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An improved Mobility Aware Clustering Based MAC Protocol for Safety Message Dissemination in VANET

T.Karthikeyan[1] V.Rajasekaran[2]

[1]Associate Professor, Department of Computer Science, PSG College of Arts and Science, Coimbatore
[2]Assistant Professor, Department of Computer Science, PSG College of Arts and Science, Coimbatore

Abstract:- *Key issues in VANETs are high mobility, constraint of road setup, common topology variations, unsuccessful network links, and timely communication of data, which make the routing of packets to a exacting destination difficult. To tackle these issues, a new reliable routing algorithm is proposed, which utilizes a wireless communication system between vehicles in urban vehicular networks. Security is a vital concern for many Vehicular Ad-hoc Network applications. This is a very reasonable assumption, since GPS receivers can be fitted easily in vehicles, a number of which already comes with this technology. In this method, each Road Side Unit calculates and stores different parameter values after receiving the inspiration packets from nearby vehicles.*

Keywords: *VANET, Message dissemination, Routing, IEEE801.11, FPAV,DMMAC*

INTRODUCTION

Vehicular communication is particular as communication between the vehicles.[1] It is a subscription of MANET. It is an important and prominent area of research in the field of vehicular technology. Vanets are self-configuring systems where nodes are act as vehicles.Vanet is an Intelligent Transportation System in which vehicle act as sender, receiver & router to broadcast the information to the vehicular network. Its aim to provide timely information, security, & management of network. Vanets are dynamic in nature because connection between nodes is impermanent. It is designed for vehicle and vehicle and vehicle to infrastructure communication.[2] Due to accidents and road mortality increasing day by day, people are facing problem & need safety. so security in VANET is very essential, because the message sent by one vehicle might have important outcome such as accident prevention. Its main objective of exploiting vanet is to diminishing the level of accidents and provides safety to the passengers sitting in the vehicles.[2]

METHODOLOGY

The communication is carried out by the affected vehicle. The warning message continuously broadcast by affected vehicle. Both (V2V) and (V2I) communication are considered for vehicle in short range and long range respectively the different system parameters are explained below. *Data Collection:* The most basic thing is to collect data from the environment. Current location and speed.

Sharing of Information: The information must be shared between vehicles. Using V2V and V2I Comunication.

Message Broadcast: The warning message broadcast continuously by affected vehicle, the vehicle in the range can receive the message and take decision accordingly.

Decision Making: Appropriate decision has to be taken so that the congestion can be detected, and accordingly the vehicle in the range takes decision after updating message field.

Bandwidth: For congestion control needs to make intelligent use of the bandwidth. Bandwidth utilization is very important for sending large amounts of information, otherwise will overload the system.

Vehicles Requirements: All Vehicles should be equipped with the same hardware which allows sharing and collection of information's. A Novel system has to be designed so that it can work even all vehicles on the road participate in the congestion detection system.

IMPROVED CONGESTION DETECTION AND CONTROL ALGORITHM (ICDC)

In the preparation of algorithm Possibility of an event of an accident condition is considered. The affected vehicle broadcast warning message continuously i.e. alert message regarding accident or about worst road condition. The vehicle in the short range and long range received the warning message and alert by using V2V & V2I communication respectively

Steps in ICDCA algorithm are as follows.

a) The affected vehicle of an accident event occur only broadcast the information.
b) Then affected vehicle broadcast the message (information) to the nearby vehicle
c) The vehicle which is in the short distance range the messages are transmitted by the V2V Communication whereas vehicle in long distance the messages are transmitted by the road side units. (V2I) Communication.
d) Each vehicle in the communication must have a unique Identification number (ID).
e) Speed of the vehicle.
f) The status of the lane to show that particular lane is blocked.
g) After receiving the message the nearby vehicle will take proper decision for diversion and then updates the message field and forwards it to other vehicles.
h) Next incoming vehicle gets decision about the blocked lane and divert form it.
i) The roadside units are also getting warning message that accident happened in particular lane, according they starts broadcasting message which assists in congestion control. This is long range communication so well in advance vehicles are getting message of slow down the speed, they have sufficient time to take proper decision and helps in avoiding the congestion.
j) Due to short range and long range communication the message are received by all the vehicles coming in range.
k) The lane changing vehicle according to the decision immediately stops the broadcasting the message thus limiting the number of messages getting broadcasted and also limiting the overloading of the system.

PROPOSED PROTOCOL

In the proposed protocol, when the vehicles enter the network region for the first time, they broadcast their status message (HELLO message) independently to make other vehicles in the vicinity aware of their presence and other positional information. Once these messages are shared among the nodes in the single-hop distance network range, they form a cluster. Nodes are clustered based upon their speed. The clustering algorithm does not require additional message other than the HELLO message since the cluster formation is mobility based. Each cluster is maintained by a cluster head (CH). A CH broadcasts a message that assigns the mini slots in the broadcasting period to the cluster members. Every node that receives the CH's message knows its mini slot and is synchronized with the other cluster members. Therefore, there are no collisions during the HELLO broadcasting period. Whenever a message is triggered at any node, it is first checked whether it is a safety message or a non safety message. As shown in the flow diagram (Figure 1), the proposed protocol follows different approach for each type of message. In the following subsections we discuss the mechanism adopted in the proposed work.

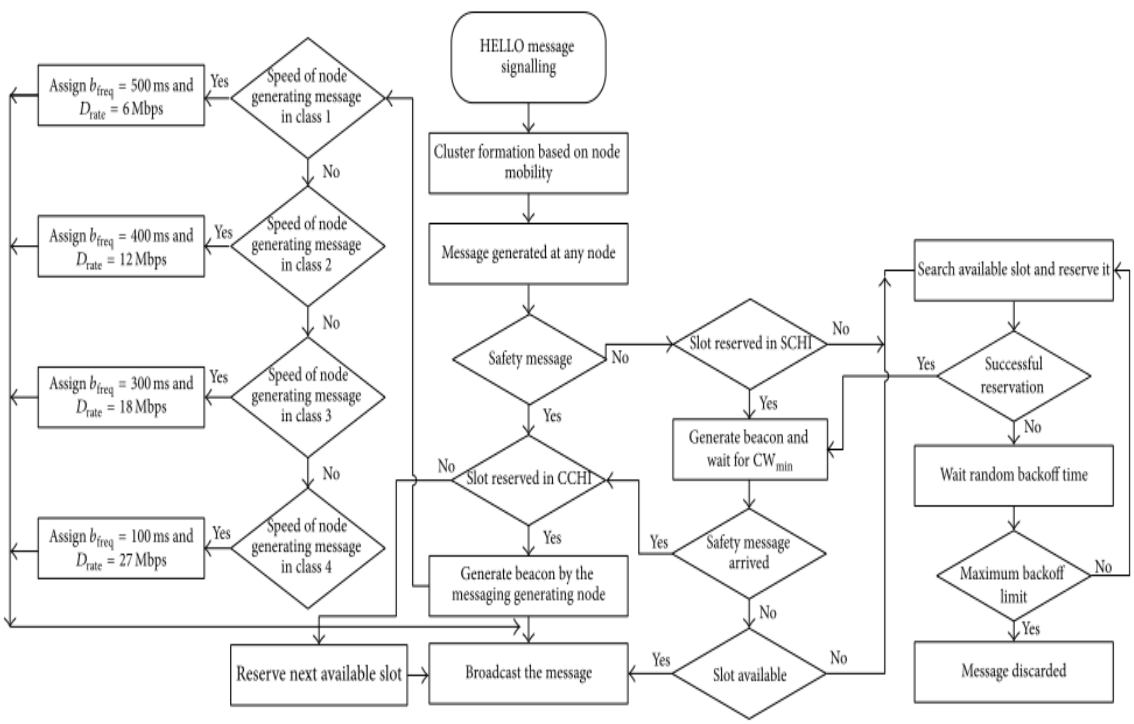


Figure 1: Flow diagram of the proposed protocol.

Safety Message Dissemination

The dissemination mechanism of high priority event-driven messages has different characteristics. They are preferred over beaconing signals. However, beaconing is equally important as it forms the basis of a diverse range of intelligent transportation systems (ITS) applications [3]. Event-driven messages are triggered only at the detection of an emergency situation and therefore are not expected to cause significant load on the channel [4]. Beacon messages, however, have a more relaxed deadline requirement and are expected to cause significant load on the channel. Especially in case of safety messages, channel availability and reliable transmission need to be ensured. The proposed protocol is so designed that it inherently prioritizes safety message by facilitating ensured channel access since it is based on TDMA-slot reservation mechanism.

Cluster Formation

The proposed scheme harnesses clustering based topology for its safety message dissemination process. Nodes are clustered based upon their mobility. They form dynamic clusters and the ones that are more suitably located become CH. Selection of CH is the most important task in a cluster. CH is responsible for monitoring the data propagation process inside and between the clusters. The clusters of high-speed vehicles ensure that, even with such dynamic mobility, moving cluster architecture results in relatively stable topology as long as velocity of the vehicles remain more or less the same. Each node within a cluster is connected by one-hop intracluster link and different clusters link to each other through multihop topology.

When a vehicle enters the road for the first time, it looks for availability of any cluster by broadcasting a cluster joining request message and starts sending its status message without an elected CH. If the vehicle receives any response, it joins the cluster whose average speed matches with its instantaneous speed. However, when the vehicle does not receive any response, it initiates the cluster formation process itself to identify cluster members by broadcasting HELLO message () to other vehicles within their communication range. The vehicles moving in the same direction and in the vicinity of each other receive the request. Algorithm 1 narrates the stepwise cluster formation process.

Step 1: vehicle x broadcasts cluster joining request message
Step 2: if request acknowledged
Step 3: vehicle x *joins the cluster*
Step 4: if no response
Step 5: x initiates cluster formation process
Step 6: end if
Step 7: end if
Step 8: vehicles $x_1, x_2, \ldots, x_n$ receives cluster joining request
Step 9: vehicles broadcast T_{hello}
Step 10: if speed of $x_1, x_2, \ldots, x_n < 20$
Step 11: add $x_1, x_2, \ldots, x_n$ to cluster class 4
Step 12: else
Step 13: if speed > 20 and ≤ 30
Step 14: add $x_1, x_2, \ldots, x_n$ to cluster class 3
Step 15: else
Step 16: if speed > 30 and ≤ 40
Step 17: add $x_1, x_2, \ldots, x_n$ to cluster class 2
Step 18: else
Step 19: if speed > 40
Step 20: add $x_1, x_2, \ldots, x_n$ to cluster class 1

Algorithm 1: Cluster formation process.

Slot Reservation Mechanism

The slot reservation phase consists of the time allocated for intracluster and intercluster communication. In intracluster communication phase when a node encounters a safety message, it raises a beacon message informing the CH about message arrival. Each cluster member will receive a different time slot for sending its beacon to its CH. In case of intercluster communication, to ensure reliable message transmission with minimal delay, every node is assigned a slot in the TDMA frame during the CCHI SCHI to transmit its message. Depending upon the mobility range of the cluster to which the message carrying node belongs, a predefined beaconing frequency and data rate are assigned which is discussed in detail in the next subsection. In order to deliver an event-driven message, the node first checks if there is any reserved time slot. If a slot is found reserved, the node transmits its message and sends it to the lower layer. Otherwise, the node reserves the next available time slot for itself and uses it for message transmission. Figure 5 depicts the above discussed clustering based slot assignment process.

Step 1: vehicle x broadcasts message P
Step 2: another message P' is received at the same channel while P is under transmission
Step 3: if priority of $P > P'$
Step 4: ignore P' and broadcast P
Step 5: else if priority of $P < P'$ and
Step 6: if its current channel = CCH
Step 7: broadcast P' instead of P
Step 8: broadcast P after finishing broadcasting P'
Step 9: else if its current channel = SCH
Step 10: broadcast P' first and then P

Algorithm 2: Priority assignment mechanism for safety messages.

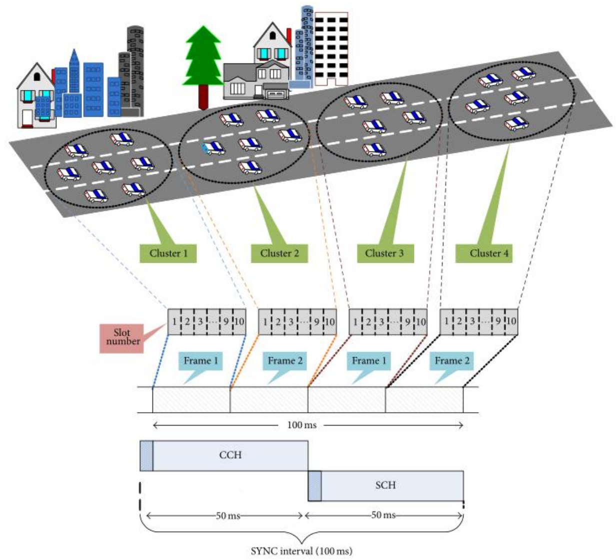


Figure 2:Clustering based slot assignment mechanism in multichannel scenario.

The proposed slot-based reservation mechanism specifically designed for safety message dissemination guarantees reliability as the emergency message is transmitted in reserved time slots, ensuring collision-free transmission.

Performance Evaluation

The aim of this simulation study is to evaluate the V2V communication performance aspect of safety as well as non safety applications where all the vehicles are equipped with on-board unit enabling wireless communication. Vehicles communicate with each other in a clustered scenario to collectively exchange data with neighbouring vehicles. Simulation results and their evaluation are used to compare the performance of different protocols for QoS metrics of throughput, PDR, end-to-end delay, and packet loss ratio along with some clustering related parameters such as average CH time, emergency message inter arrival time, and protocol overhead. We have evaluated different protocols for two different transmission ranges, 300 m and 500 m, owing to the existing literatures suggesting the optimum V2V communication range to be around 300 m. However, some researchers have opted for a higher communication range also. So, to have a discreet and in-depth analysis of the comparison and identify better communication range in V2V scenario, we have extended our simulation to 500 m as well.

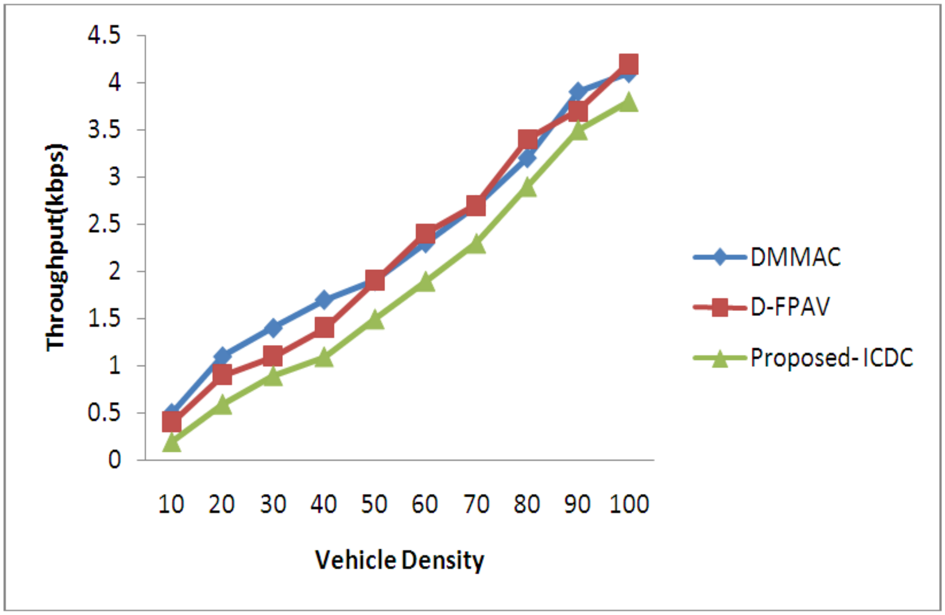
Experimental Setup

In order to evaluate the performance of the proposed protocol, simulations are performed using ns-2 simulator [33] version ns-2.34, which is modeled to provide DSRC MAC layer specifications. A total of 100 nodes are deployed in a region of size 10000 m × 10000 m. IEEE 802.11 DCF is selected as MAC layer protocol. The MAC layer data rate is set to vary within 6–27 Mbps depending upon the node mobility. We consider varying node speed in the range of 15–45 m/s (54 km/h–162 km/h). The simulation time is 300 sec. Following the recommended beaconing frequency for the vehicular safety applications, in the proposed scheme the beaconing frequency is set to vary within 2–10 Hz (100–500 ms) [5] depending upon the mobility of the node. Additionally, in order to perform the simulation in reliable communication environment, Nakagami-m fading model is used as the signal propagation model for the vehicle communication in a highway environment. We consider a highway scenario as shown in Figure 6 where vehicles are placed on a six-lane highway with three lanes in each direction. We used a realistic mobility model generator built on the simulator SUMO [6] to produce vehicular mobility traces, in which vehicles derive speeds in the range of 15–45 m/s.

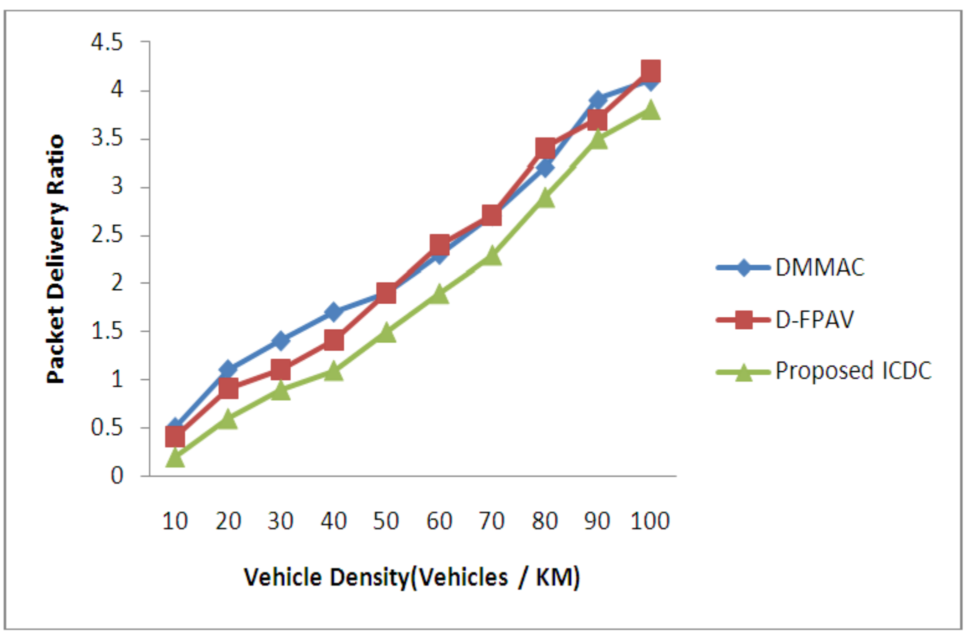
Protocols Compared

A comprehensive simulation was conducted to evaluate the performance of the proposed MAC scheme. We compare the results of the proposed ICDC protocol with the DMMAC [6], and D-FPAV [7] since these protocols carry maximum relevance to the proposed work in respect to comparability. We specify 300 m and 500 m transmission range for event-driven messages. We distinguish the results of the compared protocols based upon these two different ranges which strengthens the evaluation and provides significant conclusions. To enhance accuracy in the simulation work, we adopted a confidence interval range of 95% and for each case we replicated the simulation runs 5 times.

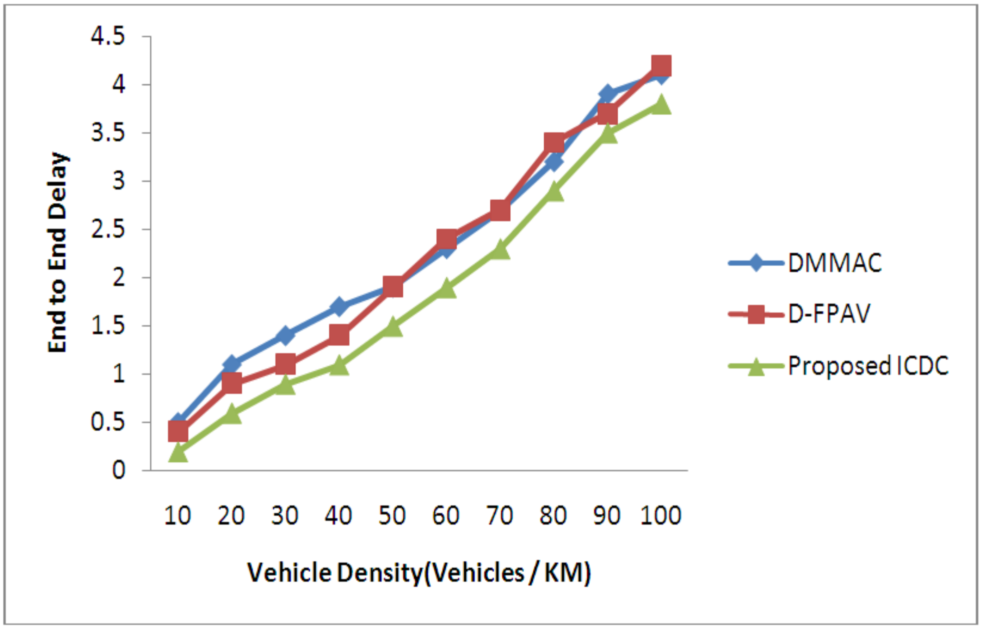
Figures 3–5 show the impact of vehicle density on the QoS parameters for two different communication ranges. Figure 3 compares the throughputs for 300 m transmission range. It shows that the proposed ICDC protocol outperforms other compared schemes. Whereas the performance of DMMAC is better than D-FPAV, it is much below the proposed ICDC protocol. This is because the proposed scheme alleviates message delivery rate by incorporating a mobility based clustering scenario. Similar results were obtained for 500 m transmission range as shown in Figure 3. The throughput value for this range is on a little higher side as compared to 300 m range.



Figures 4 show the increase in the PDR with respect to the increase in node density for 300 m and 500 m transmission range. The PDR reaches value near about 0.9 (equivalent to 90%) as the vehicular density approaches 100 nodes for the proposed protocol. However, for DMMAC, the maximum PDR attained is 0.36 for both the transmission ranges when the number of vehicles reaches 100. In the proposed protocol, any or all of the members can reserve the slot and send their message. Apparently, the delivery ratio would definitely increase by increasing the number of vehicles in a given area since there will be more number of reserved nodes to transmit and eventually receive. This explains why the proposed protocol has better performance than other compared schemes particularly under high vehicular density.



Figures 5 compare the end-to-end delay of the proposed ICDC protocol with those of other protocols under evaluation.. For D-FPAV protocol, the delay limit is below 100 ms for high vehicular density but for sparse scenario, this value surpasses the delay bound limit of 100 ms required for most of the safety applications [8]. DMMAC protocol performs much better than the previously discussed protocols and confines its delay limit much below 100 ms for all vehicular densities and transmission ranges. At the lowest node density, it shows a delay of 31 ms and 32 ms for highest node density at a transmission range of 500 m. However, the proposed protocol outperforms all other protocols with minimum value of delay caused although it is marginally lower DMMAC. This outperforming of the proposed ICDC protocol is due to its ability to reduce the probability of transmission collision as compared to DMMAC and D-FPAV.



Conclusion

In this research paper, ICDC a Secure MAC protocol for VANET has been proposed which addresses delivery of protection messages in an efficient and reliable manner. The protocol incorporates mobility based clustering and slot reservation mechanism to reduce congestion and facilitate faster dissemination. CHs are elected in a distributed manner according to their relative speed and distance from cluster members. The CH exhibits long average lifetime. Status messages are exchanged within a cluster following a sequence advertised by the CH. The multichannel feature of WAVE is harnessed while assigning the slots to the nodes. We advocate the use of multiple data rates to make the protocol scalable and avoid congestion in the presence of significant vehicle density. Then, vehicles are provided time slots in the transmission period of their respective frames.

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