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CONGESTION CONTROL VALIDATION AND PERFORMANCE OF V2V SYSTEM

[1]Sarita, [2]Dr.Ravindra P Rajput

[1]Student, [2]Professor

[1]Electronics and Communication,

[1]VTU, CPGS, Kalaburagi, India

Abstract: An empirical model is proposed for the reliability of a dedicated short-range contact channel (DSRC) control channel (CCH) for handling safety applications in vehicle ad hoc networks (VANETs). In particular, the model allows to evaluate the probability of receiving status and safety messages from all vehicles inside the transmitter range and from vehicles up to a certain distance, respectively. The proposed model is based on a modern model of mobility that takes into account the following safety rule for the vehicle in order to accurately derive the relationship between average vehicle speed and density. Moreover, the model consider some factors they are 1) Mobility impact on the vehicles density all around the transmitter, 2) system reliability depends on transmitter's and receiver's speed, 3)Communication range has been modeled as a random variable to study the effect of channel fading, and 4) Transmission collisions and hidden terminal problems from neighboring vehicles. It is shown that the current DSRC specifications will lead to severe degradation of performance under dense and high-mobility conditions. Therefore, an adaptive algorithm is implemented to improve device efficiency in terms of the likelihood of successful receipt of the packet and the delay of emergency messages in a harsh vehicular environment.

***Index Terms* - Dedicated short-range communications (DSRC), Vehicle-to-vehicle (v2v), Basic safety messages (bsms), VANET, CCH Control Channel.**

I. INTRODUCTION

Vehicle to Vehicle communication system is an important integral part of the global infrastructure of the future ITS (Intelligent Transport Systems). It operates at 5.9 GHz, and its applications mainly aim to improve road safety and the quality of traffic. IEEE 802.11p, published in July 2010. In January 2017, the U.S. Department of Transportation (USDOT) released a Notice for Proposed Rule-Making (NPRM) with the ultimate aim of mandating the installation of DSRC-based Vehicle-to-Vehicle (V2V) safety contact on all new light vehicles sold in the United States. The DSRC-based V2V technology is an outcome of nearly 15 years of efforts of the industry, academia, and the government. The DSRC-based V2V system builds standards for connected vehicle technology for safety and crash avoidance applications at the top of several Institute of Electrical and Electronics Engineers (IEEE) and Society of Automotive Engineers (SAE). Such security applications are based on V2V safety communication, which includes the transmission of vehicle status information via Basic Safety Messages (BSM). In a high-traffic area, with a high number of vehicles (transmitters), the channel is congested due to increased interference and channel contention. When it comes to channel capacity,[9] specifically as a wireless network scale has raised certain fundamental limits. Within the IEEE 802.11p standard, the traditional method for addressing intrusion is to use Carrier-Sense Multiple Access with Collision Avoidance (CSMA / CA) as the medium access protocol. When a node (or vehicle) has a packet to relay it listens to the channel first. If the channel is called idle or unoccupied, then the packet is transmitted. Otherwise, the node must wait for a random return time before transmitting the packet. While this method reduces the risk of packet collisions, it doesn't completely prevent it. Thus, the performance of safety applications in large and dense V2V networks can suffer unnecessarily if all vehicles send their BSMs at the same high transmission rate and transmit power. xThe resulting high packet losses impair situational awareness of V2V and make it difficult to predict the progress of a vehicle or identify an impending accident in a timely manner.

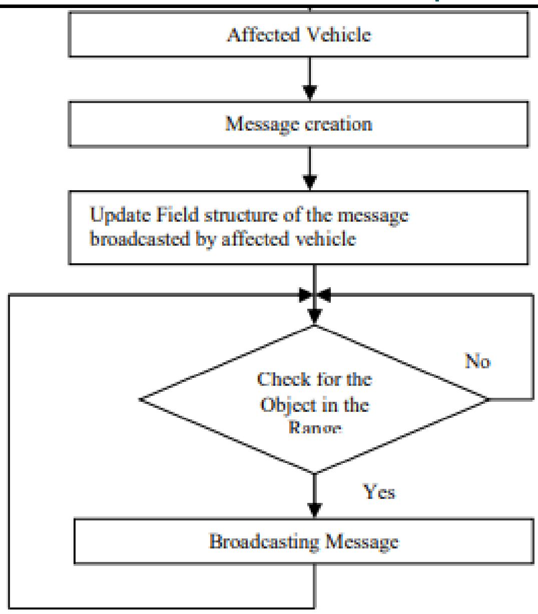

Fig. 1 Proposed System

II. RELATED WORK

[1] "Cadillacs CTS sedans can now talk to each other, which may make driving way less deadly," accessed: March 9, 2017. [Online]. Available: "General Motors announce Cadillac CTS sedans would come with "vehicle-to-vehicle" technology, which allows communicating with other similar models and helps to detect potential upcoming hazards, such as slippery roads or disabled vehicles. For example, when one CTS has a hard braking situation that information is send to other CTS sedans behind it to alert drivers about conditions. The Cadillacs will use a high-speed, low-latency medium called dedicated short-range communications (DSRC) to communicate with each other. The specification of DSRC is similar to Wi-Fi, but it has transmission band of 5.9GHz rather Wi-Fi's which has 2.4GHz frequencies".
Limitations:
It allows them to communicate with other having the similar models.
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[2] Congestion Control in V2V Safety Communication: Problem, Analysis, Approaches: "To achieve safety and efficiency in intelligent transportation systems (ITS) Vehicular Ad Hoc Networks (VANET) is considered to be an important step. In VANET vehicles communicate with each other with low latency and packet loss which is one of the important requirements of safety applications. Challenging problems for VANETs is unreliable channel quality, high mobility and high message rate. In vehicle-to-vehicle (V2V) communication congestion control algorithms provide reliable delivery of safety messages. In this paper, they present a comprehensive survey of congestion control approaches for VANET. We identify the Relevant parameters and performance metrics can be used to analyze and evaluate these approaches and Based on number of factors such as the type of traffic, whether it is proactive or reactive, and the mechanism for controlling congestion each approach is analyzed. This paper concludes with some additional considerations for designing V2V communication protocols, discuss problems and provide directions for future work".

[3] C. Campolo and A. Molinaro, "Multichannel communications in vehicular ad hoc networks: a survey," IEEE Communications Magazine, vol. 51, no. 5, pp. 158–169, 2013.: "The advent of vehicle-to-everything (V2X) communication has opened the opportunity to design advanced driver assistance systems (ADAS) that collect information from sensors in neighboring vehicles and roadside infrastructure. Network protocol standards for V2X communications have designed by ETSI and IEEE. ETSI and IEEE protocol stack have different vehicular wireless communication architecture. Two standards have common multichannel operations, with some channels dedicated to safety-critical applications and some to nonsafety services. In mid- and heavily congested scenarios these standards might not provide utilization of channel in sufficient way. This paper proposed and evaluated the performance of a driver-assistance system to reduce the connectivity gaps between vehicles and roadside units (RSUs). Radio channel utilization is improved by cooperative system of multi-service channel allocation. Using the IEEE-WAVE standards required latency for inter-vehicle communication can be obtained and dedicated short-range communication (DSRC) proposed for vehicular environments. Simulation results show that compared with the dynamic channel allocation method the proposed scheme can improve the average throughput by up to 15 % in various traffic density conditions".

[4] A. Rostami, H. Krishnan, and M. Gruteser, "V2V safety communication scalability based on the SAE J2945/1 standard," in 2018 ITS America Annual Meeting. ITS America, June 2018.: "Major international automakers have deployed on their vehicle fleets for wireless connectivity the 5.9 GHz dedicated short-range communications (DSRC). DSRC provide vehicle-to-vehicle (V2V) communication by broadcasting basic safety messages allow safety applications for crash warning and avoidance. However, in dense traffic conditions the resultant channel load increases and V2V deployment scales up leads to channel congestion and this affect the performance of the safety applications. Institute of Electrical and Electronics Engineers (IEEE) 802.11p and IEEE 1609 standards provides the performance requirements for V2V safety communications and provides a congestion control protocol for transmission power and rate adaptations to achieve good performance in dense vehicular networks. This paper contributed that using a congestion generation testbed that reproduce channel congestion by considering a large number of remote vehicles and test any V2V equipped vehicle. Our paper also demonstrates that under heavy congestion, even with 600 ms of inter-transmit time, a moving vehicle can be tracked to a lane-level accuracy".

[5] S. Kaul, M. Gruteser, V. Rai, and J. Kenney, "Minimizing age of information in vehicular networks," in 8th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON). IEEE, 2011, pp. 350–358.: "To disseminate time-critical information applications relay on wireless broadcast. For example, to enable safety applications vehicular networks exchange vehicle velocity and position information. In such networks number of nodes in one-hop communication range can be very large, leading t undesirable levels of packet collisions and congestion. Earlier work has examined protocols from a MAC perspective and focused on packet error rate. In this work, they proposed the average system information age which captures the requirement to maintain current state information from all other nearby nodes of such applications. They showed that information age can be minimized at an optimal operating point that lies between the maximum throughput and minimum delay. Also, through simulations they showed that it cannot be achieved through pure MAC techniques such as contention window adaptation in 802.11 networks. To adapt their messaging rate to keep the system age to a minimum it uses local decisions at nodes in the network. Experiments with 300 ORBIT nodes and simulation show that the algorithm effectively adapts the messaging rates and minimizes the system age".

III. PROPOSED SYSTEM

This paper presents experimental results from a test bed with prototypes of the IEEE 802.11p modem and an emulation of the RF channel, and contrasts them with simulation performance. Simulation results highlighted the importance of using the receiver's channel tracking algorithms to support very high mobility. In order to prevent congestion in VANETs environment in this paper we propose congestion control algorithm. We also study the performance of proposed congestion control algorithm in different congested scenarios for event-driven safety messages. The effectiveness of the proposed congestion control algorithm is evaluated through the simulations using Matlab simulator.

CONGESTION CONTROL ALGORITHM

1. Select maximum transmission range, calculate the required transmission power based on the transmission range.
2. For each packet a vehicle sends, repeat steps 4-5
3. Procedure Set VehicleDensity(VD)
    - a. VehicleCount(VC) = getVehicleCount()
    - b. if (VehicleCount(VC) ≥ 120) then VehicleDensity(VD)← Dense
    - c. else if (30 < VehicleCount(VC) && VehicleCount(VC) < 120) then VehicleDensity(VD) ←Moderate
    - d. else if (VehicleCount(VC) ≤ 30) then VehicleDensity(VD)←Sparse
    - e. end if
    - f. end procedure
4. Procedure AllocateTransmissionPowerLevel (ATP)
    - a. if VehicleDensity(VD)= High then setTxPower (LowTxPower)
    - b. if VehicleDensity(VD)= Moderate then setTxPower (MediumTxPower)
    - c. if VehicleDensity(VD) = Sparse then setTxPower (HighTxPower)
    - d. end if
    - e. end procedure

IV. EXPERIMENTAL RESULTS

fig 2: vehicle congestion screen

Here the system using following parameters for the simulations:

	Parameters	Values
1.	Safety distance (Ds)	= 10 meters
2.	Vehicle speed Smin	= 50 miles/hour = 22.35 meters/second, Smax = 70
3.	miles/hour	= 31.29 meters/second
4.	Vehicle acceletation	= a_min= 0 meters/seconds2, a_max = +(-) 5 meters/seconds2
5.	Road Traffic Volume	= vol = 3000 vehicles/hour/lane
6.	Vehicle Arrival rate/Departure rate	= 0.833
7.	Road Traffic Density	= 100-500 vehicles/lane

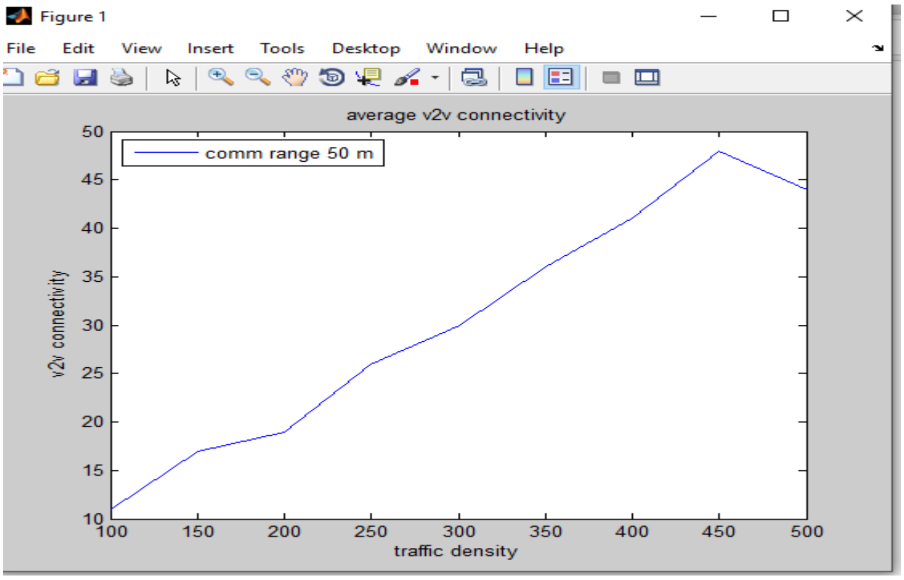

fig 3: average v2v connectivity

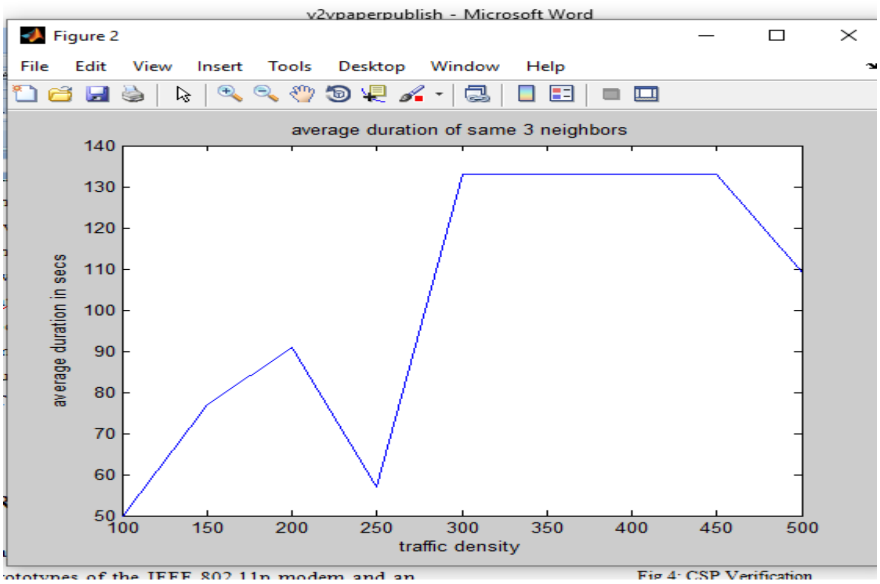

fig 4: average duration of 3 neighbors

(traffic density Vs Avearge Durtion in sec)

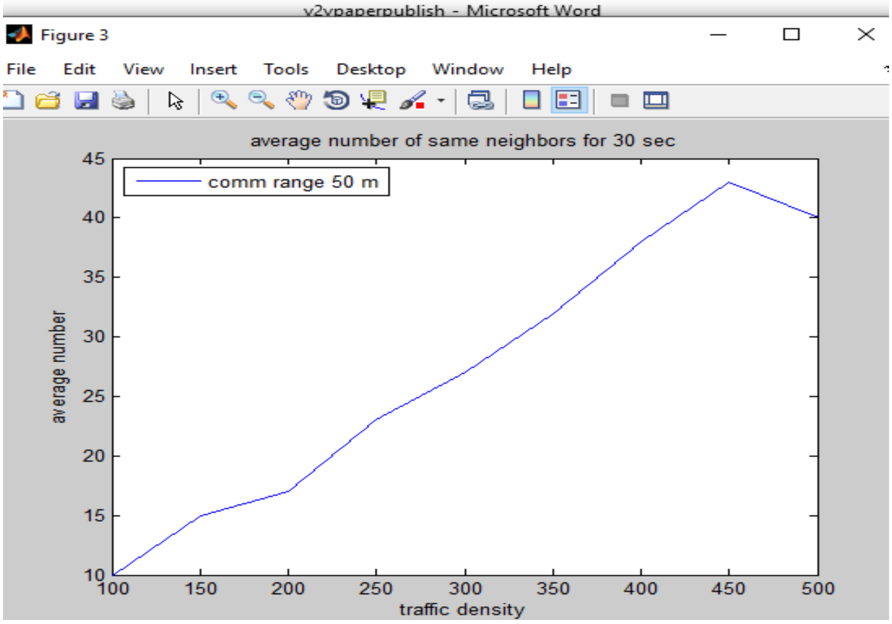

fig:5 average number of same neighbors in 30 sec

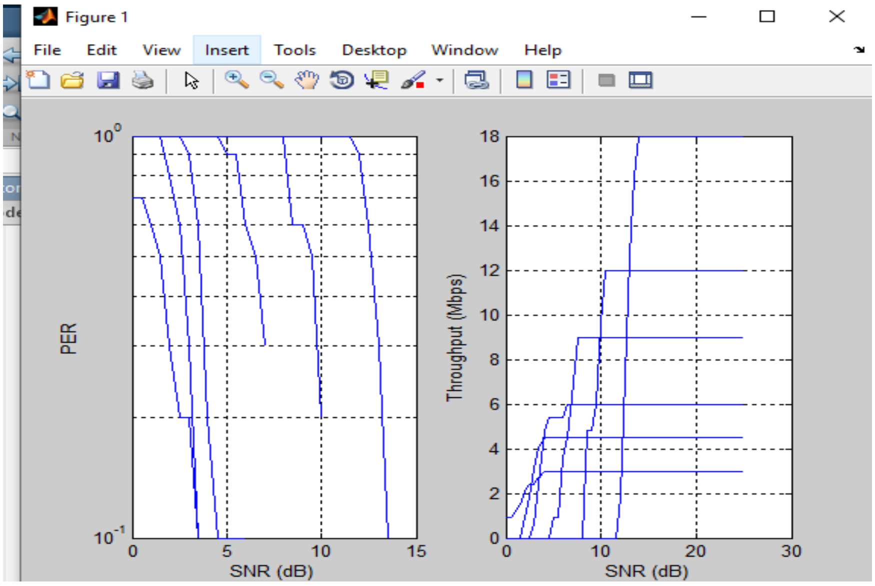

fig:6 plotting of per and throughput

Congestion affects two vital network performance parameters, namely throughput and delay. In simple terms, the percentage utilization of the network capacity can be defined as the throughput. Initially, the throughput increases linearly with the load offered, because the network usage increases. In the Fig 6: it represent the result of the signal to noise ratio to the throughput, the x axis represent the SNR in dB and the y axis represent the throughput in Mbps. Packet Error Rate (PER) is used to test the performance of an access terminal's receiver. Throughput in communication networks, such as Ethernet or packet radio. Throughput or network throughput is the rate of efficient message delivery over a communication channel. This fig shows that how the packets transferring to vehicles.

V. CONCLUSION

In this paper, an analytical model to analyze the reliability of IEEE 802.11p in the safety and warning applications of VANETs was presented. The study is based on a new model of mobility in which the relation between vehicle density, speed and the rule of the following distance is derived. Many factors were considered in the study, such as the effect of mobility on the connection availability between the transmitter and the receiver, vehicle density on the road and the total number of vehicles within the transmitter range. The model proposed is based on the assumption that vehicles transmit their status messages within the SI and model each vehicle as a 1-D Markov chain including the busy probability channel in each state. Analytically and by simulation is shown the efficient maximum contact range which can be used under certain conditions to achieve a certain performance rate. From the analytical and simulation results it is shown that the current DSRC requirements will lead to unwanted output in harsh vehicular environments. This paper presents experimental results from a test bed with prototypes of the IEEE 802.11p modem and an emulation of the RF channel, and contrasts them with simulation performance. Simulation results highlighted the importance of using the receiver's channel tracking algorithms to support very high mobility. In order to prevent congestion in VANETs environment in this paper we propose congestion control algorithm. We also study the performance of proposed congestion control algorithm in different congested scenarios for event-driven safety messages. The effectiveness of the proposed congestion control algorithm is evaluated through the simulations using Matlab simulator.

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