A Modified TDMA Traffic Model For Vehicular Ad-Hoc Networks

Shakeel Ahmed, Humaira Nishat

Abstract— Vehicular Ad hoc Networks (VANETS) is one type of mobile ad hoc networks wherein the data exchange takes place among vehicles. IEEE 802.11p is the standard which is used for Vehicle-to-Vehicle (V2V) communication and is also known as Wireless Access for Ve-hicular Environment (WAVE). Implementing this VANETs using computer simulations are required before its implementation on roads. These simulations include a combination of urban mobility simulation and network simulation. It is found through simulations that the MAC protocol in VANETs when the node density in the network is high gives a poor performance in terms of loss of data packets and jitter (delay) as collisions are encountered in the network. Thus to improve the performance Time Division Multiple Access (TDMA) schemes are introduced. However, it is difficult to implement and manage TDMA scheduling due to large network size ie., many nodes in the network, the nodes(vehicles) are mobile, and the highly varying topology of the network. Thus the paper presents a new modified clustered-based TDMA by introducing some priority conditions in the traffic. The traffic is divided into two with topmost and least priority and this is included in the MAC Header of TDMA. Simulations are carried out using Network Simulator 2 (NS2) and the evaluation results shows that the proposed cluster based model performs better even when high density network is considered with less amount of packet loss and delay.

Keywords: Delay; MAC; MANET; Packet Loss; Priority

1. INTRODUCTION

The effect of activity congestion related to data transfer in the day to day schedule and the environment inspired the innovative work of Intelligent Transportation Systems (ITS). VANETs are an essential component of ITS and are valuable for a wide assortment of applications, including both security applications and non-wellbeing applications [1]. The rise of vehicular systems administration made analysts to examine how the data exchange can be utilized to improve voyagers' solace. In the previous quite a long while, government organizations have cooperated with auto producers to outline and prototype diverse kinds of non-wellbeing related vehicular applications. The greater part of such applications depends on communication in the vehicular environment. As security related applications of communication among vehicles have strict unwavering quality and postpone prerequisites, giving every node the slot for wellbeing messages without meddling with other nodes is needed. Additionally, security messages depend on broadcast transmission, along these lines, utilizing the IEEE 802.11 RTS/CTS system for collision shirking isn't possible in VANETs.

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Vehicular Ad-hoc Networks (VANETs) consists of dynamic mobile vehicles or nodes that make extremely powerful networks. VANET is one of the exceptional sorts of Mobile Ad-hoc Networks (MANETs). The VANET comprises of an arrangement of vehicles outfitted with the unit for communication and a Global Positioning System (GPS) recipient, On Board Unit (OBU) and an arrangement of some stationary units deployed on the roads, called Road Side Units (RSUs). In view of OBU and RSU, VANET has two fundamental communications: Vehicle-to-Vehicle (V2V) and Vehicle-to-RSU (V2R). To help V2V and V2R communications, the United States Federal Communication Commission (FCC) dedicated 75MHz radio range in the 5.9GHz band for Dedicated Short Range Communications (DSRC) range.

The arrangement of the paper is given here: Section 2 presents the types of VANETs and its characteristics. Section 3 gives an introduction to multichannel vehicular network and TDMA MAC. Section 4 discusses the proposed method. Section 5 discusses the experimental setup and execution results and section 6 presents the conclusions.

2. TYPES OF VANETS

There are two types of data exchange that takes place in VANET. One is between Vehicle to Vehicle (V2V) and the other is among Vehicle-to-Roadside (V2R).

Vehicle to Vehicle Communication

V2V communication is shown in Figure 1. In this, a vehicle utilizes multi-bounce broadcast to forward data to a gathering of vehicles. There are two kinds of sending that are utilized in V2V, straightforward sending and intelligent sending. In straightforward sending, vehicles broadcast crisis message occasionally. This sending creates colossal quantities of broadcast messages, expanding impact rate, moderate conveyance times and lessen conveyance proportions. In intelligent sending, vehicles utilize some determination calculation to pick the following vehicle to broadcast the message instead of all the vehicle broadcasting similar messages. This is constraining the quantity of messages broadcast for a crisis occasion; decrease message impact rate and use organize assets to transmit distinctive messages. In the event that a vehicle gets a similar message from in excess of one source it will respond for the primary message as it were.

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Fig. 1: Vehicle to Vehicle Communication

Vehicle to Roadside Communication

Figure 2 indicates V2R communication, which is a solitary jump broadcast where the RSU transmits a broadcast message to every single prepared vehicle in the specific zone. It utilizes high transmission capacity for communication among vehicles and RSUs. In V2R, the design assumes a coordination job by social event worldwide or neighborhood data on movement and road conditions and after that recommending or forcing certain practices on a gathering of vehicles. The speed with which the vehicles are assigned and also the increasing velocities of vehicles and inter-vehicle separations are recommended by the RSUs based on movement conditions and activity speeds likewise broadcast messages like mishap zones, climate conditions, and emergency vehicle ready messages. It additionally broadcasts demand or cautioning messages to the vehicles which abuse as far as possible.

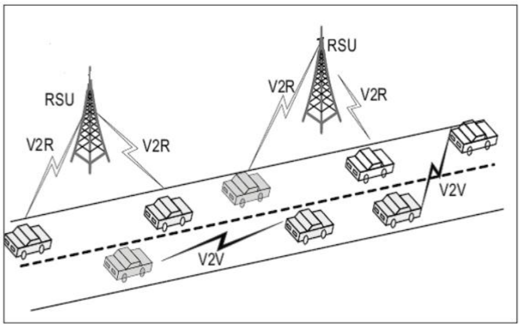

Fig. 2: Vehicle to Roadside Communication

2.1. VANET Characteristics

At the point when a vehicle knows about congested driving conditions or some other crisis risk on the road, it can utilize the VANET to pass on the data to different vehicles. In view of the data got through remote medium, driver help frameworks or OBU can caution the driver to pick the backup way to go for the goal. By VANET communication, a driver knows about the activity conditions in a geological territory quite surpassing the scope of human understanding or vehicles automobile sensors. VANETs are described by a very unique topology because of the high relative speeds of vehicles and particular development examples and conduct of the drives the significant qualities are as per the following.

Rapidly Changing Topology Due To High Mobility

Vehicles move quickly, especially on roadways. The vehicle remains in the communication scope of different vehicles only for a few moments. VANET topology is harder to oversee when the paces between vehicles are high or when the vehicle thickness is low that is might be 1-2 vehicles for every kilometer or while existing courses disengaged before building up new courses and when. The issue of portability and interfacing variable speed vehicle is a major issue for VANET. Accordingly, VANET requires an additional steering protocol instead of traditional directing protocols in MANET.

Mobility Modeling and Prediction

In VANET, the forecast of the vehicle position and their development is extremely troublesome. Vehicular network development is normally controlled by pre characterize roadways, roads, and lanes with given the speed; consequently, the future position of the vehicle can be predicted. Vehicular networks are generally worked in two ordinary interchanges situations. In expressway movement situations, the earth is generally basic and simple while in city conditions it turns out to be substantially more mind boggling. In this, vehicles moving along these ways give a chance to foresee the course of the vehicles. Anyway, there isn't generally an immediate line of communication in the boulevards in a city in light of the fact that are isolated by structures, trees and different hindrances.

Design Constraints for MAC Protocol

The WSN uses a medium for communicating the information among nodes which is shared by every one of the hubs (nodes). These nodes are spread over the entire area which is to be analyzed. The dispersion of these nodes makes significant trouble in the outline of powerful medium access protocols for WSNs. The nodes must trade a few packets so as to choose the hub for getting to the medium at a specific time. Communication channel is utilized for trading the data transfer among nodes. Intermittently the entrance to the communication channel changes which expands the MAC protocol many-sided quality and acquires additional overhead in managing the entrance to the medium by various nodes. The principal downside of the spatial appropriation is, it won't enable a node to know the present condition of another node in the system. A node can acquire the status data of other nodes just by trading the messages. This includes the proliferation delay. So any data gathered is in any event as old as the engendering delay. So it is difficult to acquire the prompt status of different nodes in the system.

TDMA is utilized to empower many nodes which can send the data on a similar recurrence channel. It separates the flag into various time outlines. Each time outline is isolated into a few time openings, where every node is allocated to a slot to send the data. The objective of any task plot is to make the way toward doling out spaces simple and direct. For VANET, security messages are more imperative, yet non-wellbeing messages should be conveyed regardless of whether there are a great deal of security messages. The task, proposes another TDMA bunch based MAC (TC-MAC) that can be utilized for intra-group communications in VANETs. The protocol coordinates the centralization approach of group administration and another plan for TDMA opening reservation. The principle target of this work is to enable vehicles to send and get non-wellbeing messages with no effect on the unwavering quality of sending and accepting security messages, regardless of whether the activity thickness is high.

To help the more priority wellbeing applications, the MAC protocol is intended to give productive broadcast administrations. For example, HER-MAC [2] gave a solid broadcast instrument of wellbeing message by using administration direct in a half and half plan utilizing TDMA and CSMA. Other cross breed plot enhanced time slots acquisition and gave strict need to quality of service (QoS) streams contrasted with best-exertion streams. E-VeMAC [3] tackled the parallel transmission issue in the VeMAC protocol [3].

The MAC protocol should select a hub for getting to the medium any time of time. The conduct of the effective MAC protocol is influenced by two components: the instrument utilized for settling on the choice and the brought about overhead. A trade-off exists between these two factors. An endeavor to diminish the overhead included may bring about decreasing the nature of choice made. So also a technique used to improve the nature of choice may not diminish the caused overhead. A decent MAC protocol should give the best choices with least overhead.

Time Division Multiple Access (TDMA)

Every client is permitted to transmit just inside indicated time interims (Time Slots). Diverse clients transmit in different Time Slots. At the point when clients transmit, they possess the entire recurrence transfer speed (partition among clients is performed in the time space). Figure 3 shows the TDMA frame structure. TDMA requires a unified control node, whose essential capacity is to transmit an occasional reference burst that characterizes a casing and powers a proportion of synchronization of the considerable number of clients. The casing so-characterized is isolated into availabilities, and every client is appointed a Time Slot in which to transmit its data.

Fig. 3: TDMA Frame Structure

In advanced frameworks, consistent transmission isn't required on the grounds that nodes do not use the allocated speed of transmission constantly. In these scenarios, TDMA is the access method that is used as alternative to this. Worldwide Systems for Mobile correspondences i.e., Global System for Mobile Communication (GSM) utilizes the TDMA strategy. In this strategy, the whole capacity for transmission i.e., bandwidth is accessible to the nodes however just for a limited timeframe. Much of the time the accessible data transmission will be divided into less channels contrasted with FDMA and the clients are designated schedule vacancies amid which they have the whole channel transfer speed available to them, as appeared in figure 3.

3. TDMA CLUSTER BASED MAC

3.1. Multichannel Vehicular Networks

One standard designed for multichannel task for VANETs is IEEE 1607.4 that takes a shot on the 802.11p which corresponds to the MAC layer [1]. The slots in the channel are isolated into a state of harmony interim of 100ms that comprises of protect interims and rotation of settled length interims, called the CCH interim (CCHI) and the SCH interim (SCHI). The term of the two interims are settled as 50ms. For the security involved applications, the consortium for Vehicle Safety Communication (VSC) characterizes some sorts of beacon messages: occasion driven and intermittent. Occasion driven messages are transmitted in conditions of identifying some dangerous situations, while intermittent messages proactively advise to the vehicles that are adjacent to them regarding the status (e.g., the character, location and speed) of its own. The VSC prescribes that life-basic wellbeing application requires a recurrence of 10 messages for every second with a most extreme dormancy of 100ms.

Real difficulties identified with multichannel administration are wasteful aspects of range usage, conceivable timeout of security information conveyance, and poor transfer speed portion for non-safety information conveyance. The present rendition of the IEEE 1609.4 MAC standard can't bolster both wellbeing and non-safety applications with huge unwavering quality at neither more activity thickness, nor give better channel use to other non security type of applications.

3.2. TDMA Cluster-based MAC (TC-MAC)

TC-MAC [4] coordinates the brought together methodology of bunch administration and another plan for reserving space in TDMA. A main goal of this plan is to enable nodes to transmit and get non-wellbeing data with no effect on the dependability of transmitting and getting security messages, regardless of whether the activity thickness is more. The TC-MAC likewise intends to diminish crashes and bundle drops in the SCHs, to give decency in dispensing the remote medium, and to limit the impact of shrouded points. TC-MAC can convey non-wellbeing messages inside sensible time limitations (i.e., reaching the necessities of least inactivity security data). At less activity of vehicles, be that as it may, the proportion of missing wellbeing/refresh messages is up to 30%, in light of the fact that the TC-MAC permits SCH opening portions for nodes while some nodes are sending security related data at the vacancy utilizing CCH. Indeed, even in overwhelming rush-hour gridlock, there is some drop somewhere around 4% of security bundles. The TC-MAC just dispenses default SCH opening, so the usage of SCH spaces is restricted up to half contingent upon the movement of vehicles. CCH and SCHs both have poor utility of channels and also obtain very less throughput. It doesn't expect all nodes in the group to convey, or dynamic, at the same time. In addition, it doesn't

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take into account the Guard Interval (GI) and Inter outline Gap (IG) between the spaces and legitimate edges, separately.

4. PROPOSED MODEL

The cluster based idea utilizes the expanse or the region to make a group. It chooses one node as the head of the cluster to fill in as the coordinator of the system in this group based model. Wang et al. proposed a VANET which demonstrates and divides the groups outline the activity, probability and conditions of the channel. Farooq et al. proposed a group based steering protocol of multicast for vehicles used in military and also the group or a cluster can be shaped by utilizing RSU as an inside.

4.1. Proposed Cluster Based TDMA System

The proposed system has two sorts of communication, intra-group (intracluster) and between groups interchanges (intercluster). Intra-Cluster is interchanges set up between individuals from a group. There is a Vehicle Coordinator (VC) in a cluster which acts as a leader and the other nodes are simply called as Vehicle Node (VN) or individuals. Inclusion of a group is characterized as the basis for the transmission scope of VC.

Transmit and receive scheme is used to appoint the VC at first and a time slot for bandwidth request is chosen randomly by a VN in cluster based TDMA system without having any limitation on the number of VNs. The announcement of a cluster is made by VC to VNs in a cluster. After receiving the VCs packet, VNs gain knowledge about VCs MAC address and also about the other VNs in the cluster. In their assigned timeslots, all VNs can send data at the same time by transmitting one message in the broadcast form without the possibility of collision. There is one VC for each cluster. VCs can communicate with its VNs in their respective transmission range. If there is an overlapping region between two clusters then the two VCs of two clusters share information for a certain time. During this, the VCs coordinate regarding the assignment of their time slot of the cluster so that the nodes belonging to the cluster can share information with the nodes belonging to other clusters. This exchanging of information with members of other cluster results in inter cluster communication.

Different pre-emptive algorithms are used in intra-cluster and inter-cluster communications. There are three phases of communication process taking place. These are i. Initiation, ii. Pre-emption and iii. Transmission. Quick sort algorithm is used in pre-emptive algorithm in order to sort the time slot request from VN. This is actually in accordance with the priority at the request.

5. EXPERIMENTAL RESULTS

Simulations are carried out using Network Simulator version 2 (NS2). A network scenario of 80 nodes as shown in Figure 4 is created using tool command language.

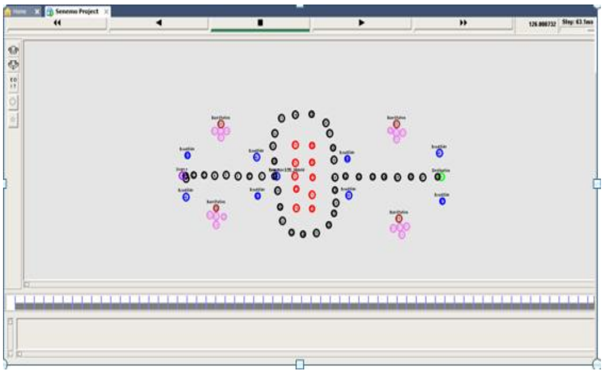

Fig. 4: NAM Window showing a configuration of 80 Nodes

In this network scenario there are 80 nodes: one source node and one destination node. Red shading speaks to the base station green shading demonstrates how data transfers starting with one node then onto the next node. Roadside units speak to by blue shading. The simulation is run for 60 seconds and the following result is obtained. The packet loss and throughput is calculated both by using x-graph as well as by conducting experiments for five times and averaging.

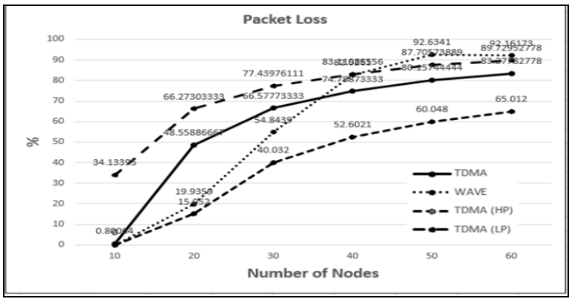

Fig. 5: Packet Loss in case of Intra Cluster

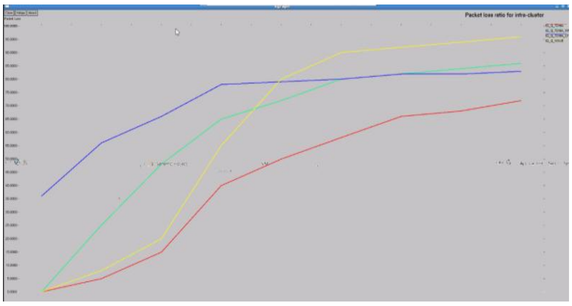

Fig. 6: Xgraph for Packet Loss in case of Intra Cluster

TDMA with more priority demonstrated the excellent execution and resulted in minimal drop of data i.e., less packet loss, yet TDMA with less priority experienced much drop of data ie., higher packet loss as shown in Figures 5 and 6.

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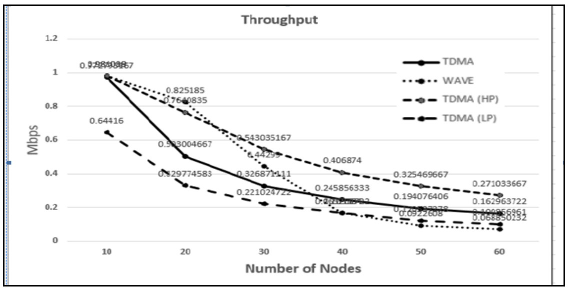

Fig. 7: Throughput in case of Intra Cluster

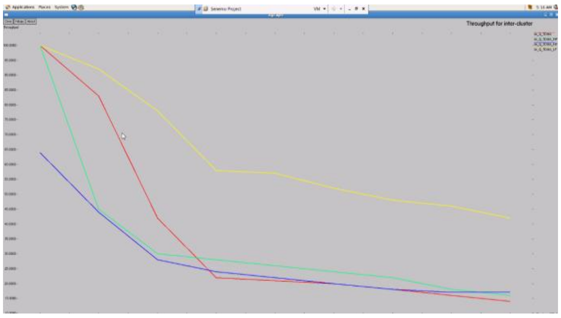

Fig. 8: Xgraph of Throughput in case of Intra Cluster

From Figures 7 and 8 it is clear that throughput diminishes with the increase in the size of the network. The execution of TDMA outperforms the other standards like WAVE, yet the execution of more priority TDMA outperforms the majority of the entrance techniques if it starts with 30 number of nodes in the network.

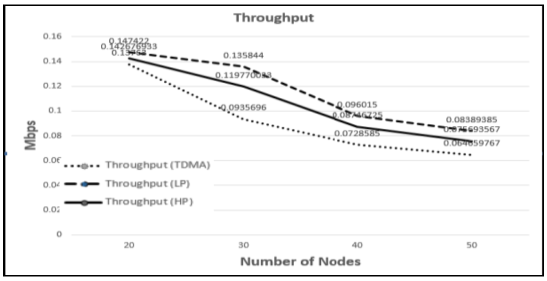

Fig. 9: Throughput in case of Inter Cluster

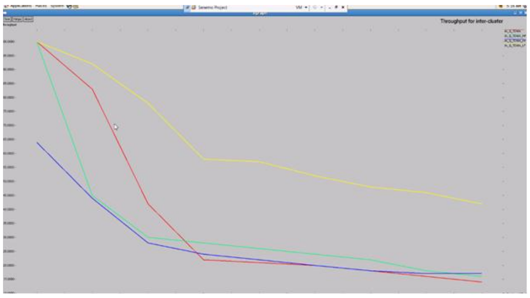

Fig. 10: Xgraph of Throughput in case of Inter Cluster

The graphs in Figures 9 and 10 outline the model, least priority TDMA and most priority TDMA for an alternate density of nodes. The result demonstrates that the successful transmission of data per second (throughput) decreases with the increase in density of nodes in the network. The execution of TDMA with more priority outperforms the majority of the entrance techniques in each network size.

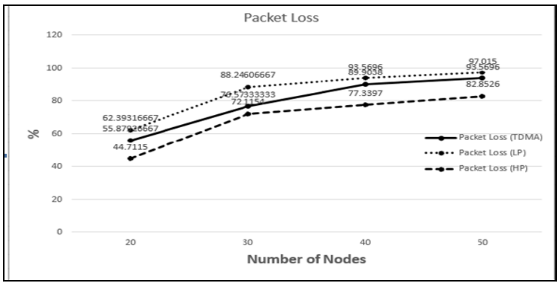

Fig. 11: Packet Loss Ratio in case of Inter Cluster

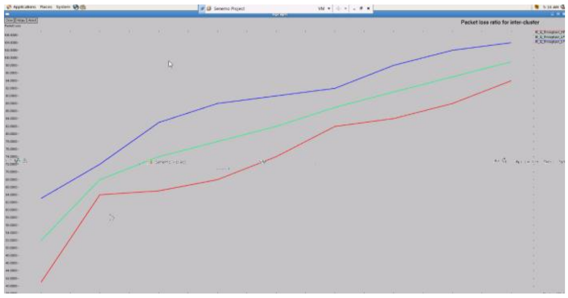

Fig. 12: Xgraph showing the data loss in Inter Cluster

It is concluded from Figures 11 and 12 that in inter-cluster communication bundle misfortune i.e., packet loss increases as various node builds due to congestion and encounters a narrow channel at VC.

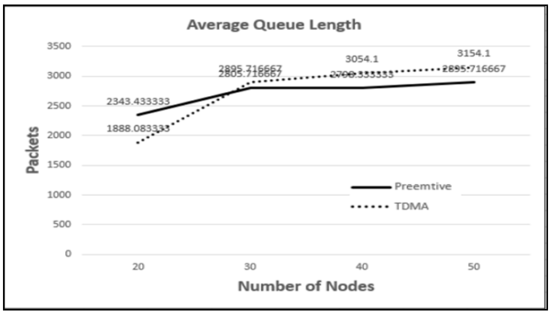

Fig. 13: Average Queue Length in VC

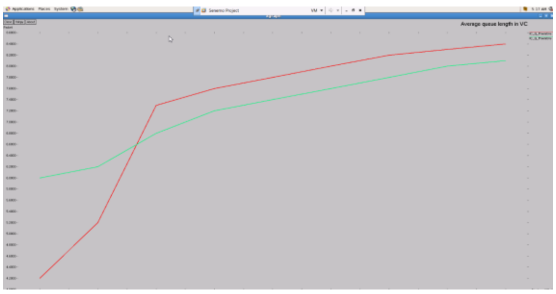

Fig. 14: Xgraph of Average Queue Length in VC

In Figures 13 and 14 it appears as if the length of the queue which occurs due to the narrowed channel when VC forwards the data packet between groups is of normal size. But as the size of network increases then it encounters an increase in queue length resulting in a little increase in delay.

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6. CONCLUSION

The paper presents a modified TDMA traffic model wherein the traffic is modeled in a cluster form by inserting priority into it. The simulation result demonstrates that in intra-cluster communication, the TDMA with top priority gives better performance with regard to throughput and also the packet loss is relatively less. Also in case of Inter-Cluster reenactment the result shows that the high priority TDMA only gives the better result with almost the same delay as compared to existing TDMA schemes.

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