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Mobility Based Cluster Using Hybrid Mac Scheme For Vanet

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Abstract— Vehicular ad hoc network addressed some issues such as overhead, low throughput of safety related messages, high mobility of the network, less utilization of channel access and hidden terminal problem in dynamic network. Mobility based cluster using hybrid MAC Scheme is proposed to reduce the lack of mobility, increase the wireless channel utilization and provide the more stabilization of the VANET. The proposed hybrid clustering mechanism integrates two techniques such as intra-cluster communication using TDMA/CSMA technique and inter-cluster communication using OFDMA technique. Cluster Head selection process based on the mobility values to improve the network stabilization. OFDMA contains Control Channel (CCH) which consist of four subcarrier sets used to avoid hidden terminal problem. Increasing throughput and reducing time delay of safety messages are the main contribution of this mechanism.

Keywords – Inter cluster communication, Intra cluster communication, Cluster Head(CH), Mobility Value, TDMA/CSMA, OFDMA, Control Channel(CCH).

I. INTRODUCTION

Vehicular ad hoc Networks (VANETs) are important parts of Intelligent Transportation Systems (ITS), this technology will provide a wide variety of applications to decrease the severity of road accidents. Low efficient and reliable Medium Access Control and protocol, such high beaconing may provide more collisions, particularly in high density networks causing low performance of safety and non-safety application. To have an efficient MAC protocol used to avoid transmission collisions between vehicles. Then emergency messages will be forwarded in a real time manner. The wireless channel has to be fairly shared between vehicles. In [3], a hybrid protocol that uses schedule-based approach for Intra-Cluster communication.

Clustering based MAC protocol to provide an advantage to limit channel contention and effectively control network topology. To In [4], a MAC scheme for vehicular ad hoc networks which is based on clustering of the vehicle nodes. It is mainly used to minimize hidden terminal problem through TDMA technique.

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The purpose of contention based MAC protocols has been used to access the channels to distribute the safety related messages timely. The node or vehicle may not have a timely and reliable message dissemination in VANETs. So, contention period is introduced before the vehicle for channel access in [7].

Contention-free and contention-based MAC scheme to support the effective broadcast service, reliability and throughput of safety related messages in [2].

Therefore, hybrid based MAC scheme effectively utilizes the channel access. In [1], Distributed Multi channel mobility aware MAC protocol which integrates two techniques such as DCF (Distributed Coordination Function) and OFDMA (Orthogonal Frequency Division Multiple Access) provide more stable and non-overlapped clusters through adaptive learning and channel scheduling within FIS which provide more reliability and reducing time delays for vehicular safety applications. Stability is the major challenge for a highly dynamic environment (VANET). Clustering schemes should take the degree of the speed difference between neighboring nodes to produce stable clustering process on highways in [6]. In [8], In order to increase the stability of clusters in high mobility vehicle based on speed difference and position of the neighborhood vehicles.

In [9], A Medium Access Control protocol for inter-vehicular wireless networking provides Dedicated Short Range Communication Standards (DSRC). The self-configuring TDMA protocol provide inter-vehicle message delivery with short delay bounds. Exchanging TDMA slot information during distributed medium access scheduling for highway traffic safety

application. In [10], a dynamic and stable cluster based medium access control protocol that includes the vehicle's on-road time and position messages like the relative speed, direction of the vehicle and connectivity among neighbor vehicles while giving priority to vehicles joining to the stable cluster to increase throughput of the message and stability of the network. Vehicles dynamically organize themselves into clusters and COMAC (Cluster and OFDMA based MAC) protocol is adaptable to drivers' behavior on the road and learning mechanism used to predict future speed and position of all cluster members using Fuzzy Inference System (FIS) and OFDMA technique used to avoid hidden terminal problem through a different subcarrier set (c1,c2,c3,c4) from its neighborhood cluster. Then increasing system reliability and reducing time delays for safety related messages in highly dynamic network using COMAC in [11]. In [12], design a weight based clustering algorithm to improve the

performance of wireless technology and provide a stable clustering process for Mobile Ad Hoc Network (MANET).

A cluster head election process based on some metric such as Energy, Weight, ID, Degree and Mobility. The cluster head maintains the information of its own cluster member. The proposed system provides a hybrid MAC scheme for intra cluster and inter-cluster communication. Cluster member to cluster head communication performed in TDMA/CSMA [2]. The vehicles which are placed in its own time slot, access medium using TDMA period and vehicles are not placed in its own time slot and access the medium using CSMA period. Cluster head to cluster head communication using OFDMA [1] through Control Channel (CCH). The rest of the paper is organized as follows: Section II formulates the related work of this process. Section III we present the proposed framework and details.

II. RELATED WORKS

The clustering process is an important technique in highly dynamic environment to reduce the overhead. Some of the medium access control scheme provides the stable cluster process in high mobility nodes (Vehicles). Mingming CHEN et.al [8] introduces the stable cluster formation for high mobility nodes. This Mobility Based Clustering (MBC) algorithm used to enhance the stability of the network through the speed difference between neighborhood vehicles and the position of current vehicles. Here we have to achieve the stability of the cluster in network topology. J.Jayavel et.al [10] presents a dynamic and stable cluster-based Medium Access Control scheme on-road time and position message such as speed, direction and connectivity between neighborhood vehicles while providing priority to vehicles joining to the nearest cluster. Zaydoun Y Rawashden et.al [6] introduce VANET clustering scheme should consider the degree of speed between neighborhood vehicles to produce reliability stable clustering process. Khalid Abdel Hafeez et.al [11] the Clustering and OFDMA based MAC (COMAC) protocol is

adaptable to drivers' behavior on the road and the adaptive learning mechanism for predicting future speed and position of all cluster members using FIS to provide a stable cluster in a highly dynamic environment. Here OFDMA used for minimizing hidden terminal problem through subcarrier sets (c1, c2, c3, c4). The cluster using different subcarrier sets from its neighborhood. So we can avoid hidden terminal problem effectively.

The Cluster Head (CH) selection process is important technique in VANET. The cluster heads are maintaining the information about its own cluster members. Mingming CHEN et.al [8] select cluster head based on high mobility factor. The node with high mobility factor (MF) elected itself as a cluster head by exchanging their status message among its neighbors. The Cluster Head (CH) selection process is important technique in

VANET. The cluster heads are maintaining the information about its own cluster members. Mingming CHEN et.al [8] select cluster head based on high mobility factor. The node with high mobility factor (MF) elected itself as a cluster head by exchanging their status message among its neighborhoods. Khalid Abdel Hafeez et.al [1] elect a cluster head based on weighted stabilization factor (βWSF). The node with the highest stabilization value (βWSF) elected itself as a cluster head by exchanging status message among its neighbors. If two cluster head in the same communication range with the highest stabilization value, one node act as a main cluster head and another cluster node act as a backup of the main cluster head. The drawback of above clustering and cluster head election process such as

[1] High latency of safety message transmission
[2] Overhead occurs during high dynamic network
[3] Low throughput of safety messages
[4] Unreliability of the cluster head election process.

III. PROPOSED WORK

The basic idea of mobility based cluster using hybrid MAC scheme for VANET provides intra cluster communication and inter cluster communication effective. The system is designed for high throughput of safety related messages, effective channel utilization and high cluster reliability. The system framework is shown in Fig 1.

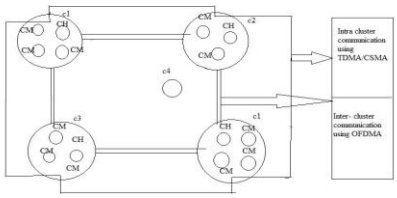

Fig 1. Hybrid Clustering Medium Access System for VANNET

A. Clustering

A basic need of clustering is to avoid or minimize the overhead. The same speed of the vehicles is grouped into clusters. Unique ID is assigned to each node.

B. Cluster Head Election

The cluster head election is an important technique in dynamic environments. Every cluster need to select a cluster head for maintaining the information about its cluster members cluster head election based on the mobility value (MV). Each node estimates its mobility value with its neighbor based on exchanging their status message. If two nodes have highest mobility values in the same communication range the node with the lowest ID elected as a cluster head. If a node move out from a cluster and doesn't have other neighbors, it will elect itself as a cluster head. If it finds other vehicles in its communication range the node with the highest mobility value elected as a cluster head. If a node placed in two cluster head communication range, it will join the cluster which is nearest itself.

C. Mobility Value Calculation

Mobility value contains E[l] and Change Factor (CF). every vehicle calculates mean link time with its neighbors

using E[l]. E[l] represents the changes of the vehicle relative location, speed and acceleration compared with its neighbors. Change Factor is the frequency that the vehicles highest changes. In default the stability value α=0.5.

$MV = \alpha \times E[l] / Tmax + (1-\alpha) \times MC[i]$ ....(1)

Tmax represents current vehicle has time with neighbor vehicle and E[l] is the mean link time.

E[l] is calculated by,

$$E[l] = 1/ p \sum_{i=1}^{p} lt_i \quad \ldots\ldots(2)$$

p represents the number of neighbors of current vehicles. lti represents link time with the neighbors of vehicle i.

The set of signed vehicle's neighbors in t seconds ago represented as n'(i) and n(i) represents set of current neighbors.

$CF[i] = |n'(i) \cap n(i)| / |n'(i) \cup n(i)|$ ….(3)

D. MCHMAC Protocol

After being completed, cluster process into a stable network and start to transmit safety related messages. Our proposed scheme leverages hybrid MAC scheme such as intra cluster and inter cluster process. Every vehicles within a cluster and communicate with each other using TDMA/CSMA period while inter-cluster communication adopts OFDMA period.

With the network, time on the channel is synchronized with GPS system. So safety messages can be transmitted orderly. TDMA provides a time slot for every cluster member. The communication process is divided into two processes: TDMA/CSMA period and OFDMA period.

During the TDMA/CSMA period, cluster members start to send messages to the cluster head orderly. Vehicles within their slot have priority to access the cluster head. The Waiting time of vehicles placed in its own time slot is called SIFS. Vehicles which are not placed in its own time slot compete with other vehicles to access the medium. The Waiting time of vehicles not placed in its own time slot is called DIFS. Then DIFS is greater than SIFS.

In OFDMA period, cluster head communicates with the other cluster head using OFDMA scheme. OFDMA provides a control channel for communication. The cluster head to cluster head communication performed in the control channel interval (CCI). Then OFDMA contains sub carrier sets (c1, c2, c3, c4). The current cluster using different sub carrier sets from its neighbor to avoid hidden terminal problem.

IV. PERFORMANCE ANALYSIS

In this section simulation is used to study the performance of proposed Mobility Based Cluster Using Hybrid MAC Scheme Using VANET (MCHMAC) protocol. The simulation is implemented using Network Simulator (NS2).

A. CREATION OF SIMULATION SETUP

To evaluate the performance of the MCHMAC protocol for VANET. We compare it with HMMAC protocol proposed in [2]. Simulation results are performed using the network simulator (NS2), version 2.35. the simulations are carried out for a 4 lane highway with a length of 10km and the width of 10m per lane. Vehicle velocity varies from 70 to 120km/h. Move vehicles on the highway mobility model described in [8]. The periodic messages are sent every 100ms and the data rate is set to 1Mbps. The size of the message, including the mobility information is 100 bytes.

Simulation Setup Parameters:

Table2. Setup parameters

PARAMETER	VALUES
Vehicle velocity	70-120 km/h
Communication range	300m
CH2CHR	1000m
CM2CHR	400m
SIFS	8μs
DIFS	40μs
CCI	5μs
Message SizeL	64×8 bits

B. Metrics of Performance

To study the performance of the proposed MCHMAC protocol for reliability of clustering process, throughput of safety messages and transmission ranges. The transmission range varies from 100 to 400m. For medium access we use TDMA/CSMA for intra cluster communication [2] and OFDMA for inter-cluster communication [1].

C. Reliability of Clustering Process

For intra cluster communication, vehicles present in their own time slot, the waiting time of the vehicles to access the medium called SIFS

SIFS=W(CMTtoCH)R …….. (4)

Vehicles are not present in their own time slot, the waiting time represented as

DIFS =W(CMT'toCH)R ……..(5)

The reliability of intra cluster communication

RICC=Number of cluster member and cluster heads+SIFS+DIFS ……..(6)

For inter cluster communication, CH to CH communication using OFDMA control

channel to medium access performed within CCI interval (Control Channel Interval).

The reliability of inter cluster communication is,

R'ICC=Number of cluster heads+CCI …..(7)

B.2 Throughput of Safety Messages

CH communicates with other CHs using OFDMA scheme. Let T be the system throughput. The throughput of OFDMA is calculated according to [2]:

$$TOFDMA=Ps^{n} \text{ Ptr } E[p] / (1-Ptr)\mu+Ps \text{ Ptr } ts + Ptr \times (1-Ps)tc \quad \ldots\ldots(8)$$

Represents the transmission occurring

Ps^n

on multiple channel access, ts is the average time, the channel is sensed busy. tc is represents the average time, the channel is busy by using CH. E[P] is the average packet size.

All cluster members communicate within CH using TDMA/CSMA period. Cluster member communicates to its CH with own time slot. Π represented as a probability that cluster member has a message to transmit.

The cluster transmits message in its own time slot calculated according to [2]

$P1 = \Pi / n$ …….(9)

The probability that the other cluster member competes for the medium access is calculated according to [2]

$P1 = 1-\Pi /$ …….(10)

Throughput of TDMA/CSMA period can be determined in the following way

$TTDMA/CSMA = P1 \times E[P] / t2 + P2 \times t1$ ….(11)

D. TRANSMISSION DELAY of Safety

Related Messages

The total transmission delay can be represented as

$tdelay = tCMtoCH + tCHtoCH + tCHtoCM$ …….(12)

the delay of transmitting message between CH to another CH is calculated as follows

$tCHtoCH = 1/ (\sigma-\lambda)$ ……(13)

There is no need for cluster members to wait its own time slot to transmit safety messages to CH based on its priority the transmission delay determined by

$tCMtoCH = tCHtoCM = ldata/ R$ …….(14)

E. Simulation Result

C.1 Cluster Reliability, Throughput of

Safety Message, Transmission Range in No

of Vehicles Fig 3 represents the ratio number of vehicles and cluster reliability. It shows a more stable cluster and provide better communication of the network than HMMAC (Hybrid Mobility MAC) protocol. Fig 4 examine the ratio been throughput and a vehicle density in VANET. Throughput of safety related messages is higher when compared to the HMMAC protocol. Fig 5 analyzes the ratio among transmission range and vehicles density in network (VANET). The communication process performed effectively in different communication range when using MCHMAC protocol. C.2 Channel Utilization in No of Clusters. Fig 6 represents all cluster heads and cluster members effectively utilize the channel for accessing the medium. The utilization is higher in MCHMAC than HMMAC protocol.

V. CONCLUSION

We proposed mobility based clustering using MAC schemes for VANET. Cluster Heads are selected based on mobility factors. Cluster members communicate within the cluster using TDMA/CSMA techniques that is called as Intra-cluster communication. Then the cluster head to cluster head communication achieved by using OFDMA technique. The proposed scheme provides collision avoidance, high throughput, minimizing overhead and low latency of the safety messages in a dynamic environment such as VANET.

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