A Study of MAC Layer Protocols for Congestion Control in VANETs

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***Abstract*—VANETs that aims to provide safety, comfort have emerged as a powerful technology and a standard of communication among vehicles. Congestion control is a challenging issue in VANETs which can degrade the network performance. In this paper survey and analysis of recently developed VER-MAC, a MAC layer protocol for congestion detection and control in VANETs is presented. A MAC protocol for efficient broadcast service is of great importance to support high priority safety applications. This protocol allows nodes to broadcast safety packets twice during both the control channel and service channel interval that increases the broadcast reliability. This protocol uses 2-D Markov chain model to analyze the performance of both IEEE 1609.4 and VER-MAC. This survey exposes the advantages and weaknesses of existing congestion control algorithm. Finally, numbers of parameters are selected for comparison and analysis with existing protocol VER-MAC.**

Index Terms—Congestion control, Control channel, Safety channel, MAC protocol, VANETs, VER-MAC.

I. INTRODUCTION

Vehicular Ad-hoc Networks represent a rapidly emerging, particularly challenging class of MANETs. VANETs are self organized networks of moving vehicles where each vehicle is equipped with advanced wireless communication devices [4]. In VANETs , two types of communication is possible: V2V and V2R which is provided by the vehicles and road side units[2,3]. One of the most challenging issue in VANETs is congestion control [6]. The internet is based on end to end paradigm, where transport protocol (e.g.: TCP) instances at end points detects overload conditions at intermediate nodes. In VANETs where topology changes dynamically, so a congested node used for transmission a few seconds ago might be not used at all at point in time when source reacts to congestion. The U.S Federal communication commission (FCC) has allocated 75-MHz frequency spectrum in5.9-GHz band for dedicated short range communication (DSRC). DSRC, a

Multi channel system is used by both V2V and V2R communications. FCC divided the DSRC spectrum into 7 channels, each of 10-20 MHz as shown in fig1. One channel was identified as control channel (CCH) and 6 of them were identified as service channel (SCH). CCHs. SCH are used for safety and non safety applications, and single CCH is used for transmission of control information high priority short safety messages or emergency messages [5].

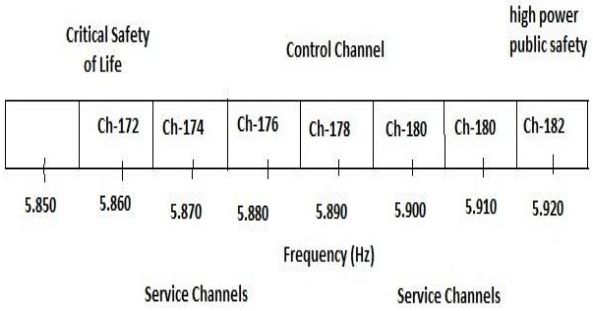

Fig.1: Seven channels of DSRC

This paper is a survey and analysis of MAC layer congestion control protocol VER-MAC and congestion control algorithm [1].A MAC layer protocol works both in data link and physical layer, so it becomes easy for such a protocol to control congestion in network where topology changes dynamically. MAC protocol for VANETs decides when a station has the right to access the shared communication channel and schedule transmission to minimize interference at receiving end. It not only provides efficient broadcast service in VANETs but also high throughput for non safety packet transmission.

In the VER-MAC [1] SCH resources are fully utilized during CCHI to increase the throughput parameter. This protocol uses retransmission mechanism for broadcast reliability and high PDR. It employs EMG retransmission and utilizes the CCH during SCHI to improve broadcast reliability. 2-D Markov model is used for performance analysis of both IEEE 1609.4 and VER-MAC.

Different from above said approach [9] uses a probabilistic model checking technique PRISM which assesses the efficiency and correctness of the congestion protocol. This verification technique

can improve both the channel utilization and message transmission.

The rest of this review paper is organized as follows. Section II includes the overview of congestion protocol that is to be analyzed. Section III is the study of related work. Section IV briefly describes the Problem statement. In section V proposed work is presented .Section VI concludes the paper and future work.

II. OVERVIEW OF CONGESTION CONTROL PROTOCOL: VER-MAC

The VER-MAC, a MAC layer protocol is chosen because it is completely dedicated to VANETs. The purpose of this protocol is to broadcast periodic/event driven EMG packets twice in both the SCH and CCH simultaneously followed by a delay of 50ms to increase the packet delivery ratio. The operation of VER-MAC is described as:

1) When an EMG packet arrives at MAC layer, nodes try to broadcast this packet on CCH in current CCHI (or SCHI).
2) This EMG packet is then rebroadcasted in the next SCHI (or CCHI).
3) Nodes will simultaneously maintain the NIL (Neighbour information list) and CUL(Channel usage list).
4) When a service packet is to be exchanged, node will send WSA (Wave service announcement) packets including its CUL.
5) When control packet WSA is received, the receiver selects a common Txslot and SCH based on CULs of both sender and receiver.
6) Now the receiver sends ACK to sender indicating the selected [Txslot, SCH], then sender sends RES (Reservation) to confirm the [Txslot, SCH] selected by receiver.
7) Receiver and sender switch to selected SCH to exchange service packets in selected Txslot.
8) Neighbour nodes will simultaneously update their CULs and NILs on overhearing ACK or RES messages.

In this work 2-D Markov chain model is used to analyze the performance of both IEEE 1609.4 and VER-MAC protocol. Markov chains model is an ensemble of chains with an initial probability distribution P(X0 = s). By multiplying this vector by the transition matrix repeatedly, one obtains P(X1 = s), then P(X2 = s) successively.

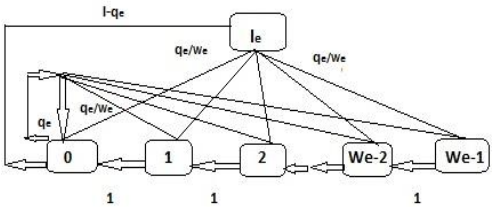

Fig 2, EMG traffic

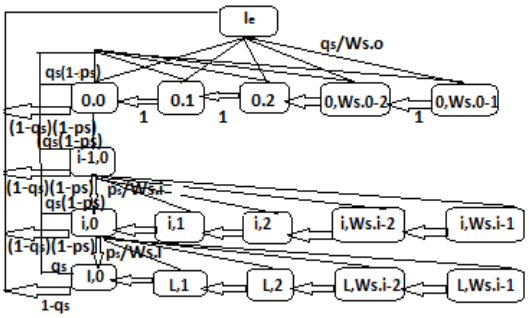

Fig 3, Service traffic

III. RELATED WORK

Choong Seon Hong, Sungwon Lee and Eui-Nam Huh has proposed [1] "An Efficient and Reliable MAC in VANETS" In this title, propose an Efficient and Reliable MAC protocol for VANETs (VER-MAC) in which nodes are allowed to broadcast safety packets during both the intervals control channel(CCH) and service channel (SCH) which increases the safety broadcast reliability. This approach uses the event- driven simulation program written in Matlab. The analytical and simulation results prove that the VER-MAC provides a better Packet delivery ratio of emergency packets and the throughput of service packets than that of the IEEE 1609.4. Due to the broadcast transmission, the average delay increases slowly. However, the VER-MAC requires the additional complex data structures and suffers from a more delay of the emergency packets.

Liang Zhou, Baoyu Zeng has proposed "Joint Congestion and Medium Access Control in Cooperative Vehicular Ad-Hoc Networks " in this title we study the congestion and medium access control (MAC) problem for cooperative vehicular ad-hoc networks (VANETs) in the utility function maximization's framework. Congestion control in a multi-hop cooperative VANETs is much more complex and requires joint optimization at both the transport layer and the MAC layer. A different cross-layer algorithm JOCMAC algorithm is proposed to solve the system problem with constraints that arise from the cooperation among the users. This algorithm works jointly at the MAC layer to adjust link persistence probability and at the transport layer to adjust flow rates. The algorithm works, and it is designed in distributed manner that is amenable to on-line implementation

for VANETs. We prove rigorously that the proposed algorithm converges to the globally optimal solution. Fei Ye, Raymond Yim, Jinyun Zhang, Sumit Roy, has proposed "Congestion Control to Achieve Optimal Broadcast Efficiency in VANETs " this paper introduces broadcast efficiency that is used to measure the average rate, which vehicles uses to receive any broadcast packets from any of the neighbours. Congestion control mechanism is used to reduce interference levels when node density increases, that can decrease broadcast efficiency. The analyzation is performed in Rayleigh fading channel that provides 3 results: (1) power control policy in VANET as node density varies; (2) Optimal transmission probability „s characterization as a function of VANET system parameters like node density, transmission power, packet length ; (3) Congestion control strategy for worst case that can achieve over 95% of the optimal performance when the network nodes have high mobility. NS-2 simulations method is used to validate its accuracy. This implies that a VANET system at most needs to spend only very little resource to conduct rough estimation of node density.

[3]. Jagruti Sahoo, Eric Hsiao-Kuang Wu, Pratap Kumar Sahu, and Mario Gerl, has proposed "Congestion- Controlled-Coordinator-Based MAC for Safety-Critical Message Transmission in VANET ", In this paper we explore congestion-controlled-coordinator-based MAC (CCC-MAC), which is based on time-division multiple access (TDMA) mechanism. This protocol addresses efficient and reliable transmission of safety-critical messages in VANETs. CCC-MAC employs a pulse-based reservation mechanism that guarantees fast and reliable propagation of emergency messages. This protocol can support number of vehicles. The network is virtually partitioned into a number of segments. Each vehicle is assigned time slots in the transmission period of their respective segments. This proposed protocol makes efficient use of bandwidth by unoccupied slots and also mitigates channel congestion by reducing the transmission time of beacons through the use of multiple data rates. The simulations result shows that CCC-MAC can perform well in different vehicular density situations and is able enough to deliver safety-critical messages to around 95% of the intended recipients. Also CCC-MAC provides a substantial improvement in latency values

[4] Mark Chih-Wei Hsu, Tien-Yuan Hsieh has proposed "A Probability Based MAC Channel Congestion Control Mechanism for VANET" In this title we study channel congestion control mechanism based on probability model to calculate the expected offset slots to improve transmission performance which reduces the collision situations, and on the estimation of potential neighbouring vehicles through broadcasting Hello messages, is developed to cope with dynamic changes in topology as in VANETs. In Vehicular Ad Hoc Networks (VANETs), the relationship between the vehicle number and its contention window size would cause the channel congestion. Distribution approach is used as input parameters for calculating expected offset slots that enables efficient safety message forwarding in the highway scenario. Number of potential neighbour vehicles and data traffic can be evaluated for a VANET using IEEE S802.11p/WAVE transceivers in multi-lanes highway situations. This approach also makes use of a simple probabilistic approach to reduce the packet loss probability as compared to other fixed contention window solutions.

Di Wu1, Dongxia Zhang, Limin Sun[5] has proposed "An Aggregate Parameter for Congestion Detection in VANETs " based on weights for congestion detection. Congestion is one of the key issues which can restrict the Network performance, and it is no exception for VANETs. This aggregate parameter can detect the network congestion accurately, fast and in real time, avoiding the weakness of using one single parameter. This parameter can monitor the network performance from the four aspects: Messages Delivered Ratio (MDR), Average Delay (AD), Throughput and Overhead Ratio (OR), so as to achieve the purpose of the congestion detection. The method of normalizing the above four parameters is used, which makes the aggregate parameter more accurate. Finally, simulation results show that the aggregate parameter is correct and effective.

Lars Wischhof and Hermann Rohling, Sungwon Lee, Eui-Nam Huh [7] has proposed "Congestion Control in Vehicular Ad Hoc Networks" this paper is study of utility-based congestion control and packet forwarding(UBPFCC) .Two algorithms have been proposed, First is control algorithm that make use of an application-specific utility function and quantitative utility information is encoded in each transmitted data packet in a transparent way for all users within a local environment and second is a decentralized algorithm that calculates the "average utility value" of each individual node based on the utility of its data , this algorithm is also used to evaluate the performance and is implemented on top of the IEEE 802.11 MAC protocol. When congestion is detected, packets with a low utility for the network are dropped. Network simulations demonstrate that UBPFCC avoids the starvation of individual nodes and significantly increases the efficiency of information dissemination.

Yi Qian, Kejie Lu, and Nader Moayer[8] has proposed "A SECURE VANET MAC PROTOCOL FOR DSRC APPLICATIONS " in this title we study a secure MAC protocol for VANETs, with different message priorities for

different types of applications to access DSRC channels. This efficient medium access control (MAC) protocols is designed so that safety related and other application messages can be timely and reliably disseminated through VANETs. This protocol ensures the freshness of message, provides authentication and integrity as well as message non-repudiation, and privacy and anonymity of the senders. The simulations and analysis results shows that the proposed MAC protocol can provide secure communications while guarantee the reliability and latency requirements as well as QoS requirements of safety related DSRC applications for VANETs.

Chang Cuyu, Xiang Yong, Shi Meilin and Lin Liang [9] has proposed "Performance Observations on MAC protocols of VANETs in Intelligent Transportation System. In this title performance of the main MAC protocols for VANETs are theoretically compared and analysed for sub-urban, urban, and free way situations. A reliable and efficient medium access control (MAC) protocol is needed so that the transmission collisions in VANETs can be reduced. First is the IEEE 802.11 protocol, based on CSMA/CA and inter-frames spaces, implemented in the 802.11b standards, which are used by many VANETs research teams in their simulations and prototype designs. protocol can overcome the hidden terminal problem in VANETs but due to CSMA/CA mechanism, 802.11 cannot guarantee a deterministic upper bound on the channel access delay, which makes 802.11 not suitable for real-time traffic. Second is ADHOC MAC protocol, which is RR- ALOHA based and works in a slotted time structure, which allows for a reliable one-hop broadcast service and avoids the hidden terminal problem and ensures a relatively good QoS, which is important for real-time traffic.. So a combination of the IEEE 802.11 standard and ADHOC MAC can provide a good and more complete solution for VANETs.

Hassan Aboubakr Omar, Weihua Zhuang, Li Li[10] has proposed "VeMAC: A TDMA-Based MAC Protocol for Reliable Broadcast in VANETs" In this title VeMAC, a novel multichannel TDMA MAC protocol is proposed and is compared with existing ADHOC MAC. The VeMAC supports two types of broadcast services, efficient one- hop on the control channel and multi hop broadcast services on service channel by using implicit acknowledgements. The nodes are allowed to access the time slots on the control channel and service channels in distributed ways, which are designed to avoid any hidden terminal problem The protocol reduces transmission collisions due to node mobility on the control channel by assigning disjoint sets of time slots to vehicles moving in opposite directions and to road side units. The simulation and performance of VeMAC shows that due to its ability to decrease the rate of transmission collisions, the VeMAC protocol can provide significantly higher throughput on the control channel than ADHOC MAC.

Boangoat Jarupan, Eylem Ekici[11] has proposed "A Survey of Cross layer design for VANETs" in this title we explore the cross layer design for VANETS as an alternative to pure layer design model such as OSI model to develop communication protocol. Cross layer approach provides high performance especially in delivering QoS support for real time applications. It allows information to be exchanged and shared across layer boundaries which is not possible in OSI strict layered model as functionality of each layer is completely transparent from another layers. Also strict layered architecture is not flexible to support the needs of wireless communication in highly dynamic vehicular network. VANETs deals with issues like noise, interference, path loss , they require information exchange among layers so that one can jointly optimize different layers to achieve better throughput and good transmission latency.

Amit Dua, Neeraj Kumar and Seema Bawa[12] has proposed "A Systematic review on routing protocols for VANETs" in this title we focus on routing protocols for VANETs, as they have high mobility so there are lot of challenges to route the packets. Routes are selected with a particular strategy depending on its application in particular field. The goal of routing is to provide safety, comfort, and infotainment and transport efficiency to users in vehicles. Routing is dependent on number of factors like velocity, density, direction etc., as vehicles can be a source or destination during process of routing.Routing protocols can be categorized on the basis of Topology, Geography, Hybrid, Clustering, Data fusion, Opportunistic.

Manish Sharma, Gurpadam Singh [13] has proposed "Performance Evaluation AODV, DYMO, OLSR and ZRP ADHOC Routing Protocol for IEEE802.11 (MAC) and 802.11(DCF) in VANETs " in this title we study performances of existing Adhoc routing protocols for use in VANETs. Basically adhoc routing protocols are reactive, proactive and hybrid. AODV and DYMO are reactive protocols, OLSR is proactive and ZRP is hybrid. Since IEEE802.11 covers both physical and data link layer, so performance of protocols in these layers helps to select a appropriate protocol for high speed mobility as in VANETs. Varying parameters (speed, Altitude, mobility etc.) of VANETS shows that proactive protocol (OLSR) performs more efficiently for IEEE (MAC) and IEEE(DCF) than other protocols. As OLSR predetermines the route in a well defined manner and minimum errors are sent in the signal. AODV and ZRP appears as second option, both being reactive in nature. DYMO although being reactive is the least considerable

Katrin Sjöberg [14] "Medium Access Control for Vehicular Ad Hoc Networks This paper presents

two different MAC protocols for VANETs: CSMA of IEEE 802.11p and STDMA(self organizing TDMA). A VANET is a challenging network for MAC protocol because number of stations in is unknown.MAC protocol for VANETs decides when a station has the right to access the shared communication channel and schedule transmission to minimize interference at receiving end. In CSMA channel access is not upper bounded and it is unknown until the transmission commences that means all the stations experience a random delay. In STDMA, channel access delay is upper bounded and known before transmission and all stations are always guaranteed timely channel access. So this paper concludes that STDMA is a very suitable MAC method for VANET because STDMA always achieve better reliability than CSMA especially for distance of 100-500m between transmitter and receiver.

Hamid Menour and Fethi Filali, Eurecom Massimilano Lenardi [15] has proposed "A Survey and Qualitative Analysis of MAC Protocols for Vehicular Adhoc Networks" In this title we have reviewed three main MAC protocols for VANETs and a qualitative comparison between them. IEEE802.11p (WAVE) protocol based on CSMA/CA and interframe spaces, ADHOC MAC which is based on RR-ALOHA and works in slotted time structure and MAC protocols based on Directional antennas. MAC protocols in VANETs where nodes are vehicles are used to avoid collisions; their main characteristics are high mobility and speed. MAC protocols for VANETs have to be concerned with dynamic topology changes, different kinds of applications for which transmission will be established and also they must be able to reduce medium access delay which is important for safety applications.

[Sunil Kumar Singh, Rajesh Duvvuru, and Saurabh Singh Thakur 16] "Congestion control technique using intelligent traffic and VANET "In this title a congestion control technique has been developed for Indian heterogeneous traffic. The local congestion problem has been taken, the basic idea proposed is RSU attached to traffic light will monitor traffic from all directions, RSU will have information regarding flow which will help it to dynamically change traffic light logic to flow with heavy load more with green light than red, which will be compensated by vehicles to spend more time waiting on low load lines. Two simulators SUMO and NS2 are used to study the impact of traffic and traffic lights over V2V communications using AODV (adhoc on demand vector) routing protocol and IEEE802.11 standard. This model worked best at both traffic level and network level, which can be used to solve real world congestion problems at traffic intersections.

Miguel Sepulcre, Javier Gozalvez, Jerome Harri, and Hannes Hartenstein[17] has proposed "Application based congestion control policy for communication channel in VANETs", This title proposes a novel proactive congestion control policy for VANETs which aims to individually satisfy application requirements while globally minimising the channel load to prevent congestion. Transmission range and packet transmission rate requirements are considered as they are needed to provide driver enough time to react and avoid harsh conditions. This approach differs from congestion control protocols based on experienced channel load which tends to assign similar transmission parameters to close vehicles. With proposed policy some application reliability can be provided to all vehicles independent of their position speed or traffic context .This approach could be extended to scenario where multiple applications each with different requirements are simultaneously run by same vehicle, while some applications could require a high packet rate and others could fix minimum distance at which messages should be received.

Ankit Gupta and Prof. Vijay Lokhande[18] has proposed "Survey of different Traffic Congestion Control Techniques in VANET " The purpose of this survey is to study different proposals that are best efficient to remove the possibility of network congestion. To achieve long range information, a combination of broadcast data transmission and store and forward approach is used. Roads are divided into segments of standard length; each segment is assigned with a fix transmission period which will reduce the bandwidth consumption. Each vehicle is provided a time slot with that collision of information is avoided. Vehicle is set to function as sensors and measure condition of their current road segment. A VANET supervision system transmits available information in form of broadcast to all nodes containing information for multiple road segments.

Savas Konur and Michael Fisher[19] has proposed "Formal Analysis of a VANET Congestion Control Protocol through Probabilistic Verification'' this title is a study of a specific congestion control protocol for VANETs is analyzed through the use of formal verification. A probabilistic model checking technique PRISM is used that will investigate its effectiveness and correctness. This approach improves both channel utilization and message transmission. This modification allows achieving better loss rate and delaying for safety messages .Three priority levels for messages are considered. First is dynamic priority assignment, second is message scheduling and third is cooperative message transmission. One dimension is to extend these priority levels and to increase number of service channels. The control channel (CCH) and service channel (SCH) are the two shared media used for the transmission of

emergency and safety messages, and for the transmission of the service messages.

Mohammad Yusuf Darus and Kamalrulnizam Abu Bakar[20] has proposed " A Review of Congestion Control Algorithm for Event-Driven Safety Messages in Vehicular Networks'' This title is a study of congestion control algorithm for uni-priority of event- driven safety message congestion. Event driven safety messages are generated when an abnormal condition or immediate danger is detected. Event driven messages have a stringent requirement of delay and reliability. In a dense network a large number of vehicles exchanges beacon messages, so the shared control channel becomes congested, so it is important to keep CCH free from congestion so that event driven messages can be timely delivered. When a node detects event-driven safety message either generated at its own application layer or received from another device, it will launch the congestion control immediately to guarantee the delivery of event.

VI. CONCLUSION AND FUTURESCOPE

This study focussed MAC layer protocols for congestion control. VER-MAC which allows nodes to broadcast EMG packets twice in both the SCHI and CCHI simultaneously increases the Packet delivery ratio and throughput of service packets. However it suffers from more delay of EMG packets and also it requires additional complex data structures.

In a future work, according to our findings, we will propose an algorithm for congestion control in VANETs based on a combination of Gaussian mobility model and Markova 2-D chain model. We also plan to verify and evaluate the performance of our proposed congestion control algorithm using a network simulator such as NS-2.

VII. REFERENCES

[1] Duc Ngoc Minh Dan, Choong Seon Hon, Sungwon Lee, Eui-Nam Huh, "An Efficient and reliable MAC in VANETs", in the proceedings of IEEE Communication Letter 2014.

[2] Fei Ye, Raymond Yim, Jinyun Zhang, Sumit Roy, "Congestion Control to Achieve Optimal Broadcast Efficiency in VANETs ", in the proceedings of IEEE 2010.

[3] Jagruti Sahoo, Eric Hsiao-Kuang Wu, Pratap Kumar Sahu, and Mario Gerl, "Congestion-Controlled-Coordinator-Based MAC for Safety-Critical Message Transmission in VANET ", in the proceedings of IEEE 2013.

[4] Mark Chih-Wei Hsu, Tien-Yuan Hsieh, "A Probability Based MAC Channel Congestion Control Mechanism for VANET", in the proceedings of IEEE 2013.

[5] Di Wu1, Dongxia Zhang, Limin Sun, "An Aggregate Parameter for Congestion Detection in VANETs", in the proceedings of IEEE 2012.

[6] Liang Zhou, Baoyu Zeng, "Joint Congestion and Medium Access Control in Cooperative Vehicular Ad-Hoc Networks", in the proceedings of IEEE 2007.

[7] Lars Wischhof and Hermann Rohling, Sungwon Lee, Eui-Nam Huh, "Congestion Control in Vehicular Ad Hoc Networks", in the proceedings of IEEE 2014.

[8] Yi Qian 1, Kejie Lu 2, and Nader Moayer, "A SECURE VANET MAC PROTOCOL FOR DSRC APPLICATIONS ", in the proceedings of IEEE 2008

[9] Chang Cuyu, Xiang Yong, Shi Meilin and Lin Liang, "Performance Observations on MAC protocols of VANETs in Intelligent Transportation System ", in the proceedings of IEEE 2009.

[10] Hassan Aboubakr Omar, Weihua Zhuang, Li Li, "VeMAC: A TDMA-Based MAC Protocol for Reliable Broadcast in VANETs", IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 12, NO. 9, SEPTEMBER 2013.

[11] Boangoat Jarupan, Eylem Ekici, "A Survey of Cross layer design for VANETs", in the proceedings of ELSEVIER 2010

[12] Amit Dua, Neeraj Kumar and Seema Bawa, "A Systematic review on routing protocols for VANETs", in the proceedings of ELSEVIER 2014.

[13] Manish Sharma, Gurpadam Singh, "Performance Evaluation AODV, DYMO, OLSR and ZRP ADHOC Routing Protocol for IEEE802.11 (MAC) and 802.11(DCF) in VANETs ", International Journal on AdHoc Networking Systems (IJANS) Vol. 2, No. 1, January 2012

[14] Katrin Sjöberg, "Medium Access Control for Vehicular Ad Hoc Networks", ISBN 978-91-7385-832-8 HALMSTAD UNIVERSITY Göteborg, Sweden, 2013

[15] Hamid Menour and Fethi Filali, Eurecom Massimilano Lenardi, Hitatchi Eurpe, "A Survey and Qualatative Analysis of MAC Protocols For Vehicular Adhoc Networks", in the proceedings of IEEE 2006.

[16] Sunil Kumar Singh, Rajesh Duvvuru, and Saurabh Singh Thakur, "Congestion control technique using intelligent traffic and VANET", International Journal of Computer Engineering & Applications, Vol. IV, Issue I/III

[17] Miguel Sepulcre, Javier Gozalvez, Jerome Harri, and Hannes Hartenstein, "Application based congestion control policy for communication channel in VANETs", IEEE communication letter, VOL. 14, NO. 10, OCT 2010

[18] Ankit Gupta and Prof. Vijay Lokhande, "Survey of different Traffic Congestion Control Techniques in VANET", IJARCSSE Volume 4, Issue 2, February 2014

[19] Savas Konur and Michael Fisher, "Formal Analysis of a VANET Congestion Control Protocol through Probabilistic Verification",in the proceedings of IEEE 2011.

[20] Mohamad Yusof Darus and Kamalrulnizam Abu Bakar2, " A Review of Congestion Control Algorithm for Event-Driven Safety Messages in Vehicular Networks", in the proceedings of International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011

[21]]http://www.pcquest.com/pcquest/news/181591/intelligent-transportation-vanet

[22] http://winfwiki.wifom.de/index.php/Standards_in_der_Car-To-Car-Kommunikation

[23]]http://file.scirp.org/Html/9-3500092_27309.htm

[24] Atulya Mahajan, Niranjan Potnis, Kartik Gopalan," Evaluation of Mobility Models For Vehicular Ad-Hoc Network Simulations", in the proceeding of international journal of computer applications 2013-14.

[25] Youssef Saadi, Said El Kafhali, Abdelkrim Haqiq, " Simulation Analysis of Routing Protocols using Manhattan Grid Mobility Model in MANET", International Journal of Computer Applications (0975 – 8887) Volume 45– No.23, May 2012.

[26] Jerome Harri, Fethi Filali and Christian Bonnet," Mobility Models for Vehicular Ad Hoc Networks: A Survey and Taxonomy", Institute Eurecom Department of Mobile Communications 2229, route des Cretes B.P. 19306904 Sophia-Antipolis FRANCE.

[27] Vishal Kumar, Shailendra Mishra, Narottam Chand," Applications of VANETs: Present & Future",in the proceedings of scrip.org journal in 2012-13.

[28] Bhavyesh Divecha1, Ajith Abraham2, Crina Grosan," Impact of Node Mobility on MANET Routing Protocols Models", Journal of Digital Information Management

