An Efficient Channel Assignment Scheme for Vehicular Ad Hoc Networks

Ranbir Singh Batth
Department of Computer Science and Engineering, Shaheed Udham Singh College of Engineering and Technology, Mohali, Punjab, India.
batth.ranbir@gmail.com

Sushil Kamboj
Department of Computer Science and Engineering, Shaheed Udham Singh College of Engineering and Technology, Mohali, Punjab, India.
er.kamboj@gmail.com

Abstract – In recent years, Vehicular ad hoc networks emerge as the promising applications of Mobile ad hoc network. It is specially designed for road safety and comforts to people. It assists vehicles to communicate among themselves and to perceive the road situation such as accidents or traffic jams in their vicinity. vehicular ad hoc network is the type of network which configures itself and can join or leave the network when they want. Due to this property of system, channel assignment is the major issue of the network. The channel assignment policy scheme is proposed in this research work is to improve the performance of the network. The channel assignment policy is based on data packets prioritization. The proposed scheme is implemented in NS2 and results are analyzed.

Index Terms – Channel Assignment, MAC, NS2, Data Priority

1. INTRODUCTION

The safety on roads needs to be increased and to do so, the vehicular ad hoc networks (VANETs) were designed primarily. VANETs are the networks in which each vehicle is considered as a router such that the data present within the nodes can be exchanged. The traffic management conditions can be improved and on-board infotainment can be provided by deploying these networks [1]. The highest possible level of safety was provided for the bounded transmission delays and low access delays.

A broad bandwidth is required by user-oriented services as well. There is a very frequent change in the topology of networks due to the high mobility of nodes. This is a major disadvantage of VANETs [3]. Also, good time synchronization can be provided through the network since the geographic position of a vehicle can be obtained using GPS [4]. No predefined schedule is required for contention-based protocols. At the time of transmission, each node wishes to compete for channel access without giving an assurance of success. For real-time applications, bounded-delays can be provided by contention-free protocols [8].

1.1. Contention-based and Contention-free MAC Protocols

The transmission device listens to the network before transmission in CSMA such that the collision can be avoided. If any collisions occur, unbounded delays can be caused in the network [9]. The frame continues to be transmitted even after the collision which is a major issue in CSMA. This results in a complete wastage of channel time. Thus, to avoid this scenario improvement were proposed. For saving the transmission time, a collision is detected when a station receives other transmissions at the time of its transmission. Since the medium is shared between several stations, the potential collisions are very obvious in this network [11]. There is pre-allocated access to the medium in case of contention-free MAC protocols [12]. The total available bandwidth is divided into several frequency bands in the frequency-division multiple access (FDMA) protocol. For data transmission, each station is allocated a separate band. So, one particular band is reserved for every different station and it is freely available at all times [13]. For confining the transmitter frequencies, a bandpass filter is used by each station. The small guard bands are used to separate the allocated bands from one another such that station interferences can be avoided. The bandwidth of the channel is shared in time by the stations when applying a time-division multiple access (TDMA) protocol [14]. For transmitting the data, each station is allocated a time slot. Within this assigned time slot, every station can transmit its data.

2. RELATED WORK

Eugene David et.al proposed a novel MAC protocol named MAP for PLNC which was based on Physical Layer Network Coding which provide the guarantee of efficiency. In VANETs, two simple modes of forwarding were implemented by MAP [5]. For using PLNC effectively in large-scale VANETs, this decentralized and dynamic priority-based wireless medium access protocol was designed. No centralized nodes were required in this mechanism. Based on the type of application, MAP could be adjusted accordingly and thus it was application in various dissemination environments. It was seen through the simulation results that high-speed. Md. Kowsar Hossain, et.al proposed ResVMAC which was a novel VANET MAC protocol that helped in reserving the Basic Channels (BCHs) at speed higher than the ones provided by previously proposed protocols [7]. A random micro slot is chosen in the Reservation period by this proposed protocol such that the data that is contended for free BCH can be transmitted by a node. The data is transmitted in its reserved BCH if no Negative Acknowledgment (NACK) is received from one-hop neighbors just after its REQ packet is transmitted. Vasileios Dragonas, et.al analyzed about, previously proposed technique TiMAC was studied again such that its performance level could be evaluated [12].

In the next section, this approach was extended by assuming disjoint sub-frames for the direction of each vehicle which was named as d-TiMAC. Comparative analysis was made against previously made improvements and this proposed protocol to evaluate the performance level. A reduction in retransmissions was achieved as per the comparisons made against TiMAC and d-TiMAC. This showed that within safety applications proposed for vehicular networks, the proposed approach was highly effective. Zhang Tianjiao, et.al proposed a novel game-based TDMA based MAC protocol in which the colliding nodes played games with each other at the time when reservation collision occurred [11].

This helped in making decisions to get the slot and to be reserved on a newly needed system. Thus, a complete utilization of time slots as possible and increment in reservation speeds was possible without any control of the base stations. It was seen that within the high-density networks, the performance of proposed GAH-MAC was calculated to be better than other existing protocols concerning the success rate of reservations, network throughput and density of networks.

3. PROPOSED METHODOLOGY

For making the anomaly appear, five different kinds of conditions were considered by this scheme at the very same time. Also, the data priority was used to provide treatment for traffic which is being uploaded. Various types of applications that are supported by particular WBAN are used to differentiate the data traffic. Based on data priorities, the characterization of applications was done. Here, the medical services are assigned as high priority and non-medical services as low priority. Further, for the evaluation of the energy efficiency with various transition states, a discrete-time Markov chain was applied. For achieving high throughput and reasonable delay, the optimization of the length of the access phase is done. The sleeping node is woken up such that the energy consumption can be reduced only for receiving the EPOLL packet from the hub.

3.1. Load balancing in LBPQA

For effective transmission of data, the load balance priority queue algorithm is designed by applying the IEEE 802.11 protocol. The classification of the packet is done if it is originated from local. The scheduling of the packet in the queue is done depending upon the condition. To process the incoming packet. The scheduler can prioritize the packet in the next step. For continuing further processing, this prioritized packet will be forwarded to the hardware scheduler. Figure 1 shows the detailed structure of LBPQA. Four different queues are available in this configuration, which include normal, high, low and medium. To anyone of the queues the packets are assigned.

3.1.1. Priority Classification

The data packets are scheduled here. Following are the certain categories among which classification is done. The highest priority is provided for critical health diseases like low blood potassium, abnormal heart rhythm. Further, due to its acyclic nature that results in causing a low recurrence rate, PP1 is always considered as critical. The transmission of such kind of data from personal devices to actuators is performed here. Particularly, to transfer this kind of traffic, more reliable routes need to be generated.

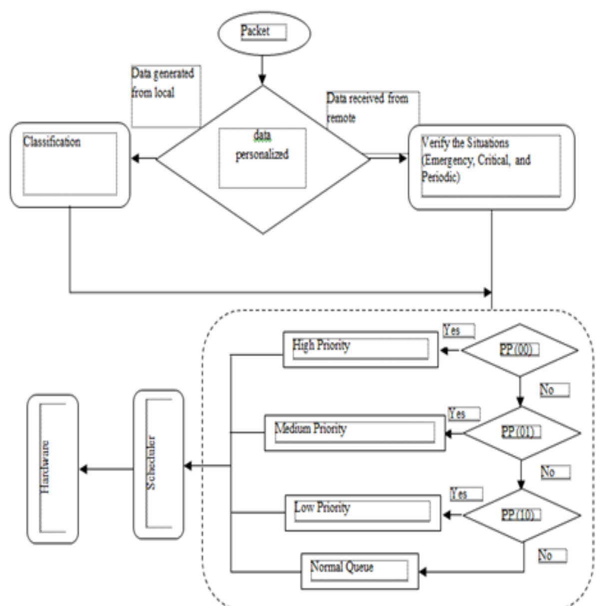

Figure 1 Layout of LBPQ Algorithm

3.2. Modified Packet Structure

Generally, the packet to be transmitted is generated by the sensors and the priority will be decided by the Personalized Device (PD). The data is forwarded to the Access Point (AP) based on priority. The general structure of the IEEE 802.15.6 is shown in the below mentioned Figure 2.

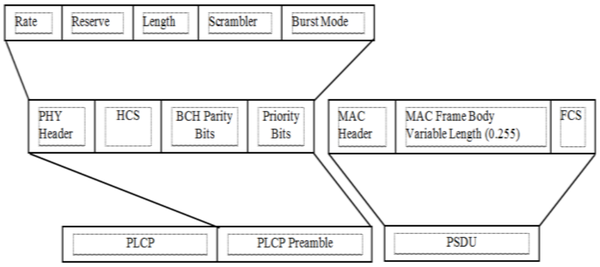

Figure 2: Modified Packet Structure

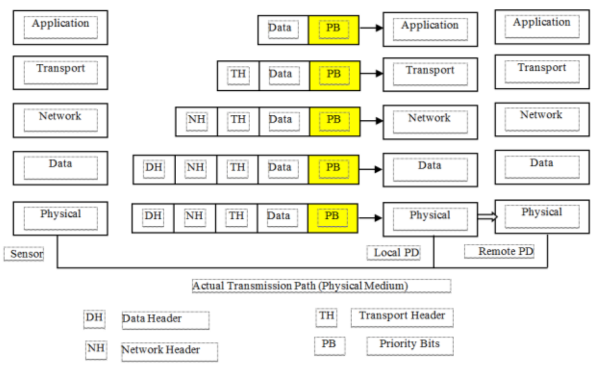

Figure 3: Layered Architecture of LBPQA

There are different layers included in the sensor. Figure 3 represents the layered architecture. Here, the priority bits are denoted by PBits, Transport Header by TH, Data Header by DH and Network Header by NH. The data will be queued based on its deadline if it is generated from a remote location. There are four different types of queues within this scheduling framework which are also mentioned in the diagram.

Emergency conditions are supported by the packet that includes PP1. In the transmission time of two packets, two PP1 packets cannot be sensed to be triggered here. Thus, at the time of two consecutive slots, at most one packet might appear. For sending an indication, at least two sub-slots are required by each PP1 packet. Here, S + 2 is defined as the maximum access delay of PP1 packet transmission. Following is the estimation of average delay of packets:

$$D_{PP1} = 2 + \frac{1}{S+2}(D_1 + D_2 + D_3) \quad \ldots (1)$$

Here, the average access delay is denoted by D_i. Following is the mathematical calculation of estimating the transmission energy:

$$E(S) = P_l t_l + P_{tx} * \left(t_{tone} + \frac{F}{S}\right) + P_{rx}\left(t_{tone} + \frac{F}{S}\right) \quad \ldots (2)$$

Here, the power consumption in the priority estimation stage is denoted as P_l. The time of listening state is denoted by t_l. The power consumed in the receiving state is denoted by P_{rx}. The frame size and information bit rate are denoted by F and S respectively. Until the data from the corresponding queue is transmitted, this process is continued repetitively.

4. RESULT AND DISCUSSION

This research work is related to channel access and data priority in vehicular ad hoc networks. The novel protocol is designed to assign priority to the data packets and assign wireless channels efficiently. The protocol architecture is presented with the frame structure for the channel assignment in VANET. The simulation of the proposed model is performed in network simulator version 2 by considering various assumptions. The area is 800*800 meters for the simulation which the 10 vehicle nodes. The wireless type of channel is used for the simulation with the LL type link layer.

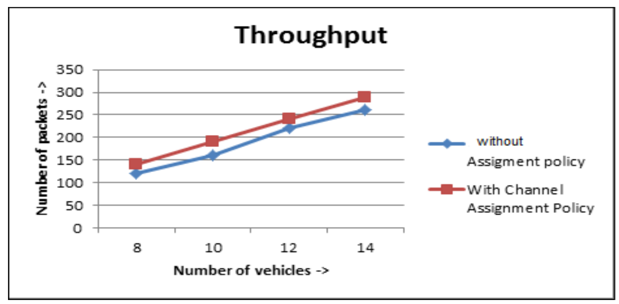

Figure 4 Throughput Comparison

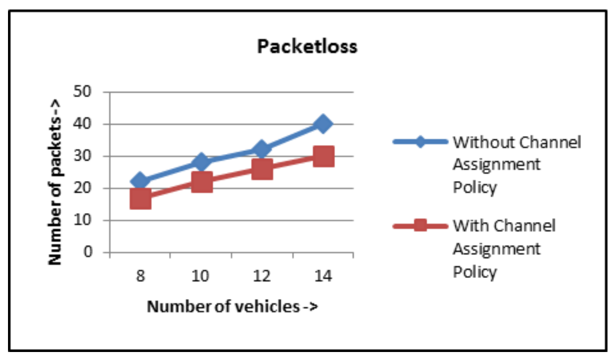

Figure 5 Packet loss Comparison

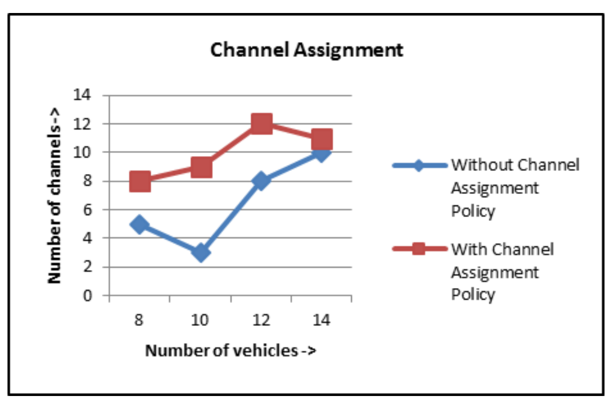

Figure 6 Channel Assignment Comparison

As shown in Figure 5, the packet loss of the with channel assignment policy and without channel assignment policy scenarios are compared for the performance analysis. It is analyzed that packet loss with channel assignment policy is low as compared to without channel assignment.

As shown in Figure 6, the channel assignment comparison is done between with and without channel assignment policy. It is analyzed that more number of channels are reallocated in the network, as compared to without channel assignment policy.

5. CONCLUSION

In this research work, the channel assignment policy scheme is proposed for the channel assignment and data priority assignment. The policy assignment scheme for VANET is implemented in network simulator version 2. The result is analyzed in terms of certain parameters like throughput, packet loss and channel assignment. It is analyzed that throughput is high with channel assignment as compared to without channel assignment policy. The packet loss of the without channel assignment is high as compared to with channel assignment policy.

REFERENCES

[1] Jiang, D., Delgrossi, L., "IEEE 802.11p: Towards an International Standard for Wireless Access in Vehicular Environments", 2008, Vehicular Technology Conference, VTC Spring IEEE, pp. 2036–2040

[2] Omar, H., Zhuang, W., Li, L., "VeMAC: A TDMA-Based MAC Protocol for Reliable Broadcast in VANETs", Mobile Computing, IEEE Transactions on 2013;12(9), pp-1724–1736

[3] Yu, F., Biswas, S., "Self-Configuring TDMA Protocols for Enhancing Vehicle Safety With DSRC Based Vehicle-to-Vehicle Communications. Selected Areas in Communications", 2007, IEEE Journal, 25(8), pp-1526–1537

[4] Almalag, M., Olariu, S., Weigle, M., "TDMA cluster-based MAC for VANETs (TC-MAC)", 2012, World of Wireless, Mobile and Multimedia Networks (WoWMoM), IEEE International Symposium, pp. 1–6

[5] Nguyen, V., Dang, D.N.M., Jang, S., Hong, C.S., "e-VeMAC: An enhanced vehicular MAC protocol to mitigate the exposed terminal problem", The 16th Asia-Pacific Network Operations and Management Symposium. 2014, pp. 1–4

[6] Dang, D.N.M., Dang, H.N., Nguyen, V., Htike, Z., Hong, C.S., "HER-MAC: A hybrid efficient and reliable MAC for vehicular ad hoc networks", 2014, IEEE 28th International Conference on Advanced Information Networking and Applications. 2014, pp. 186–193.

[7] Borgonovo, F., Capone, A., Cesana, M., Fratta, L., "RR-ALOHA, a Reliable R-ALOHA broadcast channel for ad-hoc inter-vehicle communication networks", Proceedings of Med-Hoc-Net 2002

[8] Z. Yang, Y.-D. Yao, X. Li, and D. Zheng, "A TDMA-based MAC protocol with cooperative diversity," IEEE Commun. Lett., vol. 14, no. 6, pp. 542–544, 2010.

[9] S. Bharati and W. Zhuang, "CAH-MAC: Cooperative ADHOC MAC for vehicular networks," IEEE J. Sel. Areas Commun., vol. 31, no. 9, pp. 470–479, Sept. 2013

[10] D. N. Dang, H. N. Dang, V. Nguyen, Z. Htike, and C. S. Hong, "HERMAC: A hybrid efficient and reliable MAC for vehicular ad hoc networks," in Proc. IEEE AINA, May 2014, pp. 186–193.

[11] R. Zou, Z. Liu, L. Zhang, and M. Kamil, "A near collision-free reservation-based MAC protocol for VANETs," in Proc. IEEE WCNC, Istanbul, Turkey, pp. 1538–1543, Apr. 2014.

[12] L. Zhang, Z. Liu, R. Zou, J. Guo, and Y. Liu, "A scalable SCMA and self organizing TDMA MAC for IEEE 802.11 p/1609.x in VANETs," Wireless Pers. Commun., vol. 74, no. 4, pp. 1197–1212, Feb. 2014.

[13] W. Ding, J. Wang, Y. Li, P. Mumford, and C. Rizos, "Time synchronization error and calibration in integrated GPS/INS systems," ETRI J., vol. 30, no. 1, pp. 59–67, 2008.

[14] W. Franz, H. Hartenstein, and M. Mauve, Inter-Vehicle Communications Based on Ad Hoc Networking Principles: The FleetNet Project, Universitatsverlag Karlsruhe, 2005