake lights, lane changing assistance and road condition reports. These Safety applications are ordinarily life critical. Therefore, the received data by the receivers should not only be successfully. But to provide the driver with more reaction time it should be received in a very short. For the very urgent situations, e.g. vehicle collisions, the limit of propagation time of the emergency message is extremely low. Some research focuses on Supportive Accident Avoidance to broadcast accident avoidance messages in a very short potential in order to protect as many object vehicles as possible.

In another way as an application point of view we can apply VANETs technology for an wideranging diversity of safety and security applications like Intersection Lane Changing, Accident Threatening, Road Danger Announcement, Surpassing Vehicle Threatening, Traffic Attentiveness, Head On/Read End Accident Threatening, Spontaneous Fee Reimbursement, Location Based Services such as searching the nearby restaurant, cafeteria or hotel, nearest fuel station and infotainment solicitations like receiving access to the Internet. Network cconnectivity, routing and security are the most important concern in VANETs because Dynamic network topology of VANETs makes routing packets a challenging job for researchers and it makes routing of packet from source to destination vehicle more challenging.

In VANETs, all the vehicles excepting source and destination are deliberated as routers or forwarders. The main aim of our routing protocol is to deliver ideal path between source and destination with a smaller amount overhead packets. For VANETs different routing protocols have been developed and their classification is based on techniques used, Quality of Services, network structures, routing information, routing algorithms, characteristics etc.

The goal of routing protocol is to provide finest route amongst the node vehicles by reducing the overhead. The main focus of this paper is absolutely on Quality of Service (QOS) for transferring data packets. In this paper, a QoS driven based protocol using the concept of Minimum Connected Dominating Set Vehicle(MCDSV) with Priority Queue has been proposed to minimize the overhead and broadcasting emergency messages in the network during route establishment process.

The remaining part of the paper is organized as follows: Section II explains the literature survey about the research papers in VANETs. Section III explains about the Minimum Connected Dominating Set Vehicles (MCDSV) and Priority Queue (PQ). Section IV describes about the proposed work and section V concludes thisresearch paper.

II. RELATED WORKS

In VANET, the handoff is a major concern because the moving vehicles are continuous; so the transmission of the data will become harder when the vehicles are out of the communication range. Yibo Yang et al [4] Proposed VMIPv6 schemes and MIP decreases the handoff latency and for VANET applications improve the performance of MIP.

In VANET, various methods has done with respect to routing protocol but still they are covering with different disadvantages correlated to consistent route finding and overhead[13],[15]. In this paper the methods for reliable path selection in VANET is proposed to reduce the overhead problem and to find out reliable route between source and destination are Reliability matrix and connectivity matrix.

T. Sivakumar et al [10] has been proposed A stable routing protocols for VANETs. Between each link this proposes Reliability Index (RI) metric. Optimal route were found based on the number of forwarded vehicles and reliability index.

In MANETs, Mobilityadaptive routing for constant broadcast by Xi Hu et al [11] proposed a MobilityAdaptive Routing (MAR) algorithm. MAR algorithm improves the continuousness and constancy of communication. In this protocol, Link Expiration Time (LET) of each node is used to measure the link constancy.

Yun-Wei Lin et al [14]proposed a new forward method and delay-bounded routing procedure used to reduce the channel usage.

Parminder Singh et al [6] did the comparison of Unicast routing with Multicast routing using data rates variation in VANET. They did the evaluation of performance of both the protocols by using the parameters like packet transfer ratio, delay metrics, routing overhead.

According to Osama M. Hussain Rahman et al [2], they proposed a new senderoriented broadcasting scheme i.e., Bidirectional Stable Communication (BDSC) protocol. Its shows how BDCS protocols reduces end-to-end delays and increases reachability of attentive messages over compactly occupied vehicular network.

Several locations based protocols for selecting of vehicles that they require vehicle location coordinates. Mohamed Saada Boba and Suleiman MohdNor [9] compared several greedy Algorithms in urban situations and provide specific about several problems concerning about routing and strategy method.

III. PROPOSED WORK

The proposed work in this paper describes two approaches Minimum Connected Dominating Set (MCDS) and Priority Queue (PQ) to find the connected dominating set with minimum Vehicles to reduce broadcast overhead and forwarding the emergency messages in the network. A QoS driven Based protocol has been proposed to solve the problem of high overhead in sender oriented scheme and long delay in receiver scheme.

In VANET, the task of transferring a message from a source vehicle to all other vehicles is called Broadcasting. The simple way of broadcasting a message means to allow each receiver for rebroadcasting; this process is known as flooding. With an increase in the number of nodes, accidents occur and delay increases due to retransmissions. To increase the scalability of broadcasting and to overcome the limitations of flooding only certain nodes are chosen to transmit the message. In VANET broadcasting, usually the selection of the next relay nodes is the main concern. There are many techniques have been proposed for selecting the relay nodes.

Consider an undirected graph *G = {V, E}* having the set of vehicles named as set V and set of communication links between vehicles for representing the ad-hoc network. In this graph (G), 'Va' is considered as a vehicle in the set V and *<Va,Vb>* considered as an edge (i.e., a communication link) between neighbor vehicles *'Va'* and *'Vb'* in the set *E*.

A **Dominating Setof Vehicles** for a Graph *G= {V, E}* is a subset *D* of *V* such that each and every vertex not in *D* is neighboring to minimum one member of D. The **domination number** in the Graph *G* is the number of Vehicles in a minimum dominating set for *G*.

A Connected **Dominating Set of Vehicles (CDSV)** is a sub graph of the Graph G. The vehicles in CDSV can transfer the packets or can communicate with each other without using the vehicles in set non-dominating set of vehicles. "When the set has least number of vehicles in the CDSV Then only the set CDSV can be called as a Minimum Connected Dominating Set of Vehicles (MCDSV)." The MCDSV works as a virtual backbone in VANET.

Figure 2, explains about Dominators of the network. Here, Pink color cars are Dominating vehicles and the remaining vehicles are non-dominating vehicles. In this figure, only Dominating vehicles are sending the packets and other Non-dominating vehicles are not permitted to forward the packets.

Here, in the procedure of finding MCDSV consist four main operations which are union, subtraction, counting distance of nodes and shortest path. Now, first set the MCDSV and then count the total number of nodes N in the network. If MCDSV is empty then select the node {n} which has the maximum no. of neighbor nodes. After that apply union operation between MCDV set and selected node {n}.

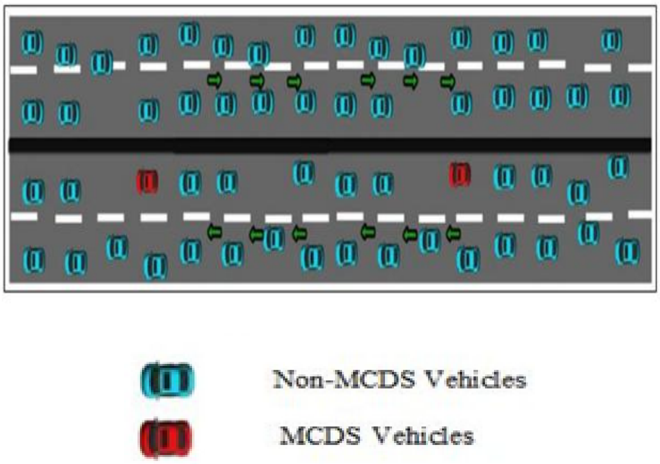

Figure 2.Scenario of a road section in urban area

Given below the procedure which is used to find MCDSV:

Procedure: MCDSV

1. ***INPUT:*** *Set of vehicles V and set of edges E*
2. ***OUTPUT:*** *Set of MCDS Vehicles Vmcds*
3. *Set number of Nodes N = V*
4. *MCDSV = ϕ*
5. *While N = ϕ*
6. *Select node n which has the max. neighbor*
7. *MCDSV=MCDSV U {n}*
8. *N = N – ({n} U Neighbor (n))*
9. *End while*
10. *Vmcds = MCDSV*
11. *Count node_Distance between two nodes in terms of intermediate node. It gives all possible paths*
12. *Find shortest path based on number of intermediate nodes Sp*
13. *Vmcds =Vmcds U Sp*
14. *return Vmcds.*

After this, again apply union operation on total no. neighbor nodes of {n} with selected node {n} and subtract it from the total no. of node N. Now count the node distance between two nodes in terms of intermediate node. The node distance function returns the no. of all possible paths. Based on the node distance function select shortest path and again apply union operation with intermediate node of shortest path *Sp*, then it returns the *Vmcds*.

Message Priority (*P*) depends mainly upon message's urgency and dissemination distance. The very urgent message at the first-time transmission will be assigned the highest priority (*P* =1).

We assume that the messages have three levels of urgencies:

(i) High Priority,

(ii) Medium Priority and

(iii) Low Priority.

Above three category of the messages that come in VANET. For these messages we use priority queue. Traditionally in VANET routing are based on the FIFO (first in first out) approach. But in this paper we are introducing the concept of Priority Queue and MCDSV for solving above problem. We take three queues for each category of message. Q_h is highest priority queue, Q_m is medium priority queue and Q_l is low priority queue.

Before sending the messages by the vehicles, vehicle check queue in the order of highest priority to lowest priority. Highest priority has given to very urgent message. The highest priority queue is used to achieve high quality of services.

This protocol has been simulated in NS2 for testing. The mobility models which are available in NS2 are not suitable for VANET. Hence, it is proposed to simulate the mobility model in Simulation of Urban MObility (SUMO) [13] and the mobility patterns of vehicles are utilized by NS2 for testing [10].

IV. SIMULATION SCENARIO

A simulation scenario of size 600 x 550 square meters mobility model has been generated using MOVE and SUMO tools. This scenario contains three horizontal roads, five vertical roads and ten intersections. The movement of Vehicles appears in the mobility model on horizontal and vertical streets. Every line in the map denotes the two lane road. With each source the File Transfer Protocol (FTP) has been attached. The time taken by each simulation is 600 seconds. There are 50 to 250 vehicles containing the average speeds of the Vehicles are 70 km/hour in the mobility model.

V. RESULT

The proposed routing protocol has been simulated using NS2 and its performance has been compared with other protocols like AODV, DSDV, DSR and AOMDV. Every vehicle in the VANET is configured with a wireless interface operating at a speed of 2Mbps. The proposed routing protocol MCDSPQ is evaluated and compared with the existing protocols using Packet Delivery Ratio (PDR), Average end-to-end delay and Control Overhead Ratio (COR) metrics. The effectiveness of the proposed protocol is demonstrated by running the simulation for 10 times and the mean values of PDR, Control Overhead Ratio and Average End-to-End Delay are considered for its performance evaluation.

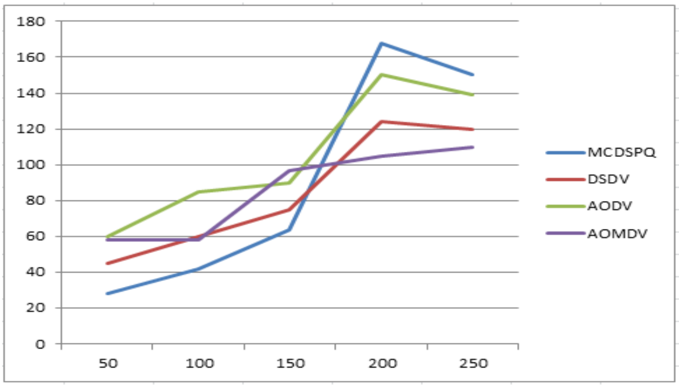

Figure 3: Effect of vehicle count on PDR with 70 km/h average speed

Figure shows the PDR evaluated for different protocols by increasing the number of vehicles (vehicular density) with average speeds of vehicles. The performance of PDR of MCDSPQ is higher than other routing protocols when the vehicular density is higher. From Figure 3, it is observed that the PDR is less in MCDSPQ protocol is less due to less number of vehicles and PDR is more when the vehicles density is more.

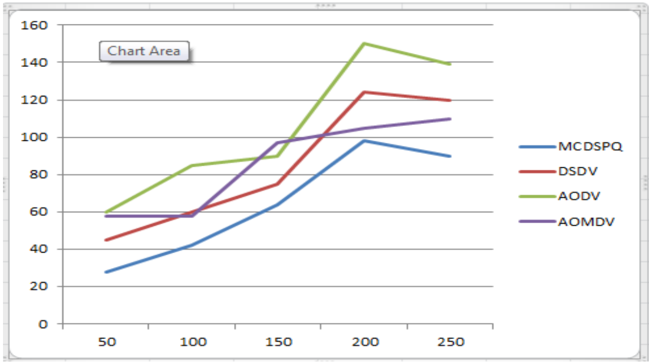

Fig4: Effect of vehicle count on Average End-to-End Delay with 70 km/h average speed

Figure shows the effect of the number of vehicles on average end-to-end delay in average speeds. Among the four protocols MCDSPQ achieves the best average end-to-end delay performance compared to other routing protocols due to better utilization of network bandwidth by avoiding unnecessary control overhead packets. Among the protocols mentioned above,the proposed MCDSPQ routing protocol perform outperformance with AOMDV when the vehicles count further increase to 200 and above. Hence, the results of this proposed MCDSPQ routing protocol increases the PDR and decreases the COR and Average End-to-End Delay.

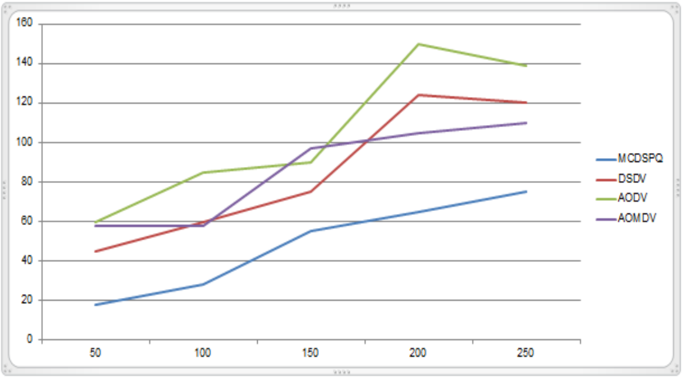

Fig5: Effect of vehicle count on COR with 70 km/h average speed

Figure shows the effect of number of vehicles on the control overhead ratio in the average speeds. Routing protocols like AODV, DSDV and DSR are using route request and route reply again when there is a break in routing path. The proposed MCDSPQ protocol has lesser COR compared to other routing protocols due to flooding of packets for route discovery is controlled by using MCDSV as a virtual backbone. In MCDSPQ routing protocol, 15% to 20% decrease in COR in dense vehicular networks.

VI. CONCLUSION AND FUTURE WORK

In this paper, a new QoS driven based protocol for VANETs has been proposed. This protocol is based on finding a route for emergency messages from source to destination using Minimum Connected Dominating Set as a virtual backbone in the network. Within the network this type of communications reduces the broadcasts overhead by finding the minimum connected dominating set of vehicles. The advantage of this proposed method is it providing fewer broadcasts overhead for communicating the vehicles within a communication range. The Future work of this paper is to experiment this protocol in rural and urban areas and measure its performance with other popular routing protocols like AODV, DSR etc.

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