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# A PROFICIENT TIME SLOT ATTAINMENT ON THE HYBRID TDMA / CSMA MULTI-CHANNEL MAC IN VANETS

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**Abstract -** The multi-channel MACs increment the throughput and lessen the crash likelihood contrasted with the single channel MACs However, coordination of different hubs crosswise over multi-channels is non-trifling. As of late, a multi-channel MAC, Called HER-MAC, utilizes both TDMA and CSMA plans to improve dependability in communicating wellbeing messages and proficiency in administration channel usage. By the by, HER-MAC languishes a high crash likelihood over an expansive number of vehicle hubs .In this paper, we propose a half and half TDMA/CSMA multi-channel MAC convention for VANETs that permits effective telecom of messages and builds throughput on the control station .Further, our proposed MAC disposes of pointless control parcel, for example, HELLO and SWITCH bundles in HER-MAC .Analysis and reproduction results demonstrate that the proposed MAC can give quicker vacancy securing on the control station than HER-MAC.

***Key Words:*** *VANET, HER-MAC, multi-channel MAC*

## 1. INTRODUCTION

One purpose of the Intelligent Transportation System (ITS)is to improve the quality and effectiveness of safety messages in the future transportation systems. Vehicular Ad Hoc Networks (VANETs) are an important component of ITS .Each vehicle is equipped with a radio interface, called an on board unit(OBU). A set of stationary units along the road called Road Side Units (RSUs) allows vehicles to connect to the Internet. VANETs support two communication type : Vehicle-to-Vehicle (V2V) and Vehicle-to-RSU (V2R). They can support a variety of safety applications and non-safety applications, and provide comfort to drivers and passengers .Dedicated Short Range Communications (DSRC) is exclusively used by V2V and V2R communications. The DSRC spectrum is divided into seven channels: one Control channel(CCH) and six Service channels (SCHs). The CCH is used for high priority safety applications and network management .Service Channels mainly support the non-safety information and entertainment applications .To provide timely and effective safety applications, the Medium Access Control (MAC) protocol needs an efficient broadcast service for safety messages. In addition, the multichannel MAC protocol is proposed to ensure reliable transmission of safety messages by using interleave operation CCH and SCH and priority access parameter. Some multichannel protocols are proposed to increase the safety broadcast reliability. Performance matrices for multi-channel protocol are the collision probability and the throughput. A collision probability is defined as an event where more than one node transmit at the same time slot. When a collision occurs, the nodes must re-transmit the collided packets. This causes more delay. Thus, the collision probability is important of safety message application and in this paper, we focus on the reducing the collision probability of safety messages on the control channel .The basic multi-channel MAC is similar to IEEE 802.11 Distributed Coordination Function (DCF) and Enhance Distributed Channel Access (EDCA). The EDCA can map the traffic which has different priorities or different virtual stations and assign different channel access parameters to each virtual station. However, this schemes has a drawback in supporting throughput-sensitive non-safety applications has been proposed for a default multichannel MAC standard for VANETs, as shown in Fig. 1c. In IEEE 1609.4, nodes broadcast safety messages or negotiate the SCHs on the CCH during the Control Channel Interval(CCHI). In the Service Channel

Interval (SCHI), nodes switch to the negotiated SCHs for their non-safety messages transmissions .This scheme has a high contention rate during the CCHI and the SCHI resources cannot be util.

1. **HTC-MAC PROTOCOL sized during this interval**

We assume that each node has one transceiver which can switch between CCH and SCHs. Each node must be on the CCH in order to broadcast safety message or exchange WSA/RFS message. For safety application, each node must acquire exactly one time slot in the TDMA-based reservation period. As such, each node must transmit an announcement packet (ANC) on the reservation period2, the ANC packet contains seven fields: (i) Node ID, (ii)its reserved time slot, (iii) switched time slot, (iv) a number of time slots, (v) IDs of neighbor nodes, (vi) time slot are allocated by neighbor nodes, (vii) safety application packet .Once a node acquires a time slot, it keeps accessing the same slot on the TDMA-based reservation period if its transceiver is not tuned to the service channel to receive or transmit non safety application packets .Considering ANC payload size of $S$ bytes and a transmission rate of $R$ Mbps, the ANC packet requires a transmission time of $t\ payload = (S\_8)=R$. The sum of the guard periods, the preamble and the physic layer header is $t\ add$. Then, a time slot i$t\ slot = t\ payload + t\ add$ . We assume that there are $K$ nodes which broadcast in the reservation period. Hence, the reservation period is $TRE = K\_\ slot$ . When the node density is high, the payload size $S$ increases because the neighbor information field becomes bigger. The reservation period $TRE$ also increases and the contention period ($TCON = 50ms$ □ $TRE$) will be decreased. Consequently, the collision probability wili increase due to many nodes attempt to broadcast packets in as small contention period.

## 3. ANALYTICAL MODEL FOR TIME SLOT ACQUISITION

### *A. Markov chain in HTC-MAC*

For comparison with HER-MAC, we determine the average number of nodes which acquire a time slot within a sync interval and the probability that all the nodes acquire a timeslot within $n$ frames. Let $K$ denotes the number of contending nodes in 2-hop neighborhood because if nodes are located at least three hop away, they can reuse the same time slot [7].The Markov chain of HTC-MAC is inherited from the MAC, as shown in Fig. 3a. Let $N$ be the number of initially available time slots in a sync-interval, and be the total number of nodes which acquire a time slot within $n$ sync interval. $X$ is a stationary discrete-time Markov chain with the transition probabilities illustrated in Fig. 3a.In this paper, we consider the case where $K\_\ N$. For the case $K > N$, it is useful to determine an optimal value for a number of time slots on the reservation period. Let $P$ be the one-step transition probability matrix, and $Pn$ be the $n$-step transition probability matrix. Then ,$p( Xn = i) = Pn1;i+1;\ i = 0;\ :::;K:$ (1)The probability that all nodes acquire a time slot within $n$ sync interval is $Falln\ ;\ HTC$□$MAC = p(Xn = K) = Pn1;K+1:$ In this paper, we consider the case where $K\_\ N$. For the case $K > N$, it is useful to determine an optimal value for a number of time slots on the reservation period. Let $P$ be the one-step transition probability matrix, and $Pn$ be the $n$-step transition probability matrix. Then,

***p* (*Xn* = *i*) = *Pn***

**1*;i*+1*; i* = 0*; :::;K:* (1)**

The probability that all nodes acquire a time slot within $n$ sync interval is

*Fall*

$n;HTC$□$MAC = p(Xn = K) = Pn$

$1;K+1:$ (2)

Let $Y$ be the average number of nodes which successfully acquire a time slot within $n$ frames. Then, we have

$E[Yn] = \Sigma K$

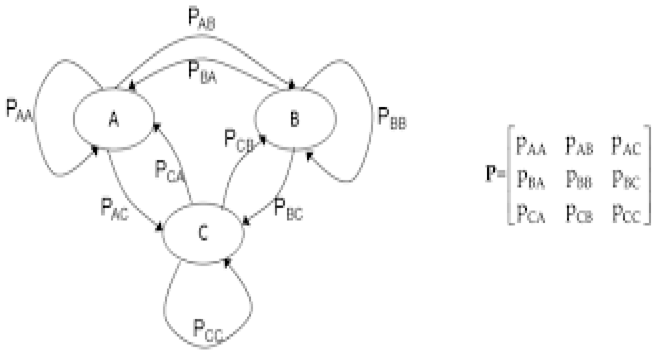
$i=0,\ iP\ n$

$1;i+1:$

***B. Markov chain in HER-MAC***

In this section, we determine formulas of the average number of nodes which acquire a time slot within a sync interval and the probability that all the nodes acquire a timeslot within *n* frames in HER-MAC. From the Markov chain [9] it is clear that the probability _ that a node transmits a HELLO or safety application packet in an arbitrary time slot can be expressed as

Let *p* be the collision probability when more than one node transmit at the same time slot. Hence, we have Consequently, based on (4) and (5), variable _ and *p* can solved by the numerical methods as in [9].Note that 0 _ *p* _ 1and 0 _ _ _ 1.In every time slot during the HELLO interval, an agreement will be successfully made with probability *p suc*, thus, we have *p suc* = *K*_ (1 □ _ )*K*□1*:* (6)In the *p*-persistent CSMA/CA, the back off interval is based on the geometric distribution with probability *p suc* [10].



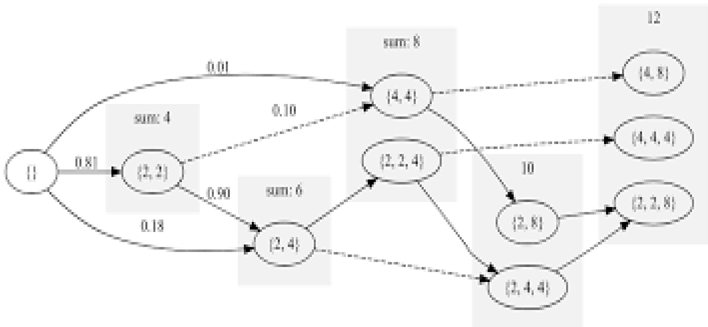




Fig. 3.1 Markov chain in HER-MAC

**4. PERFORMANCE EVALUATION**

To validate HTC-MAC, we use an event-driven simulation program written in Mat lab. For comparison with HTC-MAC, we also simulate HER-MAC where a HELLO packet configured to use Access Class 3 (*AC*3)with *CW* = 8 and *CW* = 4 due to it is a safety message using the highest priority scheme [11]. In Fig. 4, we compare HTC-MAC with HER-MAC for *CW* = 8 and *CW* = 4 in a dense scenario (*N* = 20*; K* = 10). In HER-MAC, if nodes use *CW* = 8, all nodes can successfully acquire a time slot after6frames.However, nodes using *CW* = 4 need 12 frames to successfully acquire a time slot. In the same condition, in HTC-MAC, after5 frames, all nodes have successfully acquired their time slots. Using Eq. (10) and (2), the probability that all nodes acquire time slots within *n* frames is presented in. The averagenumber of nodes which successfully acquire a time slot and *Fall* have same results. Hence, the rate of successful time slot acquisition can be shown by using the probability or average number of nodes which acquire a time slot. we evaluate Eq. (5) and (10) with the same the number of available time slots, *N* = 20. We take the average number of nodes which acquire a time slot within each frame by running 100 times. In addition, in Eq. (10), we take the floor function */E*[*Xi*]*/*. Hence, the average number of nodes which acquire a time slot within 3 frames as shown

in Fig. 6 with K= 5 and K = 10, which are close together. Consequently, than also close together as shown in Fig. 5. If we take the ceiling
function /*E*[*Xi*] /, the rate of time slot acquisition is faster than taking the floor function .In Fig. 6, we fix the number of available time slots and vary the number of contending nodes, *K*. For comparison, we simulate HER-MAC with its best performing parameter ,*CW* = 8. If *K* is 5, HTC-MAC and HER-MAC have the same rate of successful time slot acquisition. When *K* increases,the rate of successful time slot acquisition in HTC-MAC Is higher than HER-MAC. When*K* equals *N*, the collision probability when more than one node transmit at the same time slot in Eq (5) increases. Hence, the probability that all
*p*[*Xi* = *E*[*Xi*]] =8>><>>:0*;*

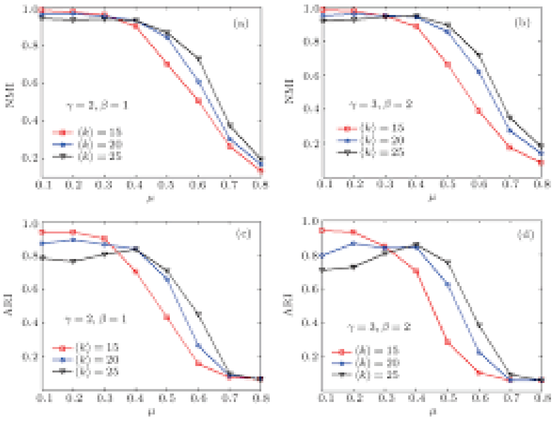


Fig. 4.1 Performance Evaluation

## 5. CONCLUSION

In this paper, we propose an efficient time slot acquisition on the hybrid TDMA/CSMA mutli-channel MAC in VANETs. HTC-MAC not only eliminates unnecessary control overhead but also increases the throughput on the control channel. The analysis and simulation results prove that HTC-MAC outperforms HER-MAC in terms of the average number of nodes which acquire a time slot. However, HTC-MAC requires a larger ANC's payload size to broadcast its neighbors' information when the node density is high.

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