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# Prioritized and on Time Safety Critical Message Transmission in VANET

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***Abstract*: -- Vehicular Ad hoc Network (VANET) is a wireless network, consisting group of vehicles. Vehicles equipped with a wave communication device can establish the wireless communication among them. Vehicular ad-hoc networks provide the communication framework for the dissemination of safety-critical messages such as beacons and emergency messages. Under high-density situations, it leads to a serious scalability problem in VANETs. Congestion in the communication channel results in packet drops, throughput reduction and degradation of channel quality. So, congestion control schemes are necessary to regulate the traffic level at an acceptable level. Proposed system can reserve time slots by dynamically partitioning the beacon interval without the expense of beacons. Dynamic time slots ensure fast and reliable propagation of emergency messages by employing a pulse-based reservation mechanism. Adaptive beacon broadcast overcomes the problem of periodic beacons broadcast that incurs high overhead and congestion in the network. Prioritized On time safety message transmission reduces the congestion in the network and emergency messages are easily transmitted without any delay. Performance of the proposed system is evaluated by delay, throughput, and packet delivery ratio.**

***Index Terms*—VANET, Adaptive beacon broadcast, Beaconing, Adaptive congestion control, periodic beacon broadcast.**

## I. INTRODUCTION

Intelligent Transportation System (ITS) is inevitable for the current growth rate in the number of automobiles in the world. It consists of applications, technology and communication infrastructure to provide mobility management, traffic management and enables coordination and safe transportation for various users and operators. Main features and services of ITS include driver and passengers, safety, comfort, efficiency, road and other information availability and management on the road. Now a day, roads are wet and very difficult to maintain the distance between two communicating vehicles with particular speed and it leads to inefficient communication. VANET is a subclass of MANET. The Wireless Access for Vehicular Environment (WAVE) provides vehicle to vehicle and vehicle to road side communication in VANET. This will enhance the features of a smart city in the aspect of traffic control and transportation. The VANET is established to improve the safety applications of vehicles and manage the traffic problems. The architecture of VANET classified into pure cellular/WLAN, pure ad hoc and hybrid.

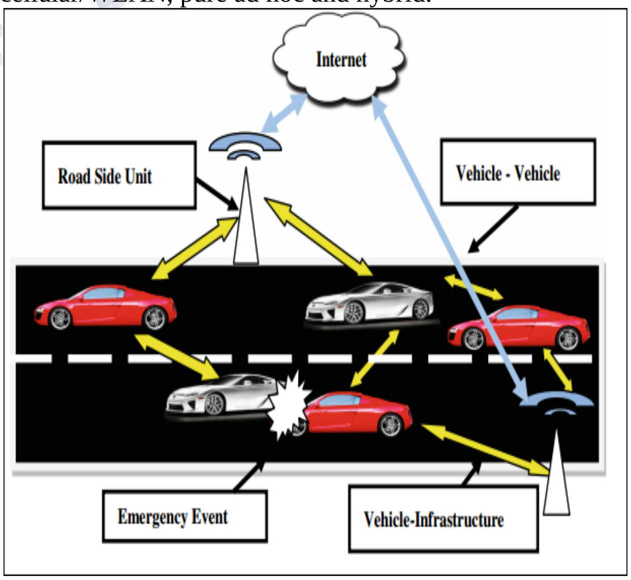


***Figure 1: communication in VANET***

The vehicle-to-vehicle and vehicle-to-roadside wireless communications in VANETs are a cost-effective platform to enhance traffic safety, traffic efficiency and driving experience. The drive to enhance traffic safety and efficiency results in many active-safety applications, which promise safe and comfortable mobility while ensuring optimized and safer use of the road network. VANET provide the communication channel for transmission of safety-critical messages such as beacons and emergency messages. Primarily, emergency messages are transmitted with higher priority over beacons. But under the high density situations communication channel observes a significant network load due to the frequently exchanged beacons. Contention based MAC protocol suffers from a large number of packet collisions. Greater number of solutions has been proposed for increasing beacon performance, but proper coordination at the MAC layer would be a critical task in presence of large vehicle density.

## II. RELATED WORK

In [2], authors have proposed a Wireless Access in Vehicular Environments (WAVE) system for VANET. The Wireless Access in Vehicular Environments (WAVE) system is developed to support such applications on the 5.9GHz ITS frequency band. The event-driven detection method monitors the safety applications and decides to start the congestion control whenever a high priority safety message is detected. However, owing to the nature of contention based channel access scheme, the WAVE system suffers from Quality of Service (QOS) degradation for safety applications caused by the channel congestion in scenarios with high vehicle with this method, each device periodically senses the channel usage level, and detects the congestion whenever the measured channel usage level exceeds the predefined threshold. The dynamic QOS parameter approach has been proved to have an efficient congestion control method for the safety application. But adaptive congestion control mechanisms are not employed.

In [3], authors have proposed Bounded Latency Alerts in Vehicular Networks. Vehicle-to-vehicle communication protocols may be broadly classified into in three categories: bounded-delay safety alerts, persistent traffic warnings and streaming media for telemetric applications. Location Division Multiple Access (LDMA) scheme is employed to suppress the broadcast storm problem and ensure bounded end-to-end delay across multiple hops. This scheme requires participating vehicles to time synchronize with the GPS time and receive the regional map definitions consisting of spatial cell resolutions and temporal slot schedules via an out-of-band FM/RDBS control channel. LDMA includes the facility to re-program slot schedules and spatial cell resolutions via an out-of-band control channel. This capability allows us to adapt the scheduling scheme for different traffic densities, street topologies and traffic incidents where messages are needed to proceed fast in certain directions or be persistently re-broadcast for the duration of the event. LDMA's globally synchronized approach to achieve bounded end-to-end delay is a promising direction for time-critical VANET protocols.

In [4], authors have proposed an adaptive LDMA (ALDMA) scheme which provides medium access to vehicle Nodes based on their time, geographical location and a Predefined location-to-time mapping. Two common message dissemination techniques are used which are event-triggered multi-hop relaying and periodic one-hop broadcast. Adaptive LDMA is used to make the broadcast storm problem of the flood less serious. It also isolates the beacon traffic from the storm so that it can achieve consistent reliability of safety messaging. A-LDMA scheme provides traffic isolation of flood and beacon messages so as to achieve the consistent reliability of safety message delivery. This scheme validates the traffic isolation capability of LDMA in coexistence of beacon and flood traffic in a single channel.

In [5], authors have proposed aTDMA-Based MAC protocol (VeMAC).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.

## III. PROBLEM DEFINITION AND OBJECTIVE

Due to high mobility of nodes and rapid changes in topology, designing an efficient congestion control protocol that can deliver a packet in a minimum period of time with few dropped packets is considered to be a critical challenge in VANET. Designing an efficient protocol has an impact on improving many factors; the first of these is enhancing the reliability of the system by leveraging the percentage of packets delivery, and second scalability. Another factor is to deliver a packet in the shortest possible time, especially in the emergency situation.

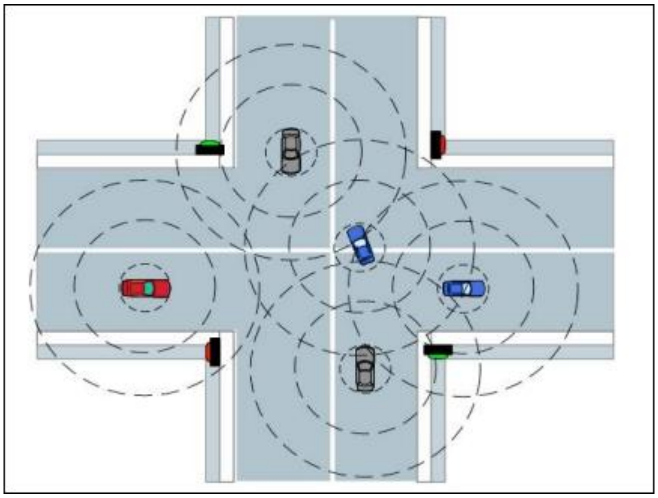

*Figure 2: periodic beacon transmission in VANET*

When large number of vehicles transmits beacons at a higher frequency then bandwidth can be exhausted very easily. As a result significant number of packet collision occurs. And in a scenario of emergency message, if the channel is already congested then highly life-critical even-driven message which will be deprived of channel access will either get lost or delivered to its intended recipients with a much higher delay. Thus loss of beacons and emergency message will severely affect the safety of a vehicle.

So 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.

## PROPOSED DESIGN

The vehicular communication model which will consist of vehicles having the transmission range of 100 m. These vehicles will be authenticated so that they can communicate securely with other vehicle in their range. Then we will partition the vehicular network into segments. Each segment will have either equal or unequal node density. If there will be unequal node density then a local coordinator will be selected according to centralized scheduling. In centralized scheduling, the vehicle which is near to the center of the segment and other vehicles in that segment is chosen as the local coordinator. This local coordinator will decide the time slots for other vehicles in that segment. Whole scheduling of time slots is done by that local coordinator. Each segment will have number of transmission periods during which vehicles will transmit beacons. Basically, safety critical messages in VANET are of two types: beacons and emergency messages. Beacons are the normal periodic status messages about vehicle speed, velocity, id location etc. And emergency messages are generated when a vehicle detects any emergency situation.

According to DSRC, every vehicle will generate beacons periodically. So, if the vehicle density is very high then channel will get congested easily. So, congestion in the communication channel should be detected. After congestion detection, if there is any emergency message then we will provide dynamic time slot reservation to the vehicle which generates emergency message. This can be done by pulse based reservation system in the communication channel. If the vehicles in segment do not find any time slot then they can use unoccupied time slots from adjacent segments. This is done by intersegment slot transfer. The time slots can be slotted by time division multiple access scheme. Each segment will have number of transmission periods and vehicles can transmit their beacon in that transmission period.

The proposed approach can adaptively control congestion in the communication channel. The flow diagram of the proposed design approach is given below. In each segments every vehicle broadcast a beacon message to its neighbors. Beacons are the normal periodic status messages about vehicle speed, velocity, id location. Adaptive beacon broadcast overcomes the problem of periodic beacons broadcast that incurs high overhead and congestion in the network. On time safety message transmission follows the mechanism of sending the beacon only when a vehicle is moving from one segment to another segment. No beacon is sent if the vehicle resides in same segment. On time safety message transmission reduces the congestion in the network and emergency messages are easily transmitted without any delay.

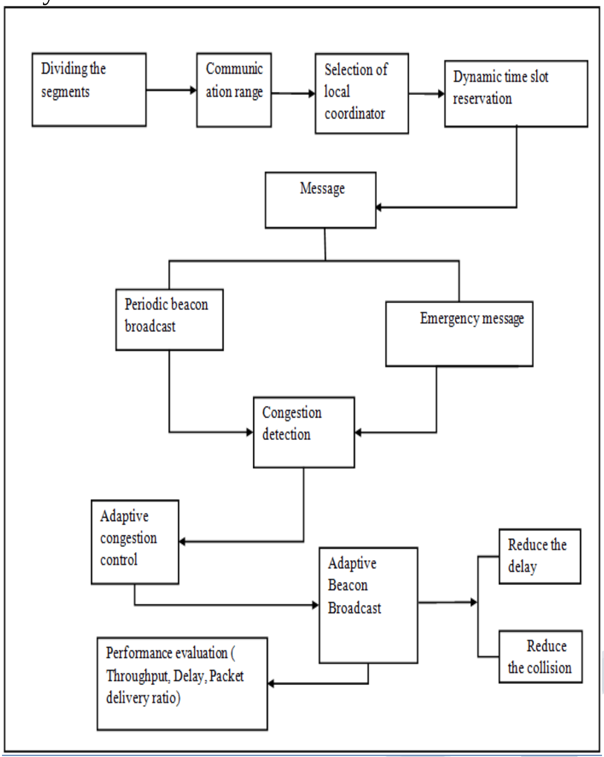


***Figure 3: flow diagram of a proposed design***

### *A. Selection of local coordinator*

The vehicular network is partitioned into segments. Each segment will have either equal or unequal node density. If there will be unequal node density then a local coordinator will be selected according to centralized scheduling. In centralized scheduling, the vehicle which is near to the center of the segment and other vehicles in that segment is chosen as the local coordinator. This local coordinator will decide the time slots for other vehicles in that segment. Whole scheduling of time slots is done by that local coordinator. Each segment will have number of transmission periods during which vehicles will transmit beacons.

### B. Periodic beacon transmission

In each segment every vehicle will generate beacons periodically. Each vehicle broadcast a beacon message to its neighbors. Beacons are the normal periodic status messages about vehicle speed, velocity, id location etc. This is achieved by processing the position and speed information received from vehicles in the last beacon interval.

### *C. Congestion Detection and adaptive congestion control*

When large number of vehicles transmits beacons at a higher frequency then bandwidth can be exhausted very easily. As a result significant number of packet collision occurs. And in a scenario of emergency message, if the channel is already congested then highly life-critical even-driven message which will be deprived of channel access will either get lost or delivered to its intended recipients with a much higher delay. Thus loss of beacons and emergency message will severely affect the safety of a vehicle. The vehicle density is very high then channel will get congested easily. So, congestion in the communication channel should be detected. After congestion detection, if there is any emergency message then we will provide dynamic time slot reservation to the vehicle which generates emergency message. This can be done by pulse based reservation system in the communication channel. The proposed approach can adaptively control congestion in the communication channel.

### *D. On time safety message transmission*

On time safety message transmission follows the mechanism of sending the beacon only when a vehicle is moving from one segment to another segment. No beacon is sent if the vehicle resides in same segment. On time safety message transmission reduces the congestion in the network and emergency messages are easily transmitted without any delay.

### *E. Simulation parameters*

| | |
|---|---|
| SIMULATOR | Network Simulator 2.35 |
| NUMBER OF NODES | 37 |
| TOPOLOGY | 452m x 452m |
| FIXED SETUP | RSU, Vanet Authority |
| INTERFACE TYPE | Phy/WirelessPhy |
| MAC TYPE | 802.11 |
| QUEUE TYPE | Droptail/Priority Queue |
| QUEUE LENGTH | 50 Packets |
| ANTENNA TYPE | Omni Antenna |
| PROPAGATION TYPE | Two Ray Ground |
| ROUTING PROTOCOL | AODV |
| TRANSPORT AGENT | UDP |
| APPLICATION AGENT | CBR |
| SIMULATION TIME | 100 seconds |

## V. CONCLUSION

In this paper, we have discussed about congestion problem which is one of the major challenges in VANETs. This issue is affected by the limited bandwidth in VANET standard, IEEE 802.11p. Although there are many congestion control based MAC protocols designed to monitor and regulate the traffic levels, but still there are many challenges that need to be solved in vehicular ad hoc network in this regard. So, with the help of the proposed approach, whenever there is a problem of congestion and emergency message occurs, the adaptive congestion control can reserve time slots by dynamically partitioning the beacon interval without the expense of beacons.

## ACKNOWLEDGMENT

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