Proficient transmit Services Using MAC Protocol in vanets

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***Abstract*— The need of a medium access control (MAC) protocol for aresourceful broadcast amenity is of great importance to supportthe high urgency safety applications in vehicular ad hoc networks (VANETs. Existing VeMAC, a different multichannel TDMAMAC protocol proposed unambiguously for a VANET development. The VeMAC supports resourceful one-hop and multi-hop broadcast services on the control channel by using containedheadings and rejecting the hidden terminal problem but it can useonly the one way time slot on the control channel, so we propose Packet arrangement multiple access (PRMA) can be observed asa fusion of the slotted ALOHA protocol and time division multiple access (TDMA). Disseminated terminals transmit packets of speech evidence to a crucial base station. When its speech activity gauge signposts the beginning of a talk emission, a terminal copes with other terminals for access to avacant time slot.**

***Keywords*— VeMACprotocol, TDMA, ALOHA Protocol.**

I.INTRODUCTION

An ad hoc network is defined as a collection of nodes vigorously forming a network withoutany existing infrastructure or centralized administration. One special type of mobile ad hoc networks is thenetwork among moving vehicles, which is known as vehicular ad hoc network (VANET). A VANET consists of a set of vehicles equipped with a communiqué device, called on-board unit (OBU), and a set of stationary units along the roads, called road side units (RSUs), which can be connected together and/or to the Internet via wireless or wireline links. Each OBU has a radio interface to connect to other OBUs and RSUs, as well as a wireless or wired interface to which an application unit can be attached. The main objectives of VANETs are to provide efficient vehicle-to-vehicle (V2V) and vehicle-to-RSU (V2R) transportations. Based on these two kinds of transportations, VANETs can support many applications in safety, entertainment, and vehicle traffic optimization [2], [3]. Motivated by the importance of vehicular transportations, the United States Federal Communiqué Commission (FCC) has allocated 75MHz radio spectrum in the 5.9GHz band for Dedicated Short Range Transportations (DSRC) to be exclusively used by V2V and V2R transportations. The DSRC spectrum is divided into seven 10MHz channels: six service channels for safety and non-safety related applications, and one control channel for transmission of control evidence and high priority short safety messages. Most (if not all) of the high priority safety applications proposed for VANETs are based on one-hop broadcast of evidence. For instance, for V2V communiqué based applications such as the pre-crash sensing, blind spot warning, emergency electronic brake light, and cooperative forward collision avoidance, each vehicle periodically broadcasts evidence about its position, speed, heading, acceleration, turn signal status, etc, to all the vehicles within its one-hop neighborhood [2].Similarly, for V2R communiqué-based applications, such as the curve speed warning and traffic signal violation warning, an RSU periodically broadcasts to all the approaching vehicles evidence related to the traffic signal status and timing, road surface type, weather conditions, etc [2]. As the precision of the safety applications is directly related to the safety of people on road, the need of a medium access control (MAC) protocol which provides an efficient broadcast service is crucial for VANETs.

Various MAC protocols have been proposed for VANETs, based either on IEEE 802.11 or on channelization such as time division multiple access (TDMA), space division multiple access (SDMA), and code division multiple access (CDMA). In SDMA schemes, each vehicle decides whether or not it is allowed to access the channel based on its location on the road [4], [5]. An SDMA scheme consists of three main parts: a discretization procedure which divides the road into small areas called cells,a mapping function which assigns to each of the cells a unique time slot, and an assignment rule which specifies which time slots a vehicle is allowed to access based on the cell where it is currently located. Similarly, CDMA is proposed for MAC in VANETs due to its robustness against interference and noise [6], [7]. The main problem which arises with CDMA in VANETs is how to allocate the pseudo noise (PN) codes to different vehicles.

Due to a large number of vehicles, if every vehicle is assigned a unique PN code, the length of these codes will become extremely long, and the required bit rates for VANETapplications may not be attained. Consequently, it is mandatory that the PN codes be shared among different vehicles in a dynamic and fully distributed way [7]. On the other hand, the IEEE 802.11p is a recently proposed MAC standard for VANETs [8]. The protocol is based on the legacy IEEE 802.11 standard [9] which is widely implemented, but does not provide an efficient broadcast service. The reason is that, for broadcast frames, no RTS/CTS exchange is used and no acknowledgement is transmitted from any of the recipient of the frame [9].

This lack of RTS/CTS exchange results in a hidden terminal problem which reduces the frame delivery ratio of the broadcast service, especially with the absence of acknowledgement frames [10]. Another limitation is that, in a VANET scenario, by employing the enhanced distributed channel access (EDCA) scheme defined in the IEEE 802.11 standard, the high priority safety messages will be assigned to the high priority access categories (ACs) which contend for the wireless channel using a small contention window size [9].Although this small contention window size allows the high priority safety frames to be transmitted with small delays, it increases the probability of transmission collisions when multiple nodes within the same communiqué range are simultaneously trying to broadcast their safety messages [11].

Moreover, unlike the unicast case, the size of the contention window is not doubled when a collision happens among the broadcasted safety messages since there is no collision detection for the broadcast service without CTS and acknowledgment frames [9].

As well, the ADHOC MAC provides a multi-hop broadcast service which can cover the whole network using a significantly smaller number of relaying nodes than that using a flooding procedure. Moreover, in ADHOC MAC, each node is guaranteed to access the channel at least once in each virtual frame, which is suitable for non-delay-tolerant applications. However, simulation results show that, due to node mobility, the throughput reduction can reach 30% for an average vehicle speed of 50km/h [13]. Another major limitation of ADHOC MAC is that it is a single channel protocol,not suitable for the seven DSRC channels.

Existing paper presents VeMAC, a novel multichannel TDMA protocol developed based on ADHOC MAC [12] and designed specifically for VANETs. On the control channel, the protocol provides a reliable2 one-hop broadcast service without the hidden terminal problem as well as an efficient multi-hop broadcast service to disseminate evidence all over the network. The VeMAC assigns disjoint sets of time slots to vehicles moving in opposite directions and to RSUs, and hence can decrease the rate of transmission collision on the control channel caused by node mobility.

As well, the VeMAC employs new techniques for the nodes to access the available time slots and to detect transmission collisions. These techniques are different from the ones used by ADHOC MAC, which have some limitations as to be discussed in details. It is shown that the proposed VeMAC protocol provides significantly higher throughput on the control channel than that of ADHOC MAC and ADHOC-enhanced (an enhanced version of ADHOC MAC introduced in this paper).

This paper describes the packet arrangement multiple access (PRMA) technique for organizing the flow of evidence from dispersed terminals to a central base station ***[6].*** A close relative of arrangement ALOHA [7], PRMA may be viewed as a combination of slotted ALOHA and time division multiple access (TDMA). As in slotted ALOHA, terminals with new evidence to transmit contend for access to the shared channel. Upon successfully contending for channel access, a terminal that generates sequence of packets obtains a arrangement for uncontested use of subsequent time slots.

The terminals with arrangements thus share the channel as in TDMA. The purpose of this paper is to explore the capacity of PRMA to convey speech packets from dispersed terminals to a central base station. We view PRMA as a statistical multiplexer operating at the physical layer (medium access control) and the data link layer of the open system interconnection protocol **[8].** The purpose of the data link layer is to ensure reliable communiqué of packets from one terminal node to another. In data transmission, reliable communiqué implies error-free evidence delivery. Data systems respond to network congestion by delaying the delivery of data packets.

II.PACKET ARRANGEMENT MULTIPLE ACCESSES (PRMA)

PRMA is designed for a two-way wireless transportations network with a star topology. It enables dispersed terminals to transmit packetized evidence over a shared channel to a base station. While PRMA controls the upstream traffic, the base station broadcasts a continuous stream of packetized evidence to the terminals. Because of the continuous nature of the base to- mobile transmission, there are no guard times required between packets, and less synchronization evidence required in each packet. If the time slots are of equal duration in both directions, downstream packets can carry more evidence than upstream packets. In PRMA, this additional capacity will be used to carry the feedback evidence described in Section 11-B.

A. In formation Categories

Terminals can send two types of evidence, referred to as “periodic” and “random.” Speech packets are always periodic. Data packets can be random, if they are isolated; or periodic, if they are part of a long stream of evidence. The packet header specifies the nature of the evidence in a packet.

B. Feedback

Feedback evidence is multiplexed into the continuous signal stream broadcast by the base station. Each downstream packet is preceded by feedback based on the result of the most recent upstream transmission. If the base is able to decode the header of an arriving packet, the feedback identifies the terminal that sent the packet to the base. The feedback also indicates whether the upstream packet contains periodic or random evidence. If the base is unable to decode the header of an arriving packet, the base broadcasts a negative acknowledgment (NACK) to indicate this result. The base need not indicate why it is unable to decode an arriving header. Possible reasons are: no packet transmitted; more than one packet transmitted; one packet transmitted but impaired by adverse channel conditions.

C. Channel Access

1) Frames and Slots: The transmission time scale is organized in frames, each containing a fixed number of time slots. The frame rate is identical to the arrival rate of speech packets. The terminals classify each slot **as** either “reserved” or “available” according to the feedback message received from the base at the end of the slot. In the next frame, a reserved slot can beused only by the terminal that reserved the slot. An available slot can be used by any terminal, not holding a arrangement, that has evidence to transmit to the base.

2) Arrangements: When it begins to generate periodic evidence, a terminal contends for the next available time slot. Upon detecting the first packet in the evidence burst, the base station grants the terminal a arrangement for exclusive use of the same time slot in the next frame. At the end of the evidence burst, the terminal transmits nothing in its reserved slot. This stimulates a NACK feedback message from the base indicating that the slot is once again available. Although the frame rate corresponds to the speech packet rate, PRMA can also transmit multiple packet data messages. If the data packet rate is higher than the speech packet rate, a PRMA periodic data terminal will contend for more than one arrangement per frame.

3)***Collisions:*** It is possible that when a terminal transmits the first packet of a burst, another terminal will simultaneously transmit a packet. When such a collision occurs, the base station may fail to detect either packet, in which case both terminals will have to retransmit the packets involved in the collision. On the other hand, when colliding packets arrive at the base withsubstantially different signal levels, the base is sometimes able to detect the packet with the strongest signal. This is referred to as packet capture. Although capture improves PRMA performance **[12],** we ignore its effects in our analysis and assume that all colliding packets require retransmission.

4) Contention and Packet Dropping: To transmit a packet, a terminal must verify two conditions. The current time slot must be "available," rather than "reserved"; and, the terminal must have permission to transmit. Permission is granted according to the state of a pseudo random number generator. (Permissions at different terminals are statistically independent.) The terminal attempts to transmit the initial packet of a burst until the base station acknowledges successful reception of the packet, or until the packet is discarded by the terminal because it has been delayed too long. The maximum packet holding time, ***D,,***s, is determined by delay constraints on speech communiqué. ***D,***is a design parameter of the PRMA system. If a terminal drops the first packet of a burst, it continues to contend for a arrangement to send subsequent packets. It drops additional packets as their holding times exceed the system delay constraint. Terminals transmitting periodic data packets store packets indefinitely while they contend for arrangements. Thus**,** they effectively operate with ***D,,***= **Q)** as in arrangement **ALOHA.**Therefore, when a PRMA system becomes congested, the speech packet dropping rate and the data packet delay both increase. Random evidence packets also contend for available time slots. However, when the base station receives a random evidence packet, it does not grant the originating terminal a arrangement for exclusive use of a time slot in the next frame.

D. mects of Network Congestion

PRMA is a form of statistical multiplexing. As such, its effectiveness in granting channel access to a set of terminals is subject to the fluctuating rates of evidence generated at the terminals. When traffic builds up, there are significant numbers of packet collisions and terminals encounter delays in gaining access to the channel. Data sources absorb these delays as performance penalties. Conversations, however, require prompt evidence delivery; and therefore, speech terminals discard delayed packets. In PRMA this packet loss occurs at the beginning of talkspurts, a phenomenon referred to as front end clipping, which impairs thequality of received speech [lo].

The amount of front end clipping, as measured by the packet dropping probability, ***Pdq,*** is an increasing function of the number of speech terminals sharing the PRMA channel. A key measure of PRMA performance is the number of speech terminals that can share a channel within a given maximum value of **Pdm,,.**In our work we consider apacket dropping probability **Pdm**= 0.01 to be the limit. Simulations (Fig. **4,** Section IV-C) in&cate that if the limit is reduced **to**0.005, estimates of system capacity decrease by ***5*** to 10%.

III.SYSTEM VARIABLES

PRMA can be viewed as a statistical multiplexing technique. Its efficiency depends on the time patterns of packet arrivals, on the packet structure, on the mode contention for channel access, and on the channel bit rate. In this section we present a model of speech activity, and we define the system variables that determine PRMA performance. In Section IV, we derive performancemeasures as functions of these variables.

A. Speech Model

A speech source creates a pattern of talks purts and gaps, as classified by a speech activity detector. There are principal spurts and gaps related to the talking, pausing, and listening patterns of a conversation. There are also "minispurts" and "minigaps" due to the short silent intervals that punctuate continuous speech. Our analysis is capable of assessing the effects of two different speech activity detectors. A "slow" speech activity detector responds only to the principal talkspurts and gaps. A more sensitive, "fast," speech activity detector also responds to the minispurts and minigaps. The model of a slow speech activity detector corresponds to the behavior of the detector designed for the original time assignment speech interpolationsystem devised to improve the efficiency of undersea transmissions [13]. The model of the fast detector is based on the behavior of the speech detector used in an experimental wide-band packet transportations system [14].

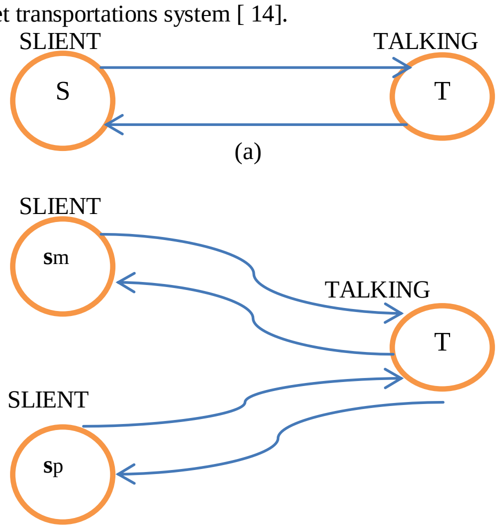

Fig. 1. (a) Two-state model of a slow speech activity detector.States are talking *(T)* and silent (S). (b) **Three-state model of a fast speech activitydetector. States are talking *(T),* principal silent gap (Sp), and minigap*CSm).***

All spurts and gaps have exponentially distributed durations. The mean duration of a principal talkspurt is ***t ,***s; the mean duration of a principal gap is ***t,*** s. The minispurts and minigaps have mean durations ***t,*** and ***t4*** s, respectively. The durations of all spurts and gaps are statistically independent of one another. Defines the notation of average talkspurt and gapdurations and displays numerical values obtained from measurements of conversational speech. A PRMA speech terminal examines the output of the speech activity detector which can be either "talking" or "silent," at the end of each time slot of duration***7*** s. Thus we model the behavior of the speech activity detector as a Markov process with transitions at the end of eachtime slot. Fig. l(a) shows a two-state Markov process that represents the behavior of the slow detector. We use a three-state model, Fig. l(b), to account for the performance of the fast detector.

1) Slow Speech Activity Detector, Fig. I(a): The probability that a principal talkspurt with mean duration 1, s ends in a time slot of duration. This is the probability of a transition from the silent state to talking. Correspondingly,the probability that a silent gap, of mean duration ***t,*** s, ends during a s time slot.

2) Fast Speech Activity Detector Fig. I(b): Here we have three **states:** talking (T), principal silent gap (***Sp),*** and minisilent gap ***(SM).*** The probability of a transition **from *S,*** to ***T*** during any time slot is ***U* as** in (2). Minisilences have **mean**duration***t*** &and the probability of a transition from **S,** At the end of a minitalkspurt (mean duration ***t,*** s) there is a transition from T to ***S,*** provided this spurt is not the **final** one in a principal talkspurt. The probability that the minispurt ends in any time slot.The mean number of minitalkspurts in each principal talkspurt isthe ratio is the probability that any minitalkspurt is the final one in its principaltalkspurt. Thus the probability of a transition from T **to*S,*** is y,(l - ***-jr)*** and the probability of a transition from Tto**S.**

3) ***UniFed Model:*** The expected spurt and gap durations are properties of the speech activity detector. We can view the slow detector, Fig. l(a), as a special case of the fast detector, Fig. lb.If***t4*** = 0 (no minigaps detected), and ***t,*** = ***t,*** (no distinction betweenminispurts and principal spurts), then ***yr***= 1, and the two figures are equivalent.

B. Packets

PRMA communicates packets of fixed length. Each packet is composed of several fields. A field contains a bit sequence provided for a specific purpose. Most important is the "evidence field" with user speech or data, or a system control message. There is also an address field and a control field that, among other things, indicates the nature of the packet: periodic or random. Other fields contain synchronization flags and parity.

C. Frames and Slots

In many applications, the source rate, ***R,*** b/s, the channelrate, ***R,*** b/s, and the required amount of header information, Hb, all appear as design constants. An important design variable is***T*** s, the frame duration. Because periodic sources generateexactly one packet per frame, the amount of source informationper packet is ***R,T***b and the total packet length is ***R,T*** + H b.Over the duration of a ***T*** **s** frame, the channel carries ***R,T***bits.It follows that ***N,*** the number of time slots (packet intervals) ineach frame, is

$$N = int\,\frac{RcT}{RsT}\text{packets per frame,}$$

Whereintis the largest integer **I *x.***

The time slot durationis ***r*** = ***T/N*** **s.**

D. Contention

At the end of each slot, the base station broadcasts a messagethat informs all terminals whether that slot will be "available"or"reserved" in the next frame. A contending terminal is one with packets to transmit and no reservation. A contendingterminal transmits a packet in a time slot if 1) the slot is"available," and **2)** the terminal has permission to transmit. Abinary random event generator issues permission with probabilityp in each time slot. Permission events are independent fromterminal to terminal. The permission probability, p, is a systemdesign parameter. In this study, p is time invariant and the same for all terminals.When a contending terminal successfully transmits a packet ina time slot, the terminal reserves that slot for uncontestedchannel access in the next frame. If the transmission fails, due toa collision with a packet from another terminal, the terminalseeks permission to transmit the packet in subsequent availableslots.

At the end of a talkspurt, the terminal stops transmittingand the base station, receiving no packet in a reserved slot,informs all terminals that the slot is "available" for contentionin the next frame.

E. Time Limit

A speech terminal contains a first-in first-out buffer to storepackets awaiting successful transmission and a counter thatrecords the age, in time slots, of the oldest packet in the buffer.When this age reaches a prescribed limit, ***D*** slots, the terminaldrops the oldest packet. With ***r*** **s** the duration of each time slot,***Dmax/ r*** is the number of time slots in ***Dmx***seconds, the delaylimit of the speech packets. In terms of the frame duration ***T*** s,

D = int [***Dmax/T]***slots

where N, above equationis the number of slots per frame and ***T/N*** = ***r,***the slot duration.

IV.CONCLUSION

A novel multichannel TDMA MAC protocol, called VeMAC, is proposed for VANETs based on the ADHOC MAC protocol. Each node is ensured to access the control channel once per frame, and hence nodes have equal opportunities to announce for services provided on the service channels and to transmit their high priority application messages. The nodes access the time slots on the control channel and service channels in distributed ways which are designed to avoid any hidden terminal problem. On the control channel, the VeMAC provides a reliable one-hop broadcast service, which is crucial for high priority safety applications supported on this channel. Packet arrangement multiple access (PRMA) can be viewed as a merger of the slotted ALOHA protocol and time division multiple access (TDMA). Dispersed terminals transmit packets of speech evidence to a central base station. When its speech activity detector indicates the beginning of a talkspurt, a terminal contends with other terminals for access to an available time slot. After the base station detects the first packet in the talkspurt, the terminal reserves future time slots for transmission of subsequent speech packets.

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