PERFORMANCE EVALUATION FOR CAH-MAC USING DSRC VEHICULAR SAFETY COMMUNICATION

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Abstract **-Vehicular ADHOC networks have been developed for set of applications that improve road safety measure, vehicle traffic coordination, and also provide comfort application. Cooperative communications that can improve the reliable communication by having a collection of radio terminals transmit signals in a cooperative way. This paper proposes a medium access control (MAC) in cooperative scheme, called cooperative ADHOC MAC (CAH-MAC). Due to a poor channel condition the neighboring nodes cooperate by utilize unreserved time slot for retransmission of a packet which fails to reach a target receiver in CAH-MAC. In this paper, we present a dedicated short range communication which performs the faster packet transmission. Through mathematical analysis and simulation, we show that reliable communication of CAH-MAC by decreasing PDR and hence increasing throughput performance in different networking scenarios.**

Index Terms **–VANETs, Cooperative scheme, Dedicated Short Range Communication, Time Division Multiple Access.**

I. INTRODUCTION

Vehicular Ad-hoc network (VANET) is used to provide an On-Demand wireless communication among vehicles and authorities. Such infrastructure is expected to deliver multiple road safety and driving assistance applications. To make these types of applications possible, vehicles will be equipped with sensors and communication device that will allow them to cooperate with each other and exchange various road application messages with other vehicles. For example, caution messages and traffic management instruction can increased for driver's awareness of potential travel hazards, which are allowed to avoid the traffic congestion and violent impact. Vehicle uses the sensors for collecting information and wireless medium for exchanging information with other vehicles. Such vehicles are equipped with on-board unit (OBU) and one or more applications units (AUs) [2]. OBU is a device which is used to exchange the information with other vehicles. Both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication are supporting by VANETs and also it will support for vehicle-to-roadside unit (V2R). The most critical and essential requirements is the data transmission with high end-to-end throughput, which is also a challenging task in VANETs.

VANETs have some unique challenges when compared with other form of wireless networks. High node mobility, security, and strict delay constraints of high priority safety messages are some common challenges in VANETs. Distribution time division multiple accesses (TDMA) based on MAC protocols. ADHOC MAC [6] and the VEMAC [8], are presented to reliable broadcast communication and point-to-point (P2P) communication in VANETs.

Most applications require real-time events knowledge and neighboring vehicles' location. A vehicle can determine its location using existing technologies such as Global Positioning Systems (GPS) [7], map matching, dead reckoning, cellular localization, image and video processing, and relative positioning.

We propose an application layer data sharing protocol with an assumption that each vehicle knows the positions of itself and its neighboring vehicles (which can be obtained through a global positioning system (GPS) device and safety related messages regularly broadcasted by neighboring vehicles [1]). Such cooperative sharing, the MAC layer collisions and the hidden terminal effect can be avoided in the data channel. A GPS network consists of 24 satellites placed in six orbital planes, so that at any given time to minimum of five satellites can be observed by GPS receiver at any location in the world. Different types of GPS receiver have been developed for many applications according to accuracy required. GPS system is used to find the location, so we can find easily where the nodes are placed by using this type of application. In VANETs, the IEEE802.11p has been proposed for medium access control (MAC)[3] to

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address the aforementioned. IEEE 802.11p add wireless access to vehicular networks and implements MAC layer and PHY layer in dedicated short range.

Distributed time division multiple access (TDMA) based MAC protocols are proposed to reliable broadcast and point-to-point communication in VANETs. Different techniques such as diversity and channel coding are very effective to mitigate wireless channel impairments and to improve the network throughput. Cooperative communication is an alternative approach, which is used to improve the transmission performance between a source and destination pair's (s-d) nodes via diversity gain. The overheard packets can be relayed to destination by a node or nodes which have good channel condition with both s-d nodes [2], when the direct transmission between the s-d pair suffer from a poor channel condition. In this paper, we introduced cooperative communication for VANETs, which is mainly focusing on the MAC layer, called cooperative ADHOC MAC (CAH-MAC).

II.SECURITYOFVEHICULAR COMMUNICATION

Vehicular systems have many characteristics that is different from mobile systems and computer networks connected to the Internet. Vehicular applications are divided into two types. The first type includes application that is related to security and driving processes. The main purpose of this type of application is to reduce the number of traffic accident and to solve the problem of congestion on road and highway. In [5], traffic congestions are formed by many factors; some are (somehow) predictable like road construction, rush hour or bottle-necks and some are unpredictable like accidents, weather and human behavior. Drivers, unaware of congestion ahead eventually join it and increase the severity of it. The more severe the congestion is, the more time it will take to clear once the cause of it is eliminated. The second type is mainly focused on ensuring comfort for the driver and the passengers while travelling. For example, access to the information (i.e. Internet, music, films and etc.).

VANETs will combine a variety of wireless technologies like DSR (Dedicated Short Range) communications described in the draft of standard for VANETs IEEE 802.11p WAVE (Wireless for Access Vehicular Environments), with Cellular, Satellite and WiMAX technologies in new future. Such a device allows the node to receive and send messages through the network.

Roads have been always in dangerous and a lot of efforts have been undertaken to improve their safety. Vehicles, road signs have been improved throughout generations. New solutions are available to assist the driver in hazardous situations and to decrease road dangers. In a near future, vehicles will be equipped with wireless devices, so that can communicate with each other. The primary application of this technology is to let vehicles exchange about their current context. The information exchanged can be divided into two types, (1) periodic exchange of status messages among the vehicles in direct communication range and (2) safety messages triggered by a critical event and distributed in a geographical region. Typically, WSN technologies help where neither the vehicle's sensors nor the driver can detect the danger, e.g. very localized road condition, animal crossing the road out of a forest, and etc. Hence, it is either the driver or the vehicle itself could initiate appropriate reactions according to the current environmental conditions with the overall aim to increase the driver's safety.

A combined scenario of WSN and VANET architecture aims at the provisioning of two services: 1.Accident prevention, 2. Post-accident investigation.

1) Accident prevention:It retrieves environmental data collected by the roadside sensors, when a car passes on road by sensor network. Data can be processed within the WSN network, in order to higher level information. Data can contain various physical quantities, such as temperature, light and humidity, and also detect moving obstacles. This information is potentially displayed to the driver and is processed in OBU vehicles. Wireless sensor nodes can measure road conditions data more than accurately an on-board sensor. Once a vehicle has processed the sensor data, it may translate the data as a risky situation and send a safety warning message to neighboring nodes. The vehicle finds a geographical region defined by geometric shape and scattered the messages to neighbor vehicles.
2) Post-accidentinvestigation: Sensor nodes measured continuously and environmental data are stored. These data contains the collected quantities (e.g. temperature) and event data also, such that previously detected obstacles. This information stored over a long time period may interest for a team of forensic.

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III.SYSTEM MODEL OF COOPERATIVE ADHOC MAC

This section describes the system model below methods and to evaluate the performance of the proposed CAH-MAC protocol using DSRC. Necessary suppositions are regarding packet transmission, high node mobility, topology changes, distribution of nodes.

A. Packet Transmission

Source node transmits a packet to the destination. If packet will directly transmitted between source and destination fails, then the cooperation is triggered. Upon detecting a transmission failure between source and destination in Cooperative MAC, node D does not acknowledged transmission from node S.

B. Neighboring Nodes

Each and every vehicle preserves a list of its one-hop and two-hop neighbors. These hops nodes are so that which can be reached at maximum one and two hops of transmission from a sender node. These nodes are considered as a set which is called one-hop set (OHS) and Two-hop set (THS) [2]. Node A can communicate directly with any nodes in its OHS1 and OHS2 because node A is a member of two OHSs. A THS formation will stops the usage of time slot simultaneously by more than one node within the same interference range and thus avoids the hidden node problem.

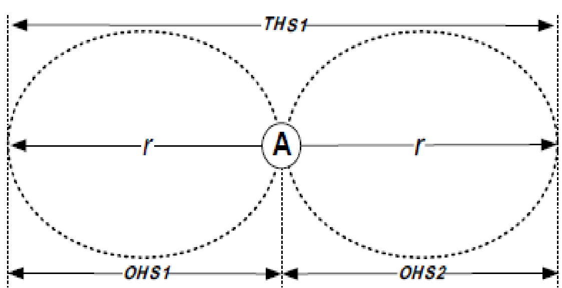

Fig. 1. Illustration of a two-hop set, where an ellipse represents an OHS such that all nodes inside one ellipse can directly communicate with each other, with node A as a reference.

C. Node Mobility

Vehicles are network participants that are used to communicate among themselves in case of any critical situation on the road. The request from source to destination is sent by gathering the geographical data with help of other intermediate nodes. The pattern of vehicles mobility depends on the traffic environment, road structure, speed of vehicles, behavior of driver's driving and so on.

It has made following settings for vehicles profile configuration.

I. Each vehicle is assigned a unique IP address and maximum high speed.

II. Vehicles acceleration and deceleration.

D. Channel Assignment

The channel access is depends on distributed time division multiple access (TDMA) as in ADHOC MAC. The Channel time is division into frame and each and every frame is divided into time slots. Each frame be made up of fixed number of time slot and every time slot is a constant time interval, frame as denoted by F. Time slot is accessed thus claims correct time synchronization among nodes. The one-pulse-per-second (1PPS) signal [4] that a GPS receiver gets every second can use is for the synchronization, when a vehicle can equipped with a Global Positioning System (GPS) receiver [12]. Nodes are supported for broadcast, multicast, or point-to-point modes of communication. Nevertheless, we consider nodes of communicating in point-to-point mode only to evaluate the performance of CAH-MAC. Helper node performs cooperation which is used to retransmit an overheard packet from the source node. When multiple nodes within the same interference range try to reserve the same time slot then the access collision occurs.

IV. DESCRIPTION OF CAH-MAC OPERATION

In this section, we discuss the detailed about CAH-MAC operation contains cooperative relay transmission, cooperation decision, packet header selection and sent time. Each node has in its own time slots transmitted a packet from source node to destination.

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A. Frame Information- Exchange Period

Frame method is a collection of ID fields (IDs). Each IDF is corresponding to the time slot of a frame. Destination node D receiving a packet successfully from the source node S up to s time slot, results s time slot belongs to S. In this section, potential relay and potential destination are access the wireless channel to exchange messages, with the topology information needed for relay selection. Two control packets are introduced, namely, relay information (RI) and destination information (DI). The RI and DI packet formats are shown, in which user ID is the sender ID. Sent time is conveys the beginning packet sending time RI, which is used for synchronization. List of neighbors consists all neighboring potential relays of the packet sender DI [11].A node that receives an RI packet without receiving the data packets sent by the gateway recognizes itself it as a potential destination.

RI

Frame Control	User ID	Sent Time	Packet Header	CRC

DI

Frame Control	Neighbors List	Packet Header	CRC

Fig. 2. RI and DI Packet Format.

B. Cooperation Decision and Cooperation Relay Transmission

Cooperation is performed always one-hop source and destination neighbor nodes. In this method, how nodes are performed cooperation. Let S denotes the Source and also denotes node D and node H are destination and header respectively (in fig. (2)). If following condition are satisfied, then the cooperation relay transmission and cooperation decision are performed: 1) packets are directly transmitted between source node S destination node D fails. 2) For cooperative relay transmission, the helper node H successfully receives a packet from the source node S. 3) From the helper node H, the destination node D is reachable. 4) There is an available unreserved time slot for cooperative relay transmission.In [10], if the cooperative relay node is selected approximately, cooperative communications can effectively increase the link capacity.

C. Cooperative Data Sharing

We discuss a cooperative secure data sharing for paid services in VANET. In the coordination channel, RSUs periodically broadcast hello messages. Vehicles are passes the first RSUs hello messages that they hear for one time by piggybacking it on the next geographic messages. The authority is defined some downloading data and distributed data unit to each of them [9]. A forward data sharing process is contains in protocol to transmit data units from back to front.

When these downloading Vehicles are at least I+R far from the RSU, they will start to share the data one by one where I is the interference range of RSUs and vehicles. The distance I+R guarantee that all receivers in the communication range of the downloading vehicle can receive data without collisions and interference from the RSU.We will share data unit 1 to the applicant by broadcast. After that, it will select the relay vehicle for who can further forward the message to applicant that are several way of hops. Finally, the applicant receives that message, it will forward a request message by broadcast. If vehicle 11 selects vehicle 8 as the next relay vehicle, vehicle 8 will broadcast data unit 1 after vehicle 9 shares the data unit 2 [11].When the RSU gets request messages, it will verify the signature and send the fresh requests to the authority.

V. PERFORMANCE METRICS

In this section, we develop a mathematical model for performance metric of proposed Cooperative ADHOC MAC protocol. Compare the performance of CAH-MAC with ADHOC MAC in terms of packet dropping rate and throughput analysis.

A. Distribution Nodes

The Nodes are randomly distributed on the road with an exponentially distributed inter vehicular distance over each lane. Let L be the vehicle density of lane in terms of number of vehicles per unit length [2]. The inter-vehicular distance follows a shifted negative exponential distribution in reality, such that a minimum safety distance (MSD) is always maintained by two adjacent vehicles in a lane to avoid any vehicle collision between them.

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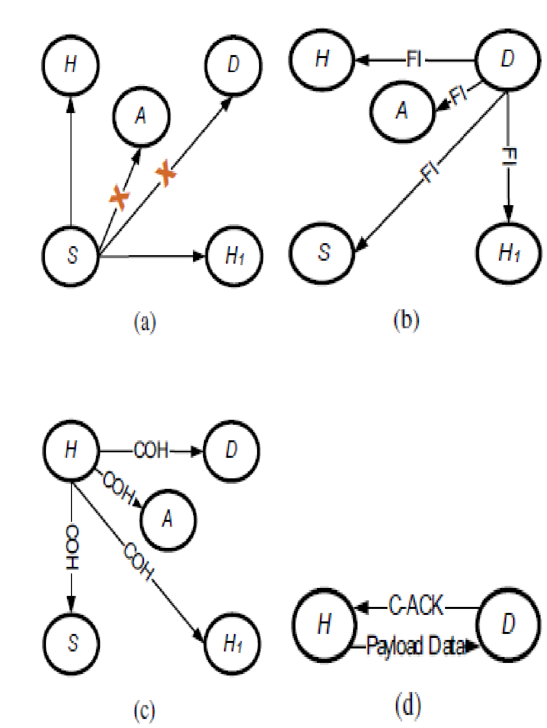

Fig. 3. Information exchanges in the CAH-MAC: a) The direct transmission; b) Neighboring nodes detect transmission failure after examining the FI from the destination; c) Helper node H, offers cooperation; d) Helper node H, re-transmits the packet that failed to reach the destination after receiving a cooperation acknowledgement from the destination.(ref. 2).

B. *Time Slots Models*

In a frame, each time slot is following under types of condition:

i) Reserved: Time slot which are reserved during which data packet are successfully transmitted to destination regarding as successful time slots. Let X is random variables which represent the number of reserved time slots in frame.

ii) Unreserved: Time slot which are not yet reserved by any node are unreserved time slots. Any time slots in a frame are reserved time slots other than unreserved. Let U be a random variable which represent the number of unreserved time slots in frame.

iii) Failed: A Time slot other than an unreserved and successful belongs to failed time slots.

C. *Packet Dropping Rate*

Packet drop shows which data packet that could not reach destination successfully. The main reason of packet drop may increase due to congestion, faulty hardware [9] and queue overflow etc. A packet is dropped by a source node from its buffer memory, when it fails deliver the packet to the destination within the predefine time limit in communication system. Packet drop affects the network performance by consuming time and more bandwidth to resend a packet. The protocol performance considered to be efficient if packet drop rate is lower. In [13], highway scenario we calculated only those drop packets that lost between the last intermediate to destination.

VI. THROUGHPUT ANALYTICAL AND SIMULATION RESULT

In this section, we presents simulation results were performed in NS2 comparing with CAH-MAC and ADHOC-MAC. A road segment with two lanes each of 5m width was considered, i.e., L=2 and w=5m. Throughput and throughput gain of CAH-MAC were obtained in comparison in with ADHOC MAC for several different scenarios.

First, we study about the effect of the exponentially distributed inter-vehicular distance on validity of the analysis. For example, we shows that the throughput are proportional to the vehicle density per lane (ρl) values. While in CAH-MAC the introduction of cooperation reduces transmission failure probability by utilizing the unreserved time slots, but in ADHOC MAC unreserved time slots are unused. In this scenario each simulation was performed for 400 seconds. 15 nodes were selected as the participants of network and each node movement was highly mobile. Nodes move with 20 m/s speed i.e. 72 km/h and 30 m/s speed i.e. 108 km/h. If throughput is high rate it means most of the sent packets to destination has been received, thus this factor reduce delay as packet receive success rate is high. In CAH-MAC, shows that higher throughput rate in entire simulation time. In highly mobile environment of VANET its performance decrease suddenly to the lower level in terms of throughput. The highway parameters scenario is shows in table 1.

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Parameter	Setting
Size of Environment	1000 x 800 meters
Total number of nodes	15
Node Type	Highly Mobile Nodes
Node Speed	20 m/s, 30 m/s
Packet Type	UDP
Packet Size	1400 bytes
Simulation Time	400 Seconds
Number of Receiver	One

Table 1: Input Parameter for Highway Scenario.

VII. CONCLUTION

This paper proposes CAH-MAC protocol and performance benefits in wireless ad hoc networks. In CAH-MAC, upon determine a transmission failure between source and destination, neighboring node offers cooperation to the packet relay to the destination during an unreserved time slot and performs faster packet transmission using dedicated short range communication. Unreserved time slot which is used for retransmission, throughput performance is achieved. Our analysis shows that the CAH-MAC protocol achieves a higher throughput and reducing time than the ADHOC MAC.

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