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Dynamic Adaptation of TX Power & Contention Window for VANET

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ABSTRACT

One of the most modernizing technologies among the transportation system where vehicles communicate through a wireless medium is vehicular ad-hoc network(VANET). In the proposed IEEE 802.11 include the interaction between the vehicles (V2V) and between vehicle and roadside infrastructure (V2I). Due to technological development there is an increase in the number of wireless devices which causes congestion which has an adverse effect on the throughput, long-latency,increase in high-error rate and data being lost in the wireless environment which leads to an immense collision of vehicles accidents. Thereby this method is used to control congestion, to regulate the traffic level to an acceptable level. Thus the proposed algorithm includes study existing 802.11 standard and develop an algorithm on MAC to modify parameters like transmit power, contention window and packet interval to reduce the congestion due to heavy broadcast traffic in the network for VANET.

Keywords: *VANET,IEEE 802.11, Contention Window, Congestion, MAC*

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I. Introduction

Vehicular Ad-hoc network (VANET) is similar to Mobile Ad-hoc network (MANET) here the mobile acts as the wireless station whereas in VANETvehicles act as wireless station .VANETs acts as a key component in the intelligent transportation system .This method is very effective as the vehicles themselves try to solve their problems individually within their communication range. VANET provide two different types of communication. One is vehicle to vehicle communication and the other is vehicle to infrastructure communication. The message propagation and transfer should be carried out in a precise time. Thus, reliability and low delay are extremely important factors for VANET applications to propagate and transfer the message to the areas of interest. Fig.1 shows the communication between the vehicles and roadside unit. Each vehicle has the on board unit (OBU) which is present in the vehicle this helps to gather the information about the other OBU or Road side unit(RSU).It is been provided with a network device for wireless communication based on IEEE 802.11 radio technology .The RSU is capable of communicating with the short range wireless networks using IEEE 802.11. VANET require IEEE 802.11 specification to communicate with the high speed vehicles. IEEE 802.11 has a minor change to IEEE 802.11 to add wireless access in vehicular environment (WAVE).All the short range radio technology like Wi-Fi, Bluetooth, Zigbee, visible light communication are used for communication purpose.

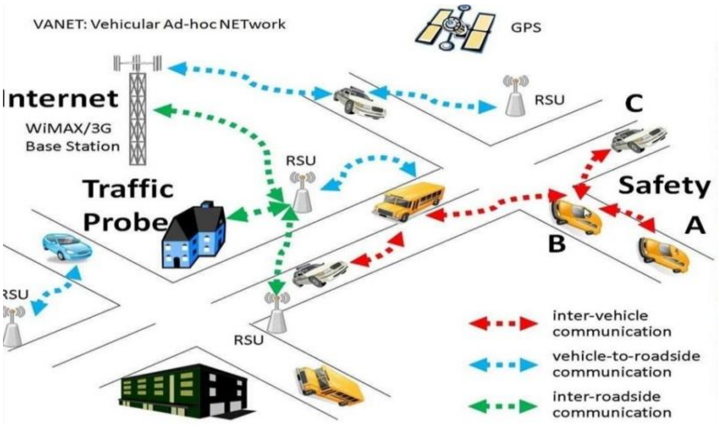

Figure 1: Communication between vehicles and roadside unit

VANET use short range radio technology for communication purpose, the Federal communication commission has allocated 75 MHz of dedicated short range communication (DSRC) at frequency range of 5.9 GHz to be used for vehicle to vehicle and vehicle to infrastructure communication. This spectrum has been divided into seven channels. One is the control channel and the other six are the service channel. Control channels are used to transmit the safety related message like beacons and event driven message. Beacon messages are periodically send by the every vehicle which includes their speed, location direction of travel to their neighboring vehicle. So using this beacon message vehicle can count number of surrounding vehicles. Even driven message are generated when the vehicle detect any abnormal situation. Six service channel are used to transmit non safety message like sharing file, gaming, web surfing, file download, theatre, petrol pump, nearest parking availability.

1.2 Characteristics of VANET

Dynamic topology: The movement of the vehicles in the different traffic condition such as during rush hours, traffic light, traffic jam, accident, late night and school area are different whichresults in dynamic topology of the vehicular network.The topology of the network can be changed by the driver's behaviordue to his/her reaction towards the messages.

Dynamic Node Density: Due to road architecture, highways and city environment node density does frequently vary. As network density depends on the node density, the network density is also variable during traffic, network can be called as highly dense network while in suburban traffic it is a sparse network.

Frequent Network Disconnection: Due to the dynamic nature of vehicular topology there is rapidly change in the link connectivity of VANETs which result in frequently network disconnection. For example during the late nights in rural area vehicle move with high speed so communication link between vehicles remains active for shorter periods.

Hard delay constraints: Themain application of the VANET is to provide safety, thus the message related to safety propagates in a timely manner thereby prevents congestion and collision.

1.3 Application of VANET

Safety: This basically focus on the reduction of the road accident, saving human life avoids collision. safety application include lane changing warning, sudden halts warning, obstacle discovery, warning on departing the highway, warning on intersection related messages.

Guidance and way optimization: Thereare many paths available to reach our goal. To find best related both in terms of travel time, fuel and toll by gathering the pertinent information system.

Monitoring and Implementation: which comprise rate limit warning and confined entries associated messages.

Travel associated Information: By use this perspective driver can find the information by communicating with other vehicles and roadside unit. Because when an unknown driver enters into the newer city than he / she don't know about the obtainable services like gas location, car service location, petrol pump, business related locations etc.

Universal Statistics Services: Universal application of internet like sharing the files, file download, gaming, web surfing, email is also available and VANETs are unsegregated to the internet.

We must use the same channel to transmit the safety data for vehicular access in wireless environment, for all V2V (Vehicle to vehicle) communication as per 802.11p amendment of IEEE 802.11. At some regular interval and /or at some critical time all vehicles communicate broadcast safety message. The number of collisions of wireless pockets increases, then the number of vehicles increased in the range of it. There is no implement to detect the collision for a broadcast frame when the messages are broadcast. So it needs some changes at MAC layer to diminish congestion / collisions.

II. Previous Work

In [5], proposedalgorithm joint adaptation of transmission rate and power to reduce channel congestion in vehicular Ad-hoc network. The rate and power adaptation has a direct influence onthe number of messages exchanged &numbers of vehicles in the awareness region respectively. By setting the collision rate value, i.e. acceptable collision rate value (5%) proposed algorithm adapts TR/TP value according to observed collision rate. Initially TR/TP value is selected between the interval $(TR/TP)_{minimum}$ and $(TR/TP)_{maximum}$ values. If collision rate is higher than the acceptable collision rate then it picks a TR/TP value in the interval between $TR/TP_{minimum}$ and current TR/TP value & if the collision rate is lower than the acceptable collision rate then it picks a TR/TP value in the interval between current TR/TP & $TR/TP_{minimum}$ value. When communication increases, collision rate also increases. To reduce the collision rate, rate adaptation is applied till minimum required rate is reached and if the collision rate is still high then power adaptation is applied.

In [6], the probability based MAC channel congestion control mechanism (PCC) is to decrease channel congestion in the vehicular environment. In this mechanism two functions are used, they area contestant estimation function and expected offset calculation function. In contestant estimation function each vehicle can count the number of surrounding vehicles based on listening messages in the listening interval. While expected offset calculation function vehicle, calculate the length of the offset slot based on the nearby vehicle. The main advantage of PCC mechanism is that each vehicle in the network varies the contention window size according to the number of nearby vehicles.Thus CW value increases when number of vehicle increases.

In [7], The joint adaptation of transmission power a contention window size is used to reduce channel congestion in vehicular environment. The movement of the vehicle is different in the different traffic condition like traffic light, accident which results in dynamic topology of vehicular network. Also during late night and rural area the vehicle speed is very low so the connection between vehicles remains active for very short periods. To extend the period one solution is there to increase the transmission power, but it create high network interference. To overcome this problem dynamic adaptation of transmission power which means increased transmission power when local vehicle density is low and decrease the transmission power when local vehicle density is high.Due to prioritization of messages, messages related to accident have higher priority than the other so they have a lower contention window size which result in high transmission opportunity compare to others. According to current collision rate, an increase or decrease in the corresponding contention window size.

In [8], author proposed adaptive congestion control transmission of safety messages to deliver an accident related message on timely manner without any delay. Here first create the vehicular network after that partition that network into equal width of segment. The vehicle which is near to the centre of the segment will be selected as the local coordinator. This local coordinator assigns the time slot to each vehicle in that segment for beacon transmission. In the case of emergency message, time slot reservation carried out dynamically and time slot will be reserved for emergency message. So by using this mechanism emergency messages can be transmitted on timely manner without expense of beacons.

In [9], author proposed adaptive and reliable medium access control mechanism by combining carrier sense multiple access with time division multiple access to avoid collision effectively and use wireless resources efficiently. Here they introduce variable duration concept called "Chip" which have transmission period (TS) and reservation period. Transmission period is basically a series of TDMA slots which is used by the nodes for their transmission while reservation period used by just newly incoming node to reserve a slot for transmission. When the local vehicle density is low, then the duration of chip is short, for this case rest of the control channel duration can be used by the service channel to improve the throughput of the service channel. When the local vehicle density is high, then the duration of the transmission period of control channel duration is high to make sure that every vehicle can transmit their safety packet successfully. In this case the duration of the control channel may be longer than service channel.

III. Proposed Solution

In the proposed technique, we will take the advantage of the MAC layer parameters which provides better performance and control in congestion of the broadcast domain in a wireless network. First, we understood the 802.11p standard and the congestion in the environment when multiple vehicles communicate with each other for warning and safety messages. All the nodes / vehicles transmit safety messages at regular configured intervals at the configured data rate and the transmit power. Each node / vehicle sends and extra information like own mac address, transmit data rate, transmit power, own contention window (CW) value, node number appended in the data payload. For V2V communication, each node broadcast this information in the message so all the node receiving the frame would parse the node information and maintain the node table which includes information of all the nodes in its range. The MAC layer parameter slot-time, transmit power, broadcast data rate, CWmin value, packet interval, etc. will be modified from its default values to enhance the broadcast congestion in the network.

IV. Algorithm used:

The Algorithm can be developed in NS3 software tool.

- The wireless stations which works in Ad-Hoc mode is developed in simulator. The wireless stations are are in mode 802.11. 'n' number of wireless stations are made. The number of wireless stations can be increased to any value.
- All the wireless stations are located at a distance of 100m each.
- Non-Vulnerable messages or packets are sent from all wireless stations. For instance 1000 messages/packets are sent from each nodes. Each messages/packets has the size of 500 bytes.
- Using the single observer the messages sent by the nodes which are interconnected are monitored.The message drop rate which results from the congestion need to be calculated(figure 2).
- MAC parameters are sent as information from all wireless stations. The parameters are TX power, Contention Window (CW_{min}), packet interval, Data Rate, Slot time, etc.The information is used to control the Congestion in the network as well as for Decision Making.
- All wireless stations adapt itself based on the configurations of the surrounding nodes.
- Each wireless station modifies its own MAC parameters such as TX power, Contention Window, packet interval in theMAC layer.
- Again the traffic is monitored and the data rate is calculated using single observer(figure 3).

Comparing the figure 2 and figure 3, the congestion is very much reduced in the proposed method.

Dynamic Algorithm – 1 (TX Power)

If the adjacent node count reaches to its threshold value then the node would change its Transmit power to lower value than the current one. This will reduce the range of the node and this node will not interfere with the node which is at far distance. Thus, the nodes which are far away from each other's range can transmit simultaneously.

```
If (adjacent node count > threshold)
 {
Decrease the Transmit power;
}
else
{
Keep the Transmit power same;
}
```

Dynamic Algorithm – 2 (Contention Window)

The following comparison is used to adjust
the Contention Window (CW):

```
IF (average- previous average >= threshold)
{
Decrease the window
}
ELSE
IF((average– previous average)>= threshold)
{
Increase the Window

}
ELSE
{
Maintain the current window.
}
```

V. Simulation Result

For simulation of the proposed algorithm, we have used Network Simulator-3 as a programming tool. We have implemented the scripts of network simulator to simulate our experimental scenario of wireless nodes and its visualizer for graphical representation & I have captured the RF congestion in the network.

PARAMETERS	VALUE
NUMBER OF NODES IN THE NETWORKS	40 NODES(VARIABLE)
NUMBER OF PACKETS	1000 PACKETS
PACKET SIZE	500 BYTES
MESSAGE INTERVAL	100ms
DATA RATE	6Mbps
TX POWER	VARIABLE
CONTENTION WINDOW	VARIABLE

Table 1: MAC Parameters used in simulation

When the number of node increases(40) then with higher transmit power more congestion in wireless environment as shown in figure 2.figure 3 shows the result of proposed Algorithm, in which for more number of nodes, the transmit power is less which reduces the congestion. Similarly we can adapt the contention window according to number of nodes.

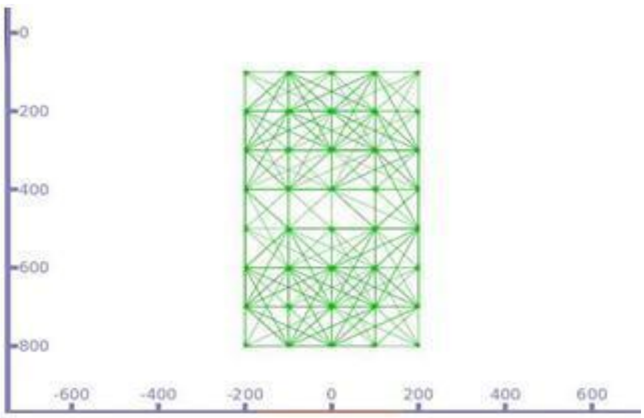

Figure2: Default method of transmission (40 nodes)

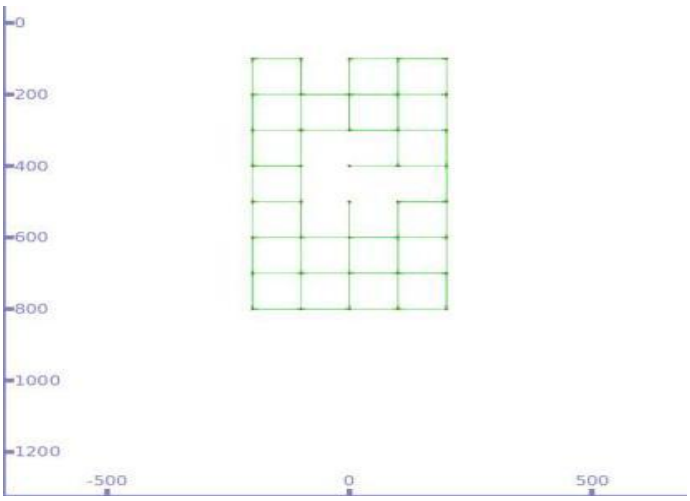

Figure 3: Proposed method of transmission (40 nodes)

VI. Conclusion

By dynamically adaptation of transmission parameter like transmit power and contention window according to number of nodes we can reduce the congestion in vehicular Ad-hoc network.

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