An Effective TDMA Based Routing for VANET to Reduce Delay

Shivani Pandey[1], Arvind Kumar[2]

[1]Computer Science and Engineering Department, KIET, A.P.J. AbdulKalam Technical University, Lucknow, India
[2]Computer Science and Engineering Department, KIET, A.P.J. AbdulKalam Technical University, Lucknow, India

Abstract- *Vehicular Ad hoc Networks (VANETs) is a radio-based real time application for traffic control and to reduce road accidents in which vehicles are communicating with each other and Road Side Units (RSU) to share traffic information so that upcoming vehicle knows about status of traffic flow in advance. Since nodes are highly mobile and network topology changes rapidly it is necessary to enhance delay. The goal of this paper is to reduce delay and collision by using MAC protocol TDMA in routing. Time Division Multiple Access (TDMA) is a method to channel access by more than one user in which available frequency is divided into multiple time slots so that nodes can access medium in its slot. In this paper we apply TDMA approach on routing such that all nodes which are active in same time slot will be selected in that particular timestamp to form route so that no node has to wait for activation of another node which would be available in another time slot.*

Keywords: - *VANET, MAC, TDMA, routing.*

I. INTRODUCTION

VANET is an emerging technology which is designed to improve road transportation by monitoring traffic flow and accidents. In VANET sharing of traffic related information is either V2V i.e. vehicles to vehicles or V2RSU i.e. vehicles to road side unit. VANETs are highly mobile network as location of vehicles is changing rapidly which results in frequent change in topology of network. Communication between vehicles and infrastructure is done by creating route between them but continuous movements of vehicles results in network partitioning. This continuous movement results in delay, network partitioning, packet loss, collision etc. In this paper we will try to reduce delay to improve end-to-end delivery and avoid collision of vehicles. For this it is required to use effective routing algorithm which can complete transmission of data packets before network partition. In VANET because of continuous movement of vehicle results in network partitioning and vehicle has to wait for allocation of channel which causes increase in delay and packet drops. These delays results in collision of vehicles as before traffic information reached to destined vehicle, upcoming vehicle reach there and results in accidents.

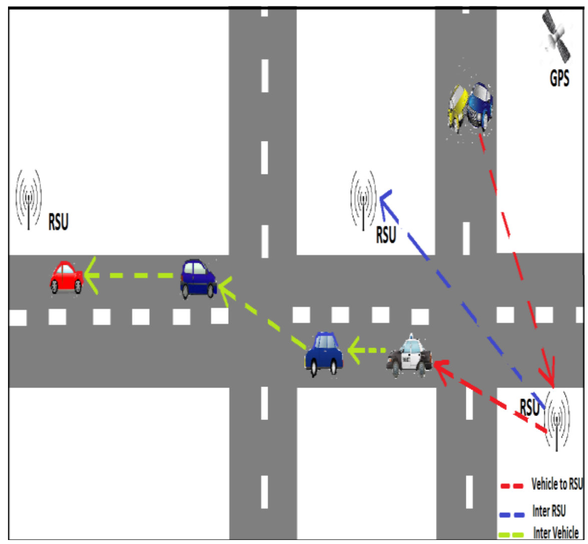

Fig.1 VANET

To support high mobility of vehicles in VANET and to provide consistent transmission of information MAC protocols are widely used in routing of VANET which allows one vehicle to access channels without interference of other vehicles. MAC protocols TDMA, FDMA and CDMA divides channels on basis of time, frequency and code to support multiple users to access available channel without interference of each other. MAC protocol TDMA is most preferred method in which available frequency is divided into time slots and nodes are able to access channels in during their allotted time slot. In this paper we will use concept existing routing algorithm TRPM i.e. TDMA aware Routing Protocol for Multi-hop vehicular network. In TRPM available channel is distributed among vehicles according to time, in this first divide time into frames then each frame is to be divide in a set of time slots in which size of time slot isequal. With respect to time slots area is partitioned where number of areas and number of time slots are same so area is associated with respected time slots. When a vehicles enters in an area it will check associated time slot is available or not to access channel. Next it will select next hop which are geographically near or belongs to adjacent areas. But for selection of next hop it has to wait for activation of node in that area. In our algorithm we select node for routing which access channel in same time slot in that particular instance. We divide area into small parts so that no vehicle can create interference in transmission of each other, at different area TDMA approach is used, vehicle at their allotted time slot get access to channel. This approach will reduce delay which improves end-to-end delivery as well as collision of vehicles will be avoided.

The complete paper is organized accordingly. In section 2 related works is discussed. Proposed work is explained in section 3 with complete description of algorithm with help of example. Section 4 simulation results and performance is analyzed. In last section conclusion is given.

II. RELATED WORK

For IEEE 802.11p standard for VANET various protocols have been proposed to support fast information exchange and dynamic topology change. For fast communication availability of bandwidth is required for which MAC Protocols have been used so that more than one vehicle will participate in information sharing process without interfering with each other to avoid collision. For this TDMA based algorithms TRPM[1] was proposed which is useful to reduce delay and selection of next hop in multi-hop wireless VANET.

In this algorithm road is divided into *n* small areas where size of areas will depend on the available transmission range of vehicles. It was assumed that location of vehicles is known as it is equipped with GPS (Global Positioning System) so that it is easy to monitor the area in which node is travelling. In this Channel Access method of MAC Protocol has been applied according to which channel at different location is divided into time frame and these time frames are further divided into three set of time slot. Time slots are associated with areas in which vehicles is moving i.e. if time slot is t_1, t_2 *and* t_3 and area is x_1, x_2 *and* x_3 then area t_1 is associated with x_1 which means vehicle moving in area x_1 will get time slot t_1 to access channel, and for area x_2 and x_3 associated time slot are t_2 and t_3.

TRPM focuses on accurate forwarding decision to select best next hop. It was proposed that to select next hop most correct decision is to select vehicle from adjacent areas or neighbor i.e. if vehicle is travelling in x_i then to select next hop, vehicle travelling in x_{i-1} *or* x_{i+1} will be best. Choice of adjacent vehicle is based on vehicle for which data frame is destined. Vehicle closest to the destination vehicle will be selected for next hop.

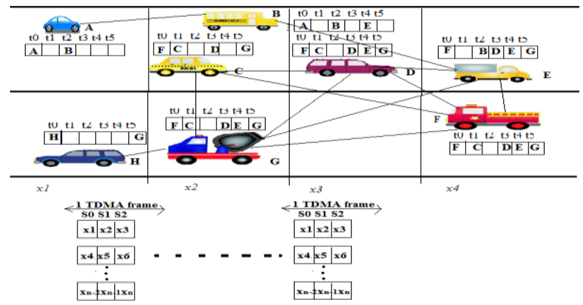

Fig.2. TRPM Based approach

In [12] authors have analyzed AODV and DSR routing algorithm performance over VANET in which simulation is performed on varying speed of vehicles (vehicle mobility) and varying number of vehicles (vehicle density). In our approach to reduce delay we will perform AODV. DSDV and DSR routing using TDMA based MAC protocol to reduce delay. Our proposed algorithm use concept of TRPM to divide transmission range into set of sub areas and in that sub area applies TDMA approach.

III. PROPOSED WORK

1. Algorithm

Input:

vid vehicle ID

i,j assigned time slot to node

1. Divide transmission range into set of areas s_i,
2. allot time slots i to vehicle - vid_i
3. Source vehicle broadcast RREQ msg to all nodes with vid_i
4. **If** Vehicle reply with RREP msg with vid_i source put vehicle id routing queue R
5. After receiving RREP message check vid_i of all nodes in routing queue R
6. **If** $Ivid_i = Dvid_i$
7. forward_packet($Dvid_i$)
8. **Exit**
9. **Else**
10. forward_packet($Ivid_i$)
11. Repeat step from 4-10
12. **Else** forward_packet(RSU)
13. **If** $Dvid_j \in$ RSU
14. RSU forward_packet($Dvid_j$) at time slot j
15. **Else** RSU forward_packet(next_RSU)
16. Repeat step 12-15
17. **Exit**

In our approach we have assumed that speed of vehicles is random. Also location of vehicles is known. Simulation is performed on variable vehicle density with random speed. In this algorithm at step1 transmission area is divided into set of sub areas. At each sub area TDMA approach is applied and time slots are allotted to vehicles which come under the range. In step 3 source vehicle will broadcast RREQ msg, vehicles which are active in time slot of source vehicle and interested in routing will reply with RREP msg. At step 5 source vehicle will check vehicle identity of all vehicles replied with RREP msg, whether vehicle id is same as desired destination vehicle id. If destination vehicle id matches source will transmit information to destination else it will transmit data packets to vehicle interested in routing. Now, this vehicle works as intermediate source and step 4-10 will be repeated till in time slot *i*. If destination is not found, vehicle holding data packets will send information to its RSU unit. At step 13 RSU will check whether destination belongs to it or not, if yes it will forward information to destination when it becomes active in its time slot *j* else it will forward data packets to next RSU and step 12-15 will be repeated. Since, in this process for routing only those vehicles tales part which are active in same time slot, no vehicle has to wait to be active so that routing can be performed. If time slot of destination is same as source it will be best case, else vehicle has to wait for the time slot in which destination will be active.

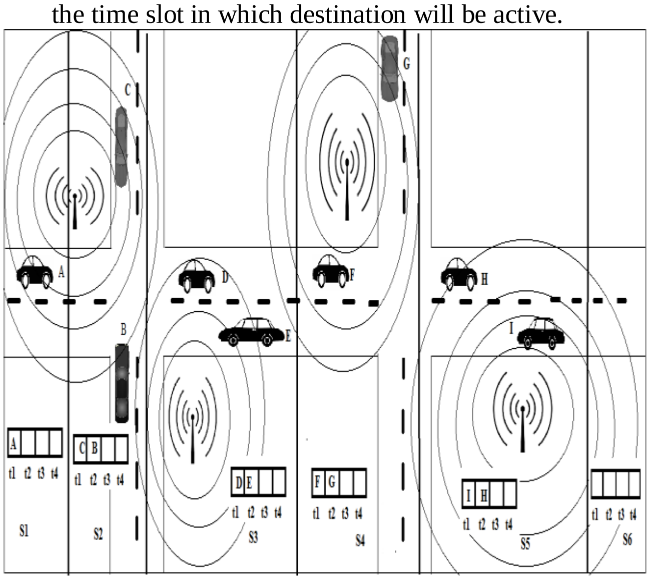

Fig.3. Example to algorithm

Let us take example (see in Fig. 3), in this let us assume time interval for each slot is 2s i.e. for 2s a vehicle can access channel or all network resources in an area will be allotted to the vehicle to whom time slot was allotted. Now suppose Avehicle in area $s_1$is source node which is active at time stamp t_1 and destination node is H in areas s_5 to whom also t_1 slot

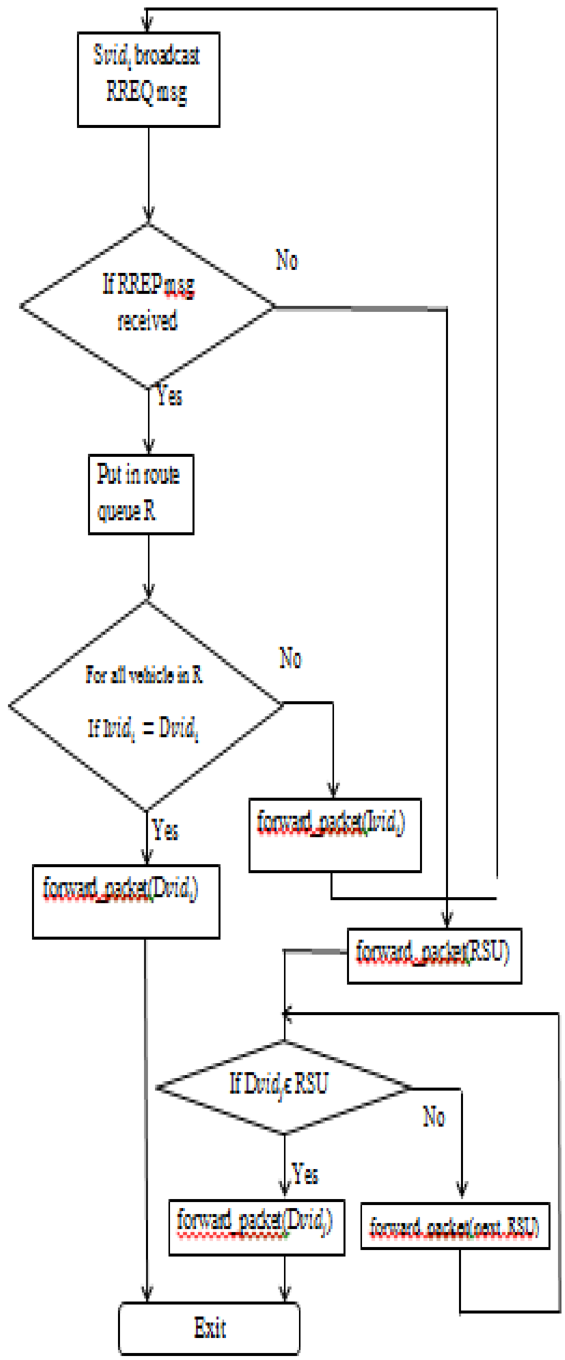

Fig.4. Flow chart of algorithm

is allotted. Now A will broadcast a RREQ message to all, vehicles which are active for time slot $t_1$and interested inrouting will reply with RREP message. At t_1 C, D and F are active in which let us assume vehicle

D and F are interested in routing and reply with RREP message and their vehicle id to source A. Since, both D and F both are not destination so, source A will forward information and destination vehicle id to D and D will work as source and broadcast Route Request message suppose from D and no vehicle reply with RREP message it will forward data packet to its respective RSU unit, RSU will check whether destination vehicle H belongs to its or not. Here, H does not belongs to current RSU unit, RSU unit will transfer data to next RSU unit, same process will be repeated until it did not found RSU unit to whom vehicle H belongs to. When in areas_5, we found H belongs to RSU unit of area $s_5$data will be forwarded to H when it has channel access at time stamp t_2, here we have consider time interval for each time slot is 2s, so only for 2s source has to wait for. Total 4s will be taken to complete transmission from source A to destination D. No vehicle will wait for others to get an access to participate in routing other than destination D for to complete transmission of traffic information.

SIMULATION SETUP AND PERFORMANCE ANALYSIS

1. Simulation Parameters

Simulation of proposed algorithm for routing in VANET is performed using ns-2.37 version of NS-2 simulator on Linux environment. The parameters for simulation which are used summarized in Table 1.

Network Simulator	Ns-2.35
Channel Mode	Wireless Channel
Mobility Model	Two Ray Ground
Antenna type	Antenna/Omni Antenna
Mac Layer	MAC/802_11
Link Layer	LL
Simulation area	1550*1550
Number of nodes	10,20,30,40,50
Simulation Time	30s
Routing Protocol	AODV, DSR and DSDV

Table I Parameters for Simulation

2. Performance metric

Simulation is performed using routing protocol AODV, DSDV and DSR and to analyze performance of routing algorithm performance parameters are used. Performance parameters used here are

- End-to-end delay: - To transmit data packet, transmission time parameters is used, it is total time taken in which complete data is reached to desired destination.. Delay is extra time taken to complete transmission of data. Delay can be caused due to unavailability of resources, congestion in network, low data rate etc.
- Throughput: - Throughput is defined as within estimated time number of data packet reached to destination.
- Packet delivery ratio: - It is ratio of packet delivered at destination to the data packets generated at source.

3. Analysis of Performance

Proposed algorithm is analyzed using three routing algorithms AODV, DSR and DSDV and simulation if performed on different vehicle density. Performance of proposed algorithm is analyzed on different performance metrics which are discussed above.
To reduce End-to-end delay proposed algorithm can be used with DSR routing protocol as delay in this algorithm is less than AODV and DSDV. But this algorithm performed well when density of vehicle is average. When number of vehicles is more than 40, delay of AODV, DSR and DSDV is almost same. Since average delay of DSR is 51 and that of AODV are 55.4 for vehicle density so we can use DSR over AODV so that delay can be reduced as much as possible.

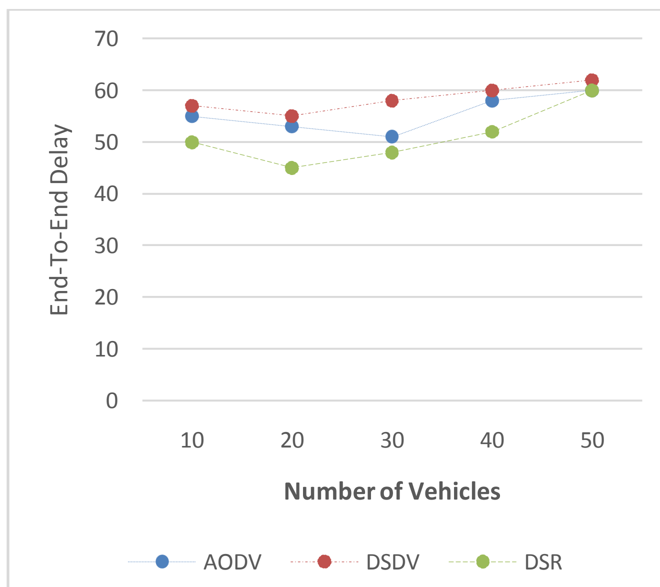

Fig.5 Number of vehicles versus End to End Delay

When throughput is analyzed we can see that DSR has performed well as compare to AODV and as well as DSDV. DSR has also performed well when number of nodes is increased from 10 to 50. Average throughput of routingprotocolsAODV, DSDV and DSR over proposed algorithm are 74.6, 78.8 and 81.

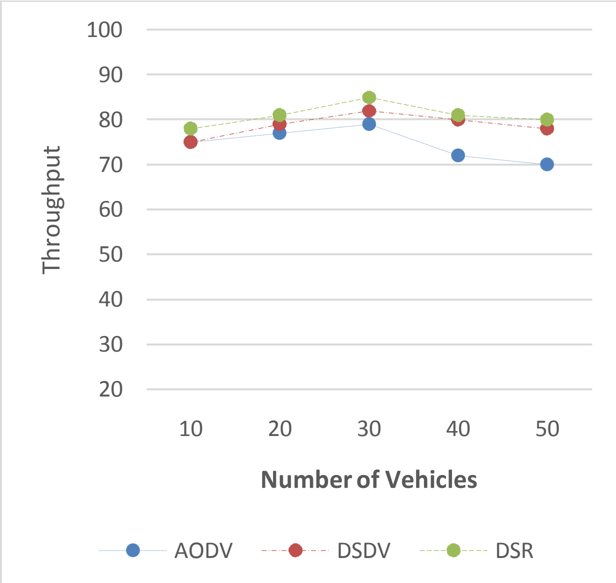

Fig.6 Number of vehicles versus Throughput

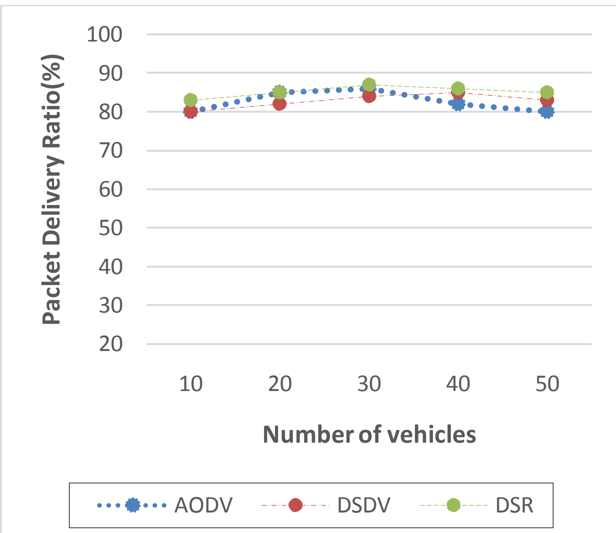

Fig.7 Number of vehicles versus Packet Delivery Ratio

Since with DSR routing throughput value is much greater than other two over vehicle density, it's better to use DSR routing protocol.

DSR has also give better results for Packet Delivery Ratio. From Fig. 7 we can see that performance of AODV, DSDV and DSR is almost same but DSR comparatively performed better and has given high average packet delivery ratio i.e. 85.2 whereas average packet delivery ratio of AODV and DSDV are 82.6 and 82.8 so it's better to use DSR.

In[12] authors have analyzed performance metric end to end delay of routing algorithm AODV and DSR for routing in VANET at different vehicle density in which vehicles are traveling at speed of 20m/s. Though their results were good for other parameters but we can see that in Fig. 8 that value of end to end delay is much larger. In our approach end to end delay is much less even when vehicle density increases also in our algorithm speed of vehicle is not fixed it is randomly selected.

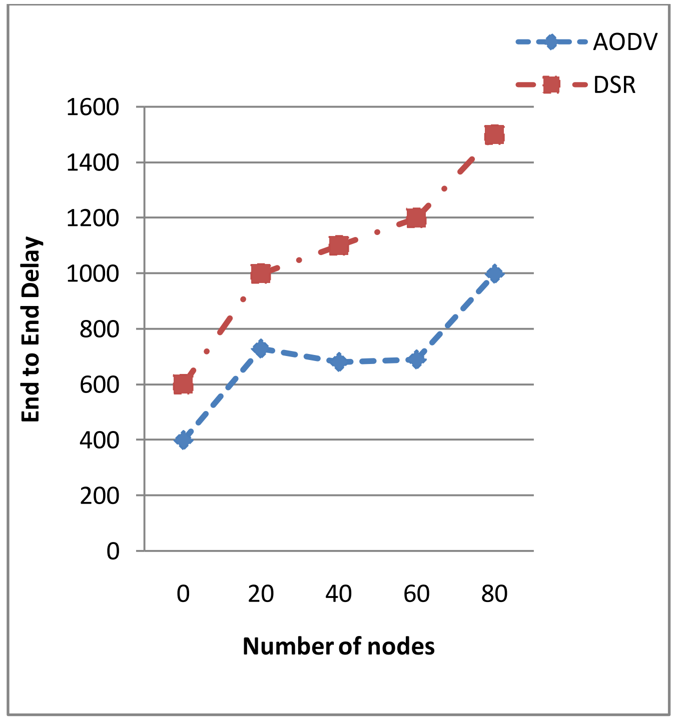

Fig.8 Analysis of AODVand DSR at vehicle speed=20m/s

IV. CONCLUSION

From our simulation results we conclude that to support vehicles mobility where location of vehicles changes and for different vehicle density TDMA based approach can be used with routing algorithm. As compared to analysis of DSR and AODV routing algorithm over VANET, TDMA based approach has performed well and delay at end has been reduced. Our proposed algorithm has been simulated with routing protocols AODV, DSDV and DSR in which DSR has performed well for Delay at end, Throughput and ratio of packets delivered at destination, this can be seen in Fig. 5, 6 and 7. Based on simulation results we can conclude that with TDMA it is better to use DSR routing algorithm rather than DSDV and DSR.

REFERENCES

[1] M.Hadded, P.Muhlethaler, A.Laouiti, R.zagrouba and L.A.Saidane "TDMA-aware Routing Protocol for Multi-hop Communications in Vehicular Ad Hoc Networks" in WCNC 2017 IEEE Wireless Communications and Networking Conference, San Francisco, United States.

[2] M.Hadded, P.Muhlethaler, A.Laouiti, R.zagrouba and L.A.Saidane "TDMA- based MAC protocols for vehicular ad hoc networks a survey, qualitative analysis and open research issues" in IEEE Communication Surveys Tutorials, vol. 17, ed. 4, pp 2461-2492, Jun. 2015.

[3] W. Zhuang, H. A. Omar and L. Lio. VeMAC"A novel multichannel Mac protocol for vehicular ad hoc networks" in IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), Shanghai, China, pp 413-418, Aug.2011.

[4] Jyoti Jain, NidhiChahal"A Review on VANET, Types, Characteristics and Various Approaches" in IJESRT, vol 9, pp 239-245, Sep. 2016.

[5] M.Hadded, P.Muhlethaler, A.Laouiti, R.zagrouba and L.A.Saidane "An infrastructure-free slot assignment algorithm for reliable broadcast of periodic messages in vehicular ad hoc networks" in Vehicular Technology Conference VTC-Fall, Montreal, Canada, Sep. 2016.

[6] B. Karp and H. Kung. "GPSR: greedy perimeter stateless routing for wireless networks" in International Conference on Mobile Computing and Networking (MobiCom). Boston,, USA, 2000.

[7] B. Blaszczyszyn, A. Laouiti, P. Muhlethaler and Y. Toor" Opportunistic broadcast in VANETs (OB-VAN) using active signaling for relays selection" in IEEE Conference on ITS Telecommunications (ITST08) , Oct. 2008.

[8] Gui-Sen Li, Wan-Liang and Xin-Wei Yao "An Adaptive and Opportunistic Broadcast Protocol for Vehicular Ad Hoc Networks" in IJAC, vol. 9 ,pp 378-387, Aug. 2012.

[9] Vishal Kumar, Shailendra Mishra and NarottamChand"Applications of VANETs: Present & Future. Communications and Networks" in Communications and Networks, vol.5, pp12-15,Feb, 2013.

[10] Rakesh Kumar and Mayank Dave "A Comparative Study of Various Routing Proctocols in VANET" in IJCSI, vol. 8, iss. 4,ppp 643-648, Jul. 2011.

[11] KatrinBilstrup, Elisabeth Uhlemann, Erik G. Strom and Urban Bilstrup. "On the Ability of the 802.11p Mac Method and STDMA to Support Real-Time Vehicle-to-Vehicle Communication" in EURASIP Journal on Wireless Communication and Networking, vol.2009.

[12] ArzooDahiya and Dr.R.K.Chauhan "Experimental Analysis of AODV and DSR with varying vehicle mobility and density in VANET scenario" in IJNSA, vol 5,pp 187-193, Jul 2013.