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An Efficient Approach for Safety Critical Message Transmission in VANETs

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Abstract— The Intelligent Transportation System (ITS) architecture is currently being developed for enhancing vehicle safety. So, vehicular ad hoc network (VANET) is one of the recent and promising technologies for revolutionizing the transportation system where vehicles can communicate by sending message with each other via a wireless medium. The main motivation of using vehicular communications is not only to reduce number of traffic accidents but also the travelling time, congestion etc. by implementing various traffic applications. Because in safety critical message transmission, vehicles need to be constantly aware of the events in their surrounding environment, so as to avoid any unwanted situation before it occurs. VANET has adopted dedicated short-range communication (DSRC), which is under the process of standardization as the IEEE 802.11p/WAVE standard.

I. INTRODUCTION

The drive to enhance traffic safety in many active-safety applications will promise safe and comfortable mobility while ensuring optimized and safer use of the road network. In some applications, vehicles should be monitored to protect from the unsafe situation. For example, in an intersection scenario, a possible collision between two vehicles approaching each other can be avoided if one vehicle has sufficient knowledge of the status of the other vehicle.

Safety messages are real time in nature as they are relevant for a certain time period. They must reach the intended recipients with bounded delay and high packet reception rates (99%) [2]. The performance of a safety system is dependent on the underlying media access mechanism. Primarily, emergency messages are transmitted with higher priority over beacons. However, beaconing is equally important as it forms the basis of a diverse range of ITS applications [3]. For a more accurate information update, beacons must be generated at an interval of 100ms. Without proper coordination at the MAC layer, such a high frequency can easily result in channel congestion in regions of high vehicle densities, thereby causing serious degradation in the quality-of-service (QoS) performance of the safety system.

Even if a greater number of solutions have been proposed for increasing beacon performance, proper coordination at the MAC layer would be a critical task in the presence of a significant number of vehicles. It is,

therefore, necessary to devise a feasible solution for an efficient beacon exchange for future DSRCs. For a predictable traffic like beacon, time-division multiple access (TDMA) is preferred over contention-based MAC.

II. LITERATURE SURVEY

The basic MAC method of 802.11p uses a CSMA/CA mechanism. In CSMA/CA, a node1 transmits only when the channel is sensed as idle. If the channel is sensed as busy, then the node performs random back off. For traffic prioritization, the MAC is extended by incorporating an enhanced distributed channel access (EDCA) mechanism of IEEE 802.11e as shown by J. R. Gallardo, D. Makrakis, and H. T. Mouftah [4]. EDCA ensures timely dissemination of highly critical emergency messages by assigning appropriate service differentiation parameters. EDCA is found to be ineffective in the sense that it does not enforce strict prioritization.

The authors M. Barradi, A. S. Hafid, and J. R. Gallardo proposed that the strict prioritization was enforced by changing AIFS parameters [5]. AIFS parameters means the minimum interval that the wireless medium has to be sensed idle in order for a node to decide that it is free. But, this method is not that efficient. Delay increases and packet delivery ratio decreases with increase in vehicle density.

CSMA-based MAC is unsuitable for real-time communications because of its nondeterministic nature. To improve safety message reliability and to ensure bounded delay, conflict-free MAC such as TDMA, SDMA/LDMA can be used.

F. Yu and S. Biswas proposed a self-configuring TDMA protocol called as vehicular self-organizing MAC (VeSOMAC)[6] . VeSOMAC is aware of the vehicle location and movement so that the MAC slots can be timely ordered based on the vehicles relative location. This is done for minimizing the multi-hop delivery delay. VeSOMAC provides faster reallocation, which is suitable for vehicular applications with frequently changing network topologies. This protocol reduces the latency of a collision warning message by allowing vehicles to acquire sequential slots based on their relative position. The advantage of VeSOMAC is that it provides vehicle safety through smaller packet latency. Protocol convergence is fast during the topology changes under highway scenarios including platoon mergers and vehicle passing The limitation of VeSOMAC is that it is only effective for oversimplified scenarios.

To overcome the limitation of VeSOMAC , H. Omar,W. Zhuang, and L. Li proposed a TDMA-Based MAC protocol called VeMAC[7]. It introduces a novel multichannel TDMA MAC protocol specifically proposed for a VANET scenario. It supports efficient one-hop and multi hop broadcast services on the control channel by using acknowledgements and also by eliminating the hidden terminal problem. VeMAC reduces transmission collisions caused due to node mobility on the control channel by assigning disjoint sets of time slots to vehicles which are moving in opposite directions and also to the road side units, VeMAC employs a technique for the nodes to access the available time slots and to detect transmission collisions. This protocol ensures that each node must acquire exactly one time slot in a frame on the channel. Once a node acquires a time slot then it will keep accessing that same slot in all the subsequent frames on the same channel unless a transmission collision is detected. The advantage of VeMAC protocol is that it provides significantly higher throughput on the control channel because of smaller rate of transmission collisions. In VeMAC protocol, it is compulsory for each and every node to transmit its packet during its time slot only, even though the node has no data to transmit. The limitation of VeMAC is that the packet delay and hence packet delay analysis must be conducted to calculate the total delay that a safety message experiences on the control channel.

III. GAPS IDENTIFIED

Contention based MAC protocol suffers from great number of packet collisions, and as a result the reliability and safety messages are severely affected. Congestion controlled coordinator based MAC protocol which is a time slot based MAC protocol that addresses beacons and emergency messages by partitioning the beacon interval in prior to transmission of these packets. There is no dynamic partition of the interval which may enhance the efficiency.

IV. PROBLEM STATEMENT

To enhance the efficiency and fairness of using multiple data rates for beacon, congestion controlled coordinator based MAC protocol is extended to partition the beacon interval dynamically.

V. OBJECTIVES

The objective is to design an approach which will ensure that enough bandwidth is allocated to beacons and emergency messages and the problem of delay and congestion will no longer be affected by the presence of high density of vehicles.

VI. METHODOLOGIES

Congestion controlled coordinator based MAC is a time-slot based medium access protocol that addresses beacons and emergency messages. Here network is virtually partitioned into a number of segments.

Within a segment, medium access is accomplished by using a time-slot scheduling mechanism which is supervised by local coordinator. This protocol mitigates channel congestion by reducing the transmission time of beacons through the use of multiple data rates. This ensures fast and reliable propagation of emergency messages and provides a substantial improvement in latency values under all density conditions.

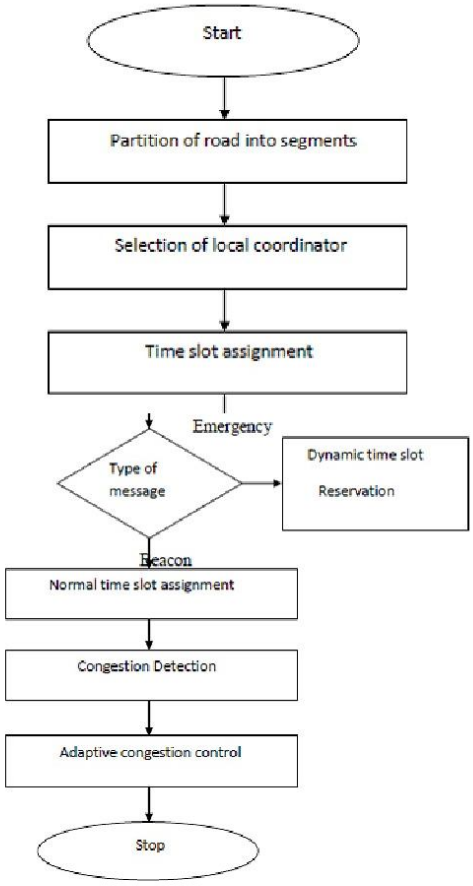

Fig 1. Data Flow Diagram

VII. CONCLUSIONS

CCCMAC addresses efficient and reliable transmission of safety-critical messages in VANETs. The use of multiple data rates make it scalable and avoid congestion in the presence of significant vehicle density. Medium access is achieved by dividing the road into a number of segments and assigning a fixed transmission period to each segment in the beacon interval. Then, vehicles are provided time slots in the transmission period of their respective segments. Techniques allow concurrent transmissions at different data rates. In addition, centralized scheduling ensures that all vehicles in a segment must receive time slots for their beacon transmissions. There will be a slot transfer mechanism to improve bandwidth utilization. Finally, CCCMAC ensures fast and reliable propagation of emergency messages over multiple hops by incorporating a pulse-based slot reservation mechanism. The protocol will be extended to dynamically partition the beacon interval to enhance the efficiency and fairness of using multiple data rates for beacons.website.

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