Analysis Of TCP Congestion On Random And Structured RSU Distribution For VANET

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Abstract: One of the significant issues is that can limit the capacity of VANET would be network congestion. The first phase is congestion management, congestion analysis is the focus of the article. We suggest cumulative parameters that can take into account the total structure of the system, including TCP traffic energy used by each node, throughput, the delay, cumulative distribution time and congestion window. The cumulative parameter can reliably, quickly, and instantaneously detect channel congestion by the Control room and eliminating the flaws of using the different variables to reduce the channel congestion. Besides that, the article suggests a necessary, but robust infrastructure-based approach by using the TCP_{Vegas} technique that can normalize these variables through the same aspect, resulting in the normalization of the cumulative value. This article helps to manage the communication traffic in VANET so that the High Priority Message reaches the destination with minimal time. This approach also helps to reduce accidents by getting information on time.

Keywords: On Board Unit, Road Side Unit, Transmission Control Protocol, VANET.

1. INTRODUCTION

According to the WHO Global report about road safety in 2018, released in December 2018, the rate of new road fatalities has risen to 1.35 million road traffic accidents becoming the leading cause of death for public age from 5 to 29; how was motorcyclist, cyclists, and pedestrians, especially in developed countries bears an unfair share of the blame. Due to this, researchers were working on congestion management strategies for standard wired, and wireless networking is extensive [2]. While detecting a swift in acknowledgments obtained from neighboring nodes, TCP manages congestion [3] through end-to-end monitoring by changing the data rate on an intermediate node. Scholars in MANETs (Mobile Ad-hoc Networks) concentrate on forwarding and additional features in multi-hop [4] platforms. Even then, because of particular difficulties and conditions of VANET, such current methods and usually not appropriate for VANET contact. For example, since safety signals are transmitted to all nearby vehicles, expecting an acknowledgment (ACKs) across all collecting vehicles is impractical, while ACK signals absorb bandwidth and worsen congestion. The conditions for single-hop self-monitoring message transmitting in VANETs are entirely different from those for multi-hop contact in MANETs. Due to high node agility and channel fading restrictions, congestion management in VANET becomes much more difficult.

Vehicles (On Board Unit) and Road Side Unit (RSU) in VANET will support VtoI and VtoV communication with IEEE 802.11p based on Short Range Wireless Communication (SRWC) [5] system. People may benefit from a wide range of application services provided by VANETs, including security, comfort & safety services [6]. Advertisements, reports, entertainment news, and other information can be found in comfort service. In this service system [7], the messages spread across the network through broadcast, geocast, and webcast, accumulating in some neighbor node and causing congestion at a specific node or connections. Furthermore, since all services in VANETs are small, the propagation of these comforts, service messages would deplete those resources, preventing protection application messages from reaching an endpoint on time. This creates significant security damage to VANET applications. As a result, congestion management throughout the VANET is now an issue that must be addressed immediately.

2. RELATED WORK

Connectivity Aware Routing was introduced by Naumov et al. [8], who ensures low latency through pre-determining its propagation route. Which, including AODV, establishes the best metric utilizing “Hello” packets from the sender to the recipient and back. Through paper [9], Moreno et al. suggested a rapidly changing transmission capacity adaptation scheme that guarantees all vehicles provide equivalent bandwidths. It involves sending and receiving control messages that included network density and neighbor add-up information. Ayaida et al. introduced an interesting concept in [10], integrating routing protocol with location-based routing to eliminate the signaling overhead in a mixed and hierarchical network. In these schemes, the last update of the receiver’s location is used to send messages. Then, with the old position information allocation request is submitted. The communication overhead is minimized because no end-to-end communication is needed.

In paper [11], Cherkaoui et al. propose a new safety message transmission and traffic control scheme for IEEE 802.11p VANETs. By propagating information over to hops while preventing the condition, the system uses a fully dispersed irregular transmitting technique for adjusting strength to ensure that delivery rates are adequate, about 300 meters. Two times-dependent performance analysis algorithm is used in the scheme which approaches to choose the right vehicle that acts as data exchange. The policy would calculate the probability of delivery rate and shipment distance, both the delivery rate and shipping distance requirements relevant to the security application.

Zang et al. describe a congestion management method for protection application in [12]. The basic principle behind this scheme is to use event-drive-in recognition and estimation to detect congestion as well as maintain MAC transmission requests for IEEE 802.11p in order to ensure that the control channel safety information is received.Event-driven congestion identification is initiated when a high-priority safety message is detected, while measurement-based state detection requires measuring channel consumption and evaluating it to a specified threshold to maintain the Quality of Service of protection applications. When it comes to network-induced, non-congestion disruption and time-out problems, Chandran et al. [13] propose removing the TCP congestion. When the routing problem or route shift occurs, each sender in TCP state attributes must be free up. The right measurement criteria are needed to allow an effective assessment of the functionality of VANET and public safety. In the earlier study, PDR and delay were used as metrics of dependability. Yousefi et al. [14] introduce two metrics for evaluating the stability and efficiency of a single hop in VANET, which are the range and beacon rate.

3. THEORIES AND TECHNIQUE USED

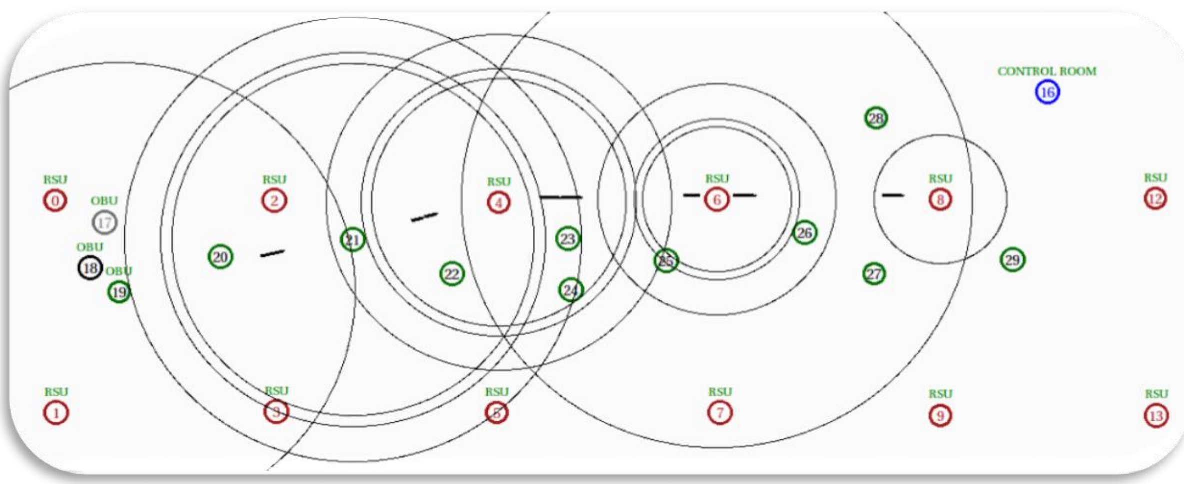

Figure-1: Structured based distribution of the RSU with OBU and Control Room

3.1 Congestion detection: Congestion detection system is divided in three different pastas

i.) RSU,
ii.) OBU and
iii.) Control Room

i.) Roadside unit (RSU):RSU abbreviation is Road Side Unit each RSU as infigure2 is usually a wave device installed mostly on the side of the street or in pertinent areas like intersections or near parking.The RSU is configured with network interface for a server based that is based on IEEE 802.11p network technologies for short-range connectivity and could also be configured with many other network equipment that can be used inside the infrastructure network for transmission. Increasing the communication range of the ad hoc network by redirecting and transmitting data to many other OBUs info is sent to another RSUs so that it can be forwarded to different OBUs. There two main applications of RSUs are as follows:

1. Operating safety applications, like a low bridge warning, accident signal, or working zone, that use vehicle infrastructure transmission and serve as communication channels.
2. Provide Internet connections to OBUs.

Figure2. Roadside unit (RSU).

ii.) OBU: An On Board Unit (OBU) is a signal device that is usually mounted inside a vehicle, and its use is to exchange information via RSUs and other OBUs. A device information processor, which contains a read/write database for storing and retrieving data, an interface, a specific network interface for all other OBUs, and a short-range VANET infrastructure built on IEEE 802.11p network technologies make up the whole system. Some other network protocols for non-safety applications using other communication technologies, like IEEE 802.11a/b/g/n [17], should be included. The OBU is capable of communicating with the RSU and other OBUs through a wireless connection based on the GSM frequency. The OBU's primary functions include wireless radio networking, ad hoc networking, geographic routing, congestion control, fast message delivery, data security, and IP connectivity. The latest equipment installs in OBU areas in figure-3.

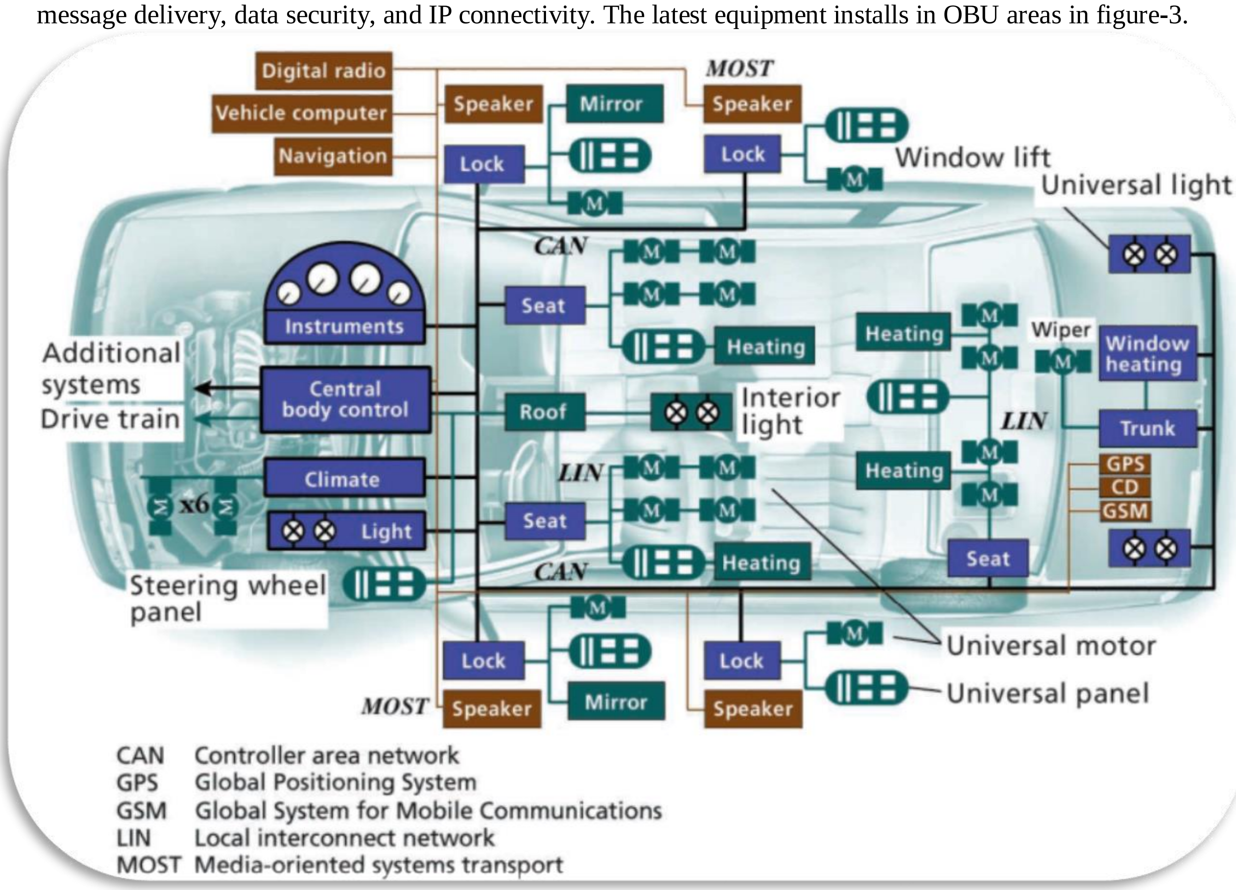

Figure-3: On Board Unit Parts [17]

iii.) Control room (CR): Control rooms for critical infrastructure are typically closely secured and closed off to the common public. Having the latest electronic displays and communication devices is also a sizeable wall-sized projection area. The control room is subjected to continuous video surveillance and tracking for TCP congestion; all control rooms were working 24/7/365. The control room is shown in figure-4.

Figure-4: Control Room for Traffic Congestion and Road Surveillance

3.2 Techniques: Two technique

i. **$TCP_{NewReno}$ Technique:** TCP_{Reno} modification technique is $TCP_{NewReno}$technique. It includes certain benefits against TCP_{Reno}. It would detect simultaneous packet loss & therefore does not exit the quick recovery mode till all the packets existing in the channel have ACKed [15]. As with TCP_{Reno}, a speedy recovery process continues. When a new acknowledgment found, there seem to be two possibilities:
1- ACK to all packets will give faster recovery
2- ACK is incomplete ACK, then the signal gets lost. Again, it tries to retransmit the packet duplicate ACK received 0 [16] $TCP_{NewReno}$ has some benefits, which are listed below:

- TCP $_{Newreno}$ can identify numerous network congestion
- The congestion management system is very effective and makes better use of network capacity
- Along with its updated path selection and late launch, $TCP_{Newreno}$ receives a limited retransmission.

ii. **TCP_{Vegas}technique:** For the lost data, the TCP_{Vegas}technique added a newer retransmission protocol. It computes each packet's delay length using circular trip delay calculations [16]. IF the older ACK packet delay duration has elapsed, the message is resent. If the retry period does not fail until the message loss is detected, timeouts allow for quicker identification of dropped packets and restoration from repeated falls without having to restart the weak start process. As a result, it resolves the issue of numerous packet loss.

4. Algorithm 1: RSU Placement Algorithm

Let,RSU_iRange is r_i=300m, Area is Pi*$r_i^2$and RSU_{i+1}Range is r_{i+1} 300m, Area is Pi r_{i+1}^2than total distance is 600m from RSU_i to RSU_{i+1} the connection have no link to connect. On the base of distance(d) the four positions are possible:

a) Rise and RSU_{i+1} are placed greater than d $_{(I,i+1)=}$600m
b) RSU_i and RSU_{i+1} are placed equal to $d_{(i,i+1)}$=600m
c) RSU_i and RSU_{i+1} are placed less than $d_{(i,i+1)}$=600m
d) RSU_i, RSU_{i+1} and RSU_{i+2} are placed close to one another in the same direction

Algorithm for placement of RSU_i

1. ***Input:*** *RSU Range (r_i ,) Area (a_i) And Distence ($d_{i,i+1}$)*
2. ***Output:****RSU Position (P_i)*
3. *Set RSU $r_{(i,i+1 \ldots n)}$=300m*
4. *Set Area $a_{(i,i+1 \ldots n)} = pi*r_i^2$*
5. *Set Distance $d_{(i,i+1 \ldots n)}=r_i+r_{i+1}, r_{i+1}+r_{i+2} \ldots\ldots r_n+r_{n+1}<600m$*
6. *Set Direction of $RSU_{(i, i+1, \ldots\ldots n)=}$North, South, East and West;*
7. ***The direction of $RSU_{(i, i+1, \ldots\ldots n)}$=North***
8. *Initial P_i is fixed,Find, locate P_{i+1}*
9. *For P_{i+1}, $d_{(i,i+1 \ldots\ldots n)}=r_i+r_{i+1}, r_{i+1}+r_{i+2} \ldots\ldots r_n+r_{n+1}>600$;*
10. ***Case 1***

11. *When $d_{(i,i+1 \ldots\ldots n)}$>600m;*
12. *No link between RSU_i and RSU_{i+1}= ∞*
13. *P (RSU_{i+1})=? (unknown)*
14. ***Case 2***
15. *When $d_{(i,i+1 \ldots\ldots n)}$=600m;*
16. *link between RSU_i and RSU_{i+1}= less*
17. *P(RSU_{i+1})=? (unknown)*
18. ***Case 3***
19. *When $d_{(i,i+1 \ldots\ldots n)}$<600m;*
20. *link between RSU_i and RSU_{i+1}=1*
21. *P (RSU_{i+1}) =set (known)*
22. ***Case 4***
23. *When $d_{(i,i+1)}$<600m, $d_{(i+1,i+2)}$<600m but $d_{(i,i+2)}$<600;*
24. *link between RSU_i and RSU_{i+2}=1*
25. *Eliminate RSU_{i+1}*
26. *P (RSU_{i+2}) =set (known)*
27. ***Direction of RSU $_{(i,\, i+1, \ldots\ldots\, n)}$ = South;***
28. ***…***
29. ***…***
30. ***Direction of RSU $_{(i,\, i+1, \ldots\ldots\, n)}$ = East;***
31. ***…***
32. ***…***
33. ***Direction of RSU$_{(i,\, i+1, \ldots\ldots n)}$= West;***
34. ***…***
35. ***…***
36. ***End for***

Matrix based RSU_i placement: As RSU_i is an important section of the VANET Communication which help to regulate the HPM to Destination**.**

RSU	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
R0	∞	∞	**1**	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
R1	**1**	∞	∞	**1**	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
R2	**1**	∞	∞	**1**	**1**	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
R3	∞	**1**	**1**	∞	∞	**1**	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
R4	∞	∞	**1**	∞	∞	**1**	**1**	∞	∞	∞	∞	∞	∞	∞	∞	∞
R5	∞	∞	∞	**1**	**1**	∞	∞	**1**	∞	∞	∞	∞	∞	∞	∞	∞
R6	∞	∞	∞	∞	**1**	∞	∞	**1**	**1**	∞	**1**	∞	∞	∞	∞	∞
R7	∞	∞	∞	∞	∞	**1**	**1**	∞	∞	**1**	**1**	∞	∞	∞	∞	**1**
R8	∞	∞	∞	∞	∞	∞	**1**	∞	∞	1	∞	**1**	**1**	∞	∞	∞
R9	∞	∞	∞	∞	∞	∞	∞	**1**	**1**	∞	∞	∞	∞	**1**	**1**	∞
R10	∞	∞	∞	∞	∞	∞	**1**	∞	∞	∞	∞	**1**	∞	∞	∞	∞
R11	∞	∞	∞	∞	∞	∞	∞	∞	**1**	∞	**1**	∞	∞	∞	∞	∞
R12	∞	∞	∞	∞	∞	∞	∞	∞	**1**	∞	∞	∞	∞	**1**	∞	∞
R13	∞	∞	∞	∞	∞	∞	∞	∞	∞	**1**	∞	∞	**1**	∞	∞	∞
R14	∞	∞	∞	∞	∞	∞	∞	∞	∞	**1**	∞	∞	∞	∞	∞	**1**
R15	∞	∞	∞	∞	∞	∞	∞	**1**	∞	∞	∞	∞	∞	∞	**1**	∞

Table-1: Matrix of RSU_i Mapping: where ∞ = no link and **1** = link to their neighbor RSU_i

Algorithm 2: Efficient Data Flow Algorithm

1. **Input:** Position of RSU_{ij}, Position of Vehicles OBU_{ij}, Energy(E_{ij}), Traffic of data
2. **Output:** Energy(E_{ij}), Total Energy(TE), Packet received(P), Throughput(T).
3. *Set position of RSUij<300m*
4. *Set position of 0<OBUij<=300m*
5. *Set energy(Eij) = 50 joule*

6. *Set Packet=1500*
7. *Set TCP_0,$TCP_{Newreno}$,TCP_{Vegas}*
8. *Set $Sink_0$, $Sink_{Newreno,}$ $Sink_{Vegas}$*
9. *Number of queues at each node as HPM,LPM*
10. *#Node compares priority*
11. *#Packet in queue*
12. *If Priority=HPM*
13. *Put HPM FF*
14. *Else put LPM*
15. *End if*
16. *Packet (HPM) FF immediately*
17. *Start timer to resend*
18. *Forward the data packet*
19. *Reply ACK to other node*
20. *From neighbor node (OBU_{ij} or RSU_{ij})*
21. *FF to destination*
22. *If no OBUij or RSU_{ij} received packet then*
23. *If resend time expires then*
24. *Drop the packet*
25. *Else*
26. *goto 10*
27. *End if*
28. *End if*
29. *Set timer of Simmulator for 5sec*
30. *Run simulator*
31. *Output as .tr and .NAM file*
32. *Through .tr file*
33. *Calculate E_{ij} used, Totel E_{ij} Used, Throughput (T), and sum of all Packet(P)*
34. *Plot Graph*
35. *Return 1*
36. End

5. SIMULATION AND ITS RESULT

We use simulation software ns2 with a specific set of input like setting the exact location of RSU, OBU and Control Room (CR).

Table-2: Initial Value for Network Simulator

Simulation Parameters Setup	
Parameters	**Values**
Mac or 802.11 SET DataRate	11 Mb
Mac or 802.11 SETBasicRate	1Mb
SETValue (channel)	Channel/WirelessChannel
SET Value (propagation)	Propagation/TwoRayGround
SET Value (netif)	Phy/WirelessPhy
SET Value(MAC)	Mac/802.11p
SET Value (ifq)	Queue/DropTail/PriQueue
SET Value (ll)	LL
SET Value(Ant)	Antenna/OmniAntenna
SET Value (ifqlen)	50

SET Value (nn)	30
SET Value (rp)	AODV
SET Value (x)	1672x
SET Value (y)	100y
SET Value(STOP)	5.0 sec

Table-3: Initial Value of Energy Model for Network Simulator

Energy Model	
InitialEnergy	50
T_x Power	0.9
R_x Power	0.7
Ideal Power	0.6
Sleep Power	0.1
Transition Power	0.02

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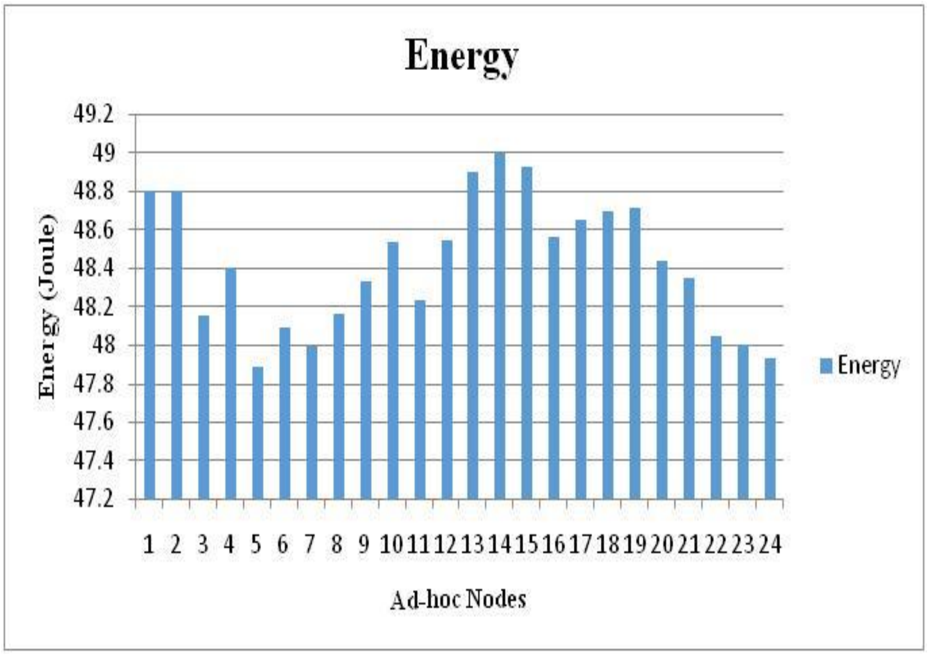

Figure-5: Node energy recorded on the Control Unit

5.1 Important Parameter and Its Results

i.) **The Cumulative sum of receiving packets over Event time:** Result of Cumulative sum of receiving packets at Control Room areas in figure6.

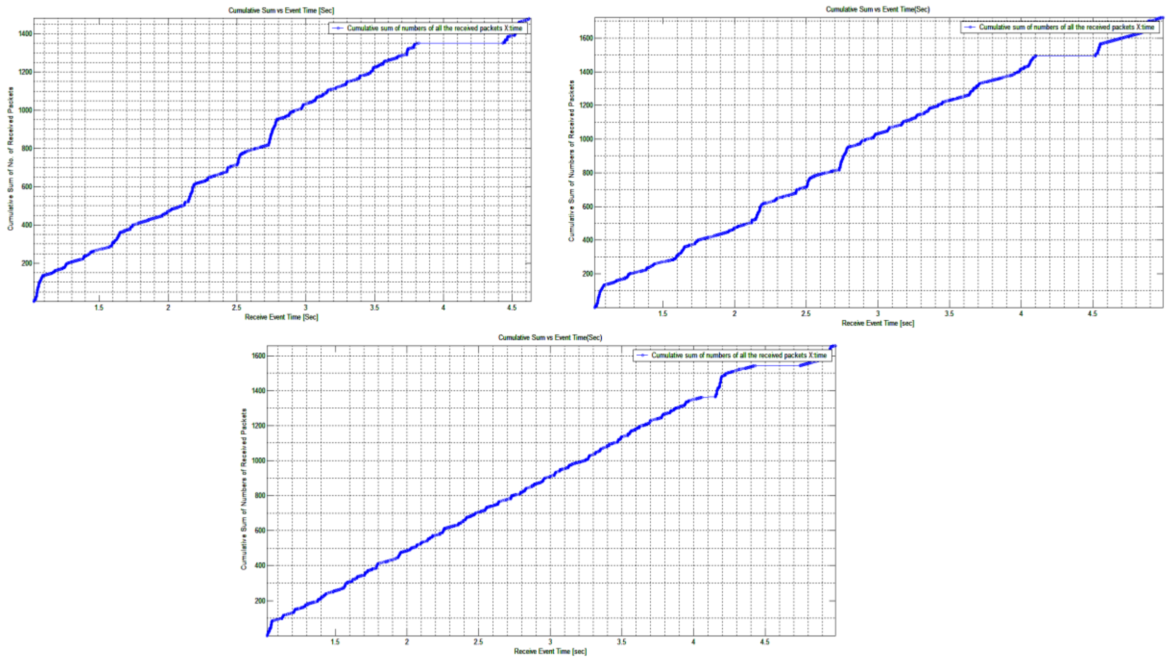

Figure-6: Received Packet vs Time a) and b)Random and c) Structured based of the RSU

ii.) **Throughput over Simulation time:** Result of Throughput observed in Control Room areas in figure7.

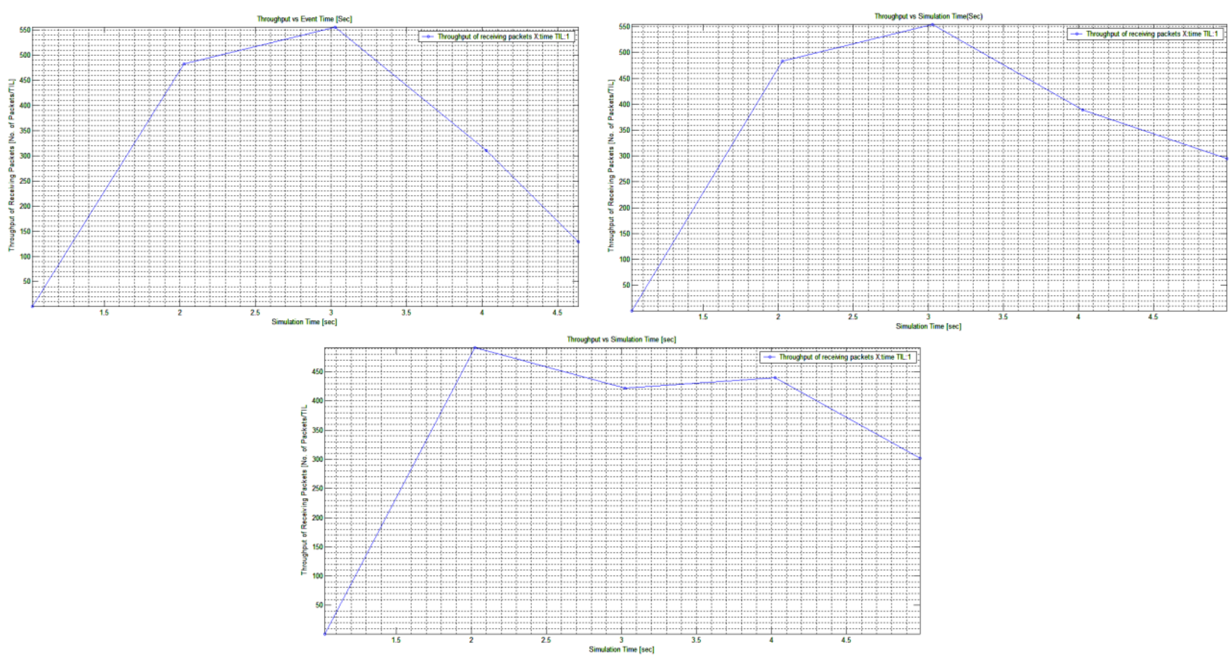

Figure-7: Throughput vs Time a) and b) Random and c) Structured based of the RSU

iii.) **E2E Delay over Packet received time in the Control Room:**Result of End to end delay of packet can be observed in figure8.

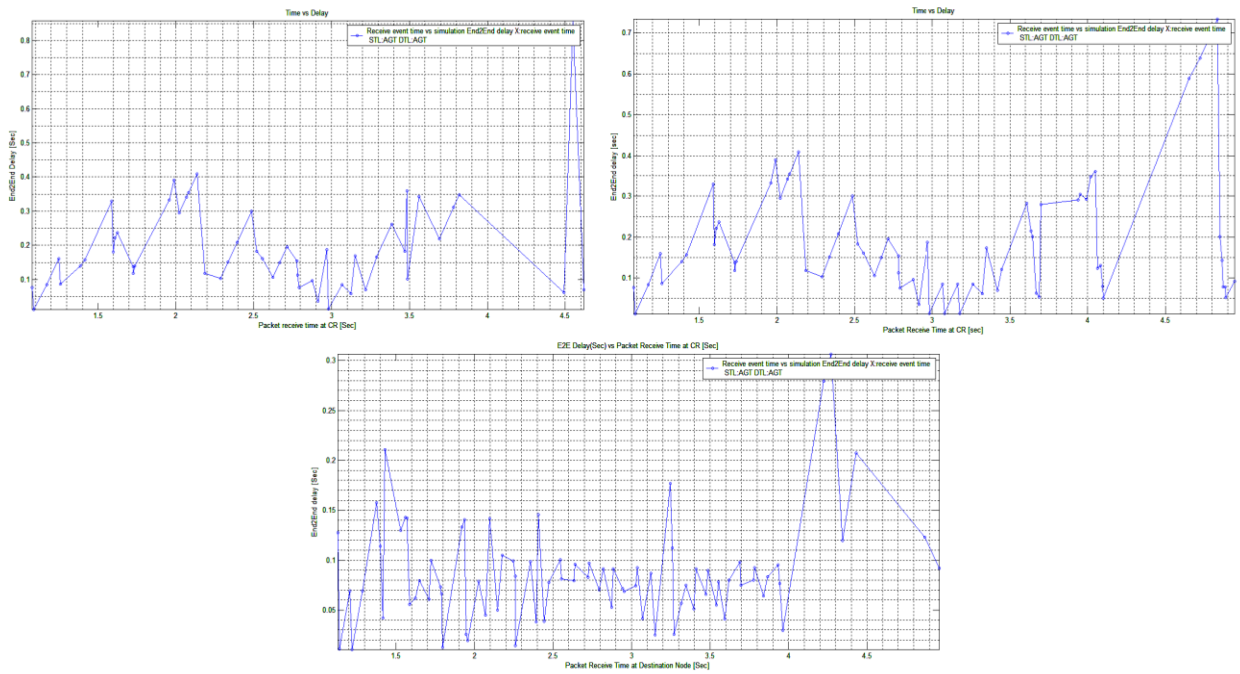

Figure-8: E2E Delay vs Time a) and b) Random and c) Structured based of the RSU

iv.) **Processing Time Cumulative Distribution over Processing Time:**The result of Cumulative distribution time of packets graph can be observed in figure9.

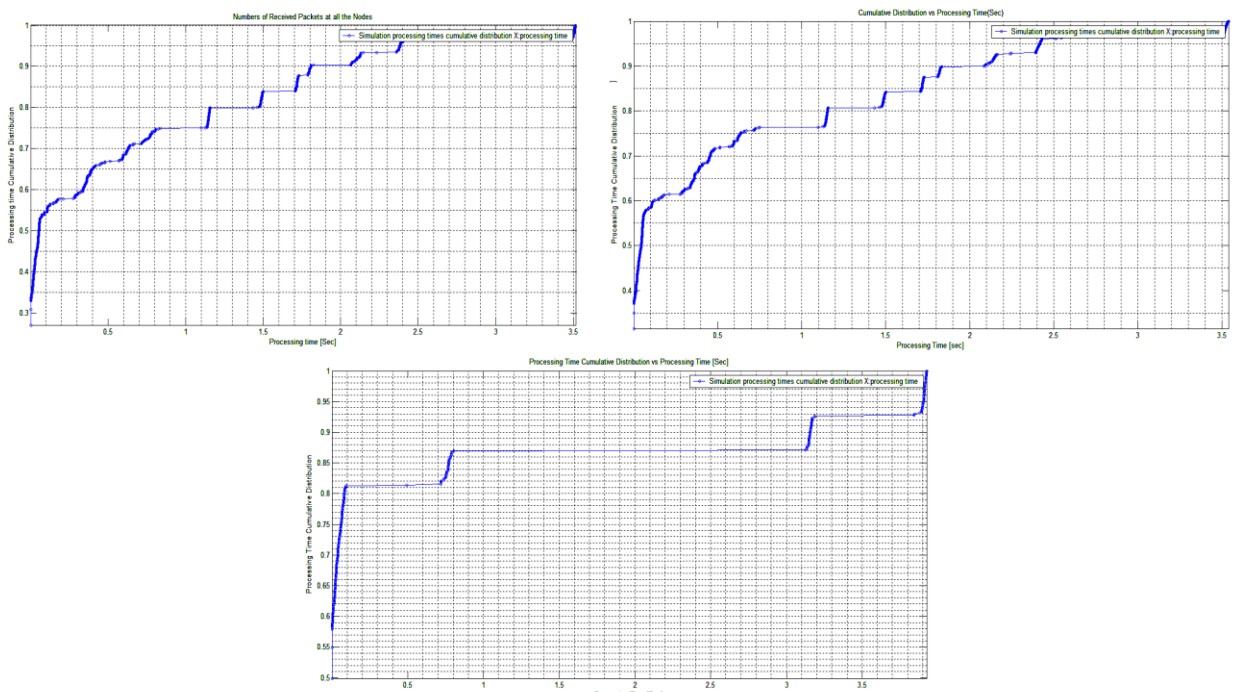

Figure-9: Processing Time of Cumulative Distribution vs Processing Time a) and b) Random and c) Structured based of the RSU.

v.) **Received Packets from sender to CR:** Result show that the Congestion of TCP traffic (packets) from different source get reduced in c graph by the use of structured Matrix mapping of VANET RSU.

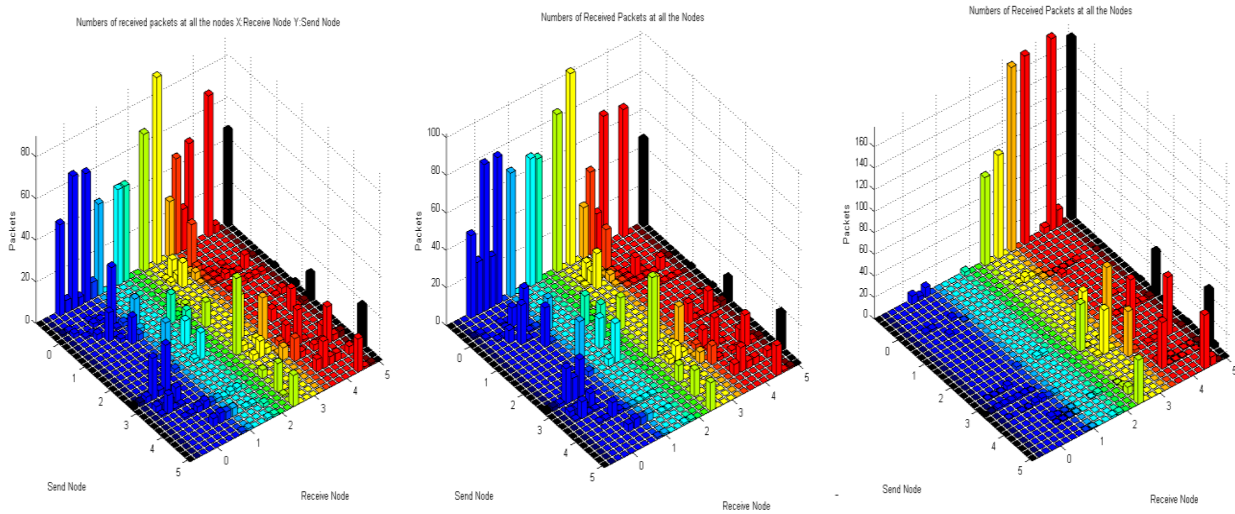

Figure-10: Received Packetsvs Time a) and b) Random and c) Structured based of the RSU

vi.) Congestion Window over Transmission round:

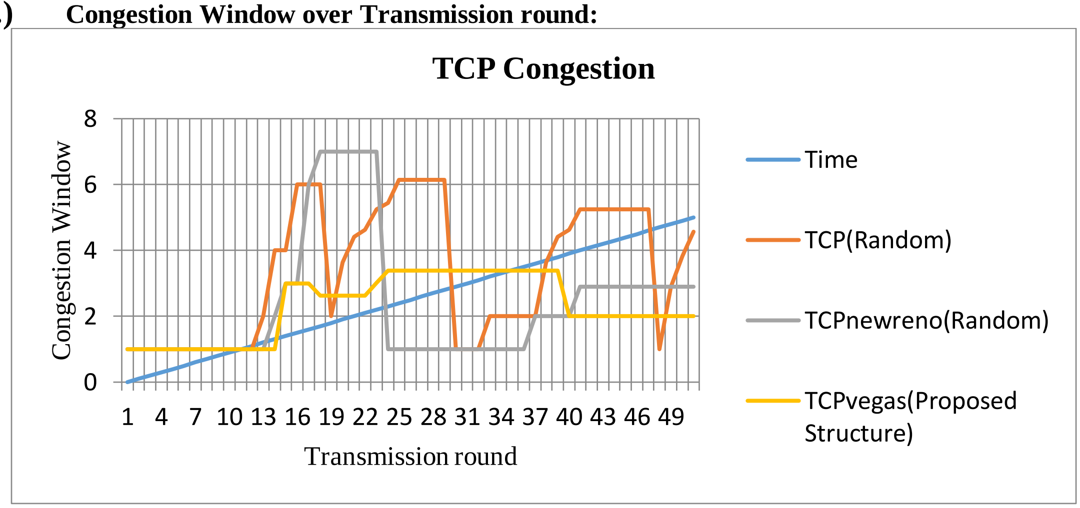

Figure-11: Three different readingsof TCP congestion using TCP, $TCP_{NewReno}$ and TCP_{Vegas} (Proposed Structure)

6. CONCLUSION

In this paper, researchers did an analysis of TCP congestion of random and structured-based RSUi placement. The problem of congestion detected by CR as TCP and $TCP_{NewReno}$ with the random distribution of the RSU_i. Using an algorithm of structured RSUi on TCP_{Vegas} technique. We get results from figure6 to figure11 on throughout, E2E delay, Cumulative Sum of the packets, Distributed Density, and Congestion window. According to the outcome, TCP_{Vegas} (Proposed Structure) is more efficient than a random distribution of RSU_i on TCP and $TCP_{NewReno}$. However, VANET data delivery is transmitted in such an open-source system. It is vulnerable to a variety of threats. Many hackers try to affect public info routing to cause major incidents, including traffic disruption. It'll be useful to look at how to incorporate some security features into the latest architecture of VANETs.

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