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# PBMAC – Position Based Channel Allocation for Vehicular Ad Hoc Networks

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**ABSTRACT**

**In Vehicular ad hoc networks road safety and traffic management applications required stable communication channel with minimum disturbances. In vanets vehicles used bandwidth to forward packets towards destination with the help of relay nodes. While exchanging information there are chances of collisions due to improper bandwidth allocation in a network. Some applications such as safety and traffic management required consistent channel conditions. However the design of an efficient medium access control (MAC) is a challenging task due to dynamic topology changes. The existing cluster based TDMA MAC protocols used traffic loads for bandwidth allocation in such a manner position of vehicle in the cluster is not considered. As part of that, vehicles located at end of cluster region can request for channel, as consequence the cluster head (CH) allocates bandwidth based on traffic loads. In this case vehicles are not in a stage to use total reserved slot allocated for usage, because in short span vehicles move to next cluster region, it shows inefficient allocation of channel. In this paper we proposed an efficient approach for allocation of bandwidth which depends on vehicle position in cluster. Here vehicles at starting position can get more bandwidth when compare to end position vehicles. The simulation shows position based bandwidth allocation where the channel is allocated based on effective and reduces collisions as result improves overall network performance.**

Keywords -– **Vanets, collision free, cluster and position based MAC, QoS, and Queue theory.**

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## I. INTRODUCTION

Due to advancement in transport technology, VANETS have attracted great interest from both industry and research area. The key idea behind Vanets is to build intelligent transport system to enhance safety driving, entertainment services and traffic optimization [1]. VANET provides Vehicle-Vehicle (V2V) communication and vehicle-infrastructure (V2I) communication and is defined as a group of vehicles that are dynamically establishing a network without any existing infrastructure. The vanets consists of set of vehicles inbuilt communication device called On-Board Units and Road-Side Units, which is used to communicate with vehicles. Another dimension of VANET uses Dedicated Short Range Communication (DSRC) with 5.9 GHZ bandwidth particularly for V2V and V2I [2]. Due to this dynamic nature, there exists frequent disconnection of links between vehicles, which leads to delay that affects network performance. The Medium Access Control (MAC) Protocol share common channel for sending and receiving the data between nodes. However inefficient usage of channel may lead to collisions, waste of bandwidth and delay. In general MAC protocols are broadly classified into two categories Contention-based and Contention-free [3]. In Contention-based approach every node requests for bandwidth to transmit data. In Contention-free approach the channel is pre-allocated like TDMA and FDMA where the medium becomes reserved It is necessary to design an efficient MAC protocol which plays major role that satisfies Quality of Service (QoS) requirements. Several contention-free protocols have been proposed which uses IEEE 802.11p standard with different frequency band or time slots assigned to each vehicle in a given channel. An interesting area of research in the field of VANETs is TDMA based MAC protocols where time slots are divided and distributed to all vehicles. Only one vehicle must access channel at each time slot. Existing MAC protocols like VESOMAC [4],VC-MAC[5], and ACFMAC [8] used traffic load, congestion and free slots information to allocate bandwidth for nodes, all above protocols provides channel access without collisions but still there are some issues to consider because in cluster networks cluster head (CH) is responsible for allocating bandwidth to members.CH collects requirement from members and dynamically assigns channel for their usage. However vehicle at end position of cluster cannot use channel fairly. Bandwidth is again re-allocated or wasted if vehicle moved to another cluster. To address this issue we propose PBCMAC system uses position information of vehicle in cluster i.e. vehicles between starting to middle position in cluster

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allocated maximum requested bandwidth, whereas vehicles between middle to end position get calculated bandwidth based on duration in cluster.

## II. STATE- OF-THE-ART

In research [4] VESOMAC self-organising MAC protocol supports dynamic topology changes with fast slot rescheduling. Such environment mainly applicable for cooperative collision avoidance applications (CCA) (E.g.: an accident). This protocol efficiently used for highway safety applications. In research [5] VC-MAC a cooperative information downloading network is formed into group of clusters. These clusters depend on the direction of vehicles used for large volumes of data transmission. It contains cluster head and cluster members where they can communicate directly to each other. Here, nodes add acknowledgment after receiving message. If any node fails to receive message, Node ID is added to a list which contains nodes that have not received any message. Finally, cluster head sends the message in ideal slots. In research [6] DMMAC uses CCH time and is divided into Adaptive Broadcast Frame (ABF), Contention-based Reservation Period (CRP), and a node dynamically reserves time slot. DMMAC uses a dynamic TDMA mechanism for basic channel reservation. In research [7] Vanets Coordinator is elected through a transmit and listen method. Here, CBT provides nodes to dynamically choose a slot for bandwidth request. Inter-cluster communication is used to share information between group of clusters and intra cluster communication is used to share bandwidth, control signals and necessary information with in cluster. In research [8] used adaptive collision free MAC protocol based on time division multiplexing access. ACFM guarantees fairness in packet delivery ratio and network throughput. RSU allots slots for vehicles dynamically based on its coverage. However, when the traffic in a particular region is thin then ACFM will minimise assignment of slots. On other side, if the traffic is high the ACFM could expand the slots. ACFM adaptively changes slot assignment according to the density of vehicles in its coverage. In research [9] VEMAC protocol also called multi-channel TDMA protocol, which reduced the broadcast collisions due to high node mobility using disjoint sets. VEMAC allots disjoint sets of time intervals to vehicles moving in opposite directions and to road side units. In research [10] CAHMAC intermediate nodes used as co-operative nodes to transfer packets to the destination using unreserved time slots. It aimed to improve packet transmission probability. If failure occurs between source and destination an intermediate node takes responsibility to carry the packet to the destination by using unreserved time slot. Therefore, here efficient use of unreserved time slots for retransmission improves network throughput.

In research [11] ATSA vehicles chooses a frame length and compete for time slots available in its direction. It uses binary tree algorithm to avoid collisions and unbalanced traffic conditions. In research [12] STDMA self-organising time division multi access used to support highway traffic with periodic packets broadcasting. This protocol provides fair and predictable way communication channel. This decentralised approach contains initialisation, network entry, and frame allocation, operation phases for channel allocation uses position information and uses four phases to allot the channel Initialisation.

In research [13] HERMAC (Hybrid Efficient and Reliable) used dynamic TDMA slot allotment. It uses both TDMA and CSMA access methods. It provides safety message broadcast with TDMA access method in the reserved time slot to increase the reliability.

In research [14] VERMAC, priority is given to emergency packets (EMG), this protocol increases the EMG broadcast reliability. It uses control channel (CCH) and six service channels (SCH) to enhance service throughput. The VERMAC uses CCH during the SCHs for broadcasting the EMG packet and each periodic or event EMG packet is send twice to increase packet delivery ratio.

In research [15] DTMAC used accurate geographic position of the vehicle (direction, speed and time) and vehicle synchronisation performed by using GPS. It also added features VEMAC protocol such that the channel time is divided into frames. Here the motivation is to minimise access collision and achieve high throughput.

## III. PROPOSED METHODOLOGY

In this section we present position aware bandwidth assignment in cluster based vehicular ad hoc networks, now a day's cluster networks gains lot of attention for vanets due to fair channel allocation between nodes and also effectively handles dynamic topology changes.

In cluster one node is selected as coordinator that is responsible for slots assignment and making coordination inside cluster members.

Collision can occur while two nodes in cluster try to access same channel at a time this happens when limited bandwidth shared among multiple nodes, sometimes bandwidth unused if node moves out of cluster without utilizing given slot.

In contrast, proposed approach focused on position of node for channel allocation.The main intention is to analyse and assign optimal bandwidth for all nodes in cluster depends on exact usage irrespective of the channel request.

In such methodology, initially cluster head (CH) analyses bandwidth which is needed for all members and same is requested on RSU for bandwidth and then RSU connected to base station.

Later CH efficiently shares channel among nodes that are allotted by RSU, similarly all cluster heads can performs the same.

In General for cluster with more vehicles time frame i given as

$$C_{Max}(i) = n-T_i * ([n/T_i]) \dashrightarrow \quad (1)$$

$C_{Max}$ – no of clusters

$T_i$ – Time frames

n – size of available bandwidth

cluster with less number of vehicles

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$C_{Min}(i) = T_i *( [n/T_i] ) - n$ ------→(2)

RSU allocates bandwidth to cluster head computed by (1) and (2).Every node in vanets inbuilt with global positioning system which provides accurate position, direction and velocity information timely update the CH table. Using table information CH take decisions. In our approach cluster is divided into two zones namely green and orange.

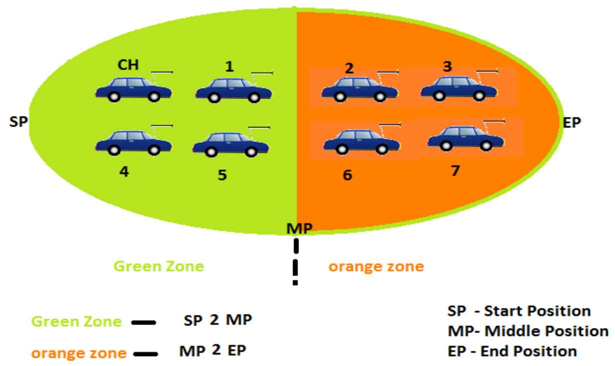


Fig.1 proposed system model.

| Node ID | Zone | Direction | speed | Required bandwidth |
|---|---|---|---|---|
| 2 | orange | right | 13.56,2.92m/s | 10MHz |
| 3 | orange | right | 14.56,2.92m/s | 15MHz |
| 4 | green | right | 15.56,2.92m/s | 9MHz |
| 5 | green | right | 12.56,2.92m/s | 10MHz |

TABLE 1. CH Table information.

Two queues are used and maintained by CH, in which green queue stores information about vehicles in between start position and middle position, similarly orange queue maintains vehicles information in between middle position and end position as shown in Fig 2. CH1 contains 3 Vehicles in green queue and 4 vehicles in orange queue.

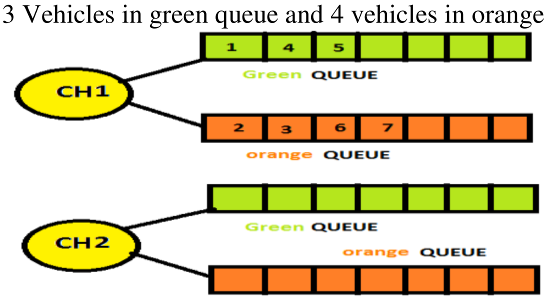


Fig 2. Proposed system Queue Model.GQ – *green queue,* OQ-*orange queue,* CH – *cluster head.*

Here our motive is to assign maximum slots for vehicles in GQ than vehicles in OQ irrespective of their requests, so that bandwidth would not waste. In such way, they stay more time in cluster and uses slots efficiently when compared with vehicles in OQ. So for optimal channel allocation between cluster member's combination of round robin and priority scheduling algorithms are used. Finally this method achieved acceptable performance and computation also avoids drawbacks of existing timeslot allocation techniques.

## IV. ALGORITHM

*/* fair round robin & priority technique*
*to allocate channel for all vehicles */*

*Var veh [max],* $BW_{req}$ *[max] : initial vehicle vector.*
*Var* $T_i$ *: Time slots index.*
*Var n : size of available bandwidth.*
*Var GQ [max], OQ [max] : queues to store vehicles based*
*on regions.*
*Var* $Bw_{req}$*,* $Bw_{assg}$ *: bandwidth request and assign.*
*Var CH : cluster head.*
*do*
*{*
*//CH stores all bandwidth requests BWreq [max] w.r.t*
*Veh [max].*
*For (i=1 to max) Initial slot allocation*
*{*
*Veh[i] = min slot..*
*}*
*// Calculating actual channel requirement and assign slots for each vehicle.*
*While (1)*
*{*
*J=1;*
*If (pos[i] <MP)*
*// checking position of each vehicle in table given by GPS.*
*{*
*GQ[j] =Veh[j].*
*//Assign two continuous channel slots.*
*Given Priority for vehicles in GQ.*
*}*
*else*
*{*
*OQ[j] =Veh[j].*
*// Assign one channel slot.*
*}*
*j++;*
*}*
*} While (end);*

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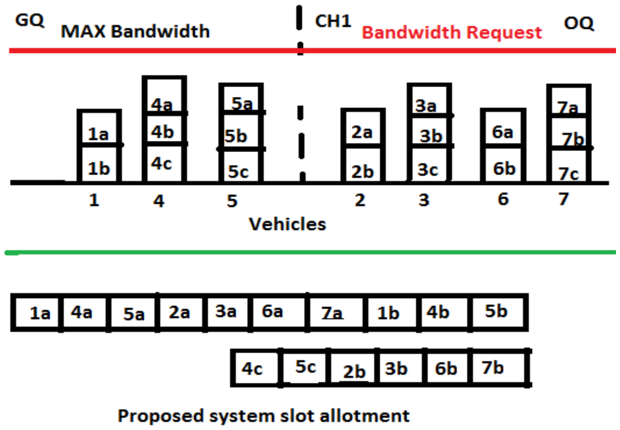



Fig 5. Bandwidth allocation between vehicles

## V. SIMULATION ENVIRONMENT

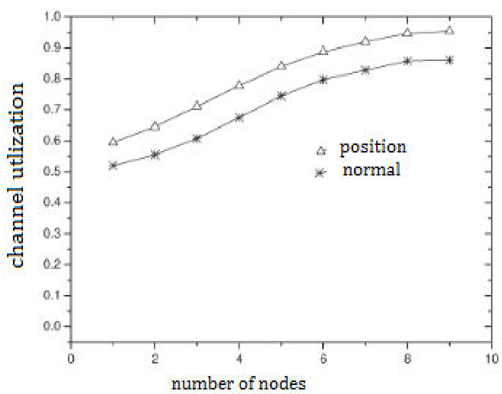
| Factor | Range of Values |
|---|---|
| **Simulation Area** | **1.2 * 1.2 km²** |
| **Inter vehicle distance** | **20m** |
| **No. of Vehicles** | **300** |
| **Communication range** | **100-300m** |
| **No. of vehicles in one cluster** | **Max 20** |
| **Vehicle speed** | **10-60 mph** |

TABLE 2. Simulation parameters and range of values

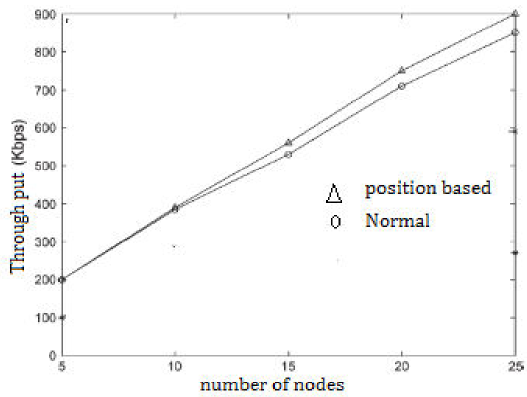
## VI. RESULTS

This section shows results of our proposed system verified on NS2 simulator. Simulation results shows clearly that proposed method improves performance in terms of throughput, packet delivery ratio,collision rate is reduced and channel usage is very fair because allocation of slots totally depends on position so that vehicles at starting position will get more slots dynamically compared to end position in cluster. Graphs shows QOS metrice performaces increased interms of Throughput and Channel utlization, End to End delay is reducd overall transmission probability is maximized.

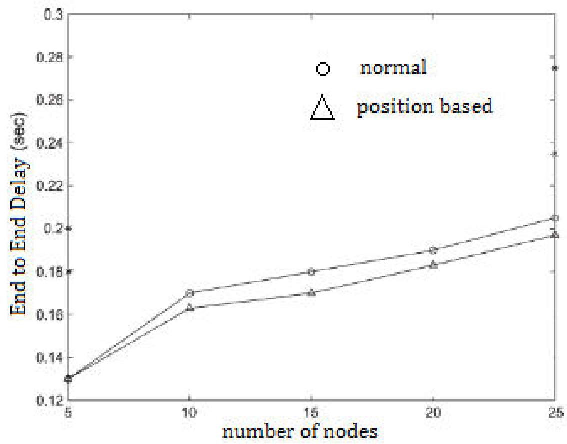
*Graph1. Channel Utlization Metric*



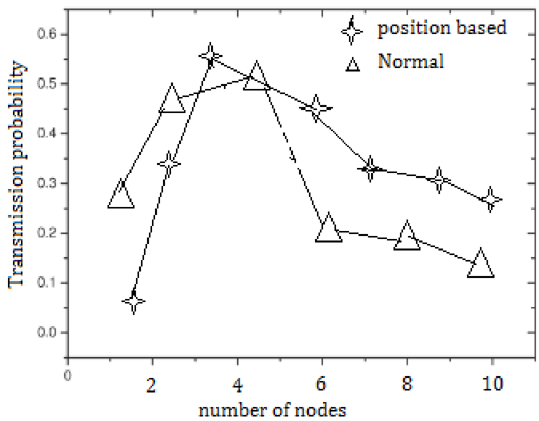

*Graph 2. Through Put Metric*




*Graph 3. End to End Delay Metric.*




*Graph 4. Transmission Probability Metric*



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## VII. CONCLUSION

Efficent channel utlization is required in VANETs because node mobility is high also topology changes frequently. In order to improve QOS requirements in this paper we proposed position based slot assignment protocol for cluster based vehicular Adhoc network, which assigns bandwidth slots effectively based on vehicle position in cluster.The simulation results shows that the PB-MAC outperforms in aspects of channel utlization,Throughput,End to End delay is reduced and overall network performances is increased.

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