*IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)*
*e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 9, Issue 4, Ver. II (Jul - Aug. 2014), PP 48-58*
*www.iosrjournals.org*

# A Method for controlling congestion in VANET

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***Abstract***: *Due to the availability of multiple sensing units on a single radio board of the modern VANET nodes, some sensor networks need to handle heterogeneous traffic within the same application. This numerous traffic may have completely different priorities in terms of transmission rate, required throughput, packet loss, etc. Because of the multi-hop transmission characteristic of this prioritized heterogeneous traffic, incidence of congestion is extremely common and unless handled effectively, it may thwart the appliance objectives. To address this challenge, in this work we propose a Prioritized Oriented Congestion Control Protocol (PCCP) which performs hop-by-hop rate adjustment controlling the congestion and ensures efficient rate for the prioritized diverse traffic. This protocol conjointly might be applied for healthcare infrastructure. We exploit cross layer approach to perform the congestion control. Our protocol uses intra-queue priorities along with weighted fair queuing for ensuring feasible transmission rates & throughput of nodal data. It also guarantees efficient link utilization by using dynamic transmission rate adjustment. In this work we present detailed analysis and simulation results with the description of our protocol to demonstrate its effectiveness in handling prioritized traffic in Bluetooth enabled VANET.*
***Keywords:*** *Congestion, scheduler, sensor, VANET, Bluetooth, hop.*
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## I. Introduction

A Vehicular Ad Hoc Network (VANET) could be a technology that uses moving cars as nodes in an exceedingly network to form a mobile network. VANET turns each collaborating automobile into a wireless router or node, permitting cars roughly one hundred to three hundred meters of every alternative to attachand, in turn, produce a network with a good vary. As cars fall out of the signal vary and drop out of the network, alternative cars will take part, connecting vehicles to at least one another so a mobile web is made. it's calculable that the primary systems which will integrate this technology are police and fireplace vehicles to speak with one another for safety functions.

Vehicular Ad Hoc networks (VANET) play a vital role in future car-to-car communication systems and connected applications like self-organizing traffic info systems (SOTIS) that are supported broadcast transmission schemes. Congestion management for VANETs has not been studied completely up to now - however this feature is very necessary for VANET applications and network performance. Because of the high quality and therefore the ensuing extremely dynamic constellation, congestion management has to be performed in an exceedingly decentralized and self-organized method, domestically in every VANET node.

VANET is that the technology of building a sturdy Ad-Hoc network between mobile vehicles and every alternative, besides, between mobile vehicles and margin units. As shown in Fig. 1, there are two sorts of nodes in VANETs; mobile nodes as On Board Units (OBUs) and static nodes as Road facet Units (RSUs). Associate OBU resembles the mobile network module and a central process unit for on-board sensors and warning devices. The RSUs will be mounted in centralized locations like intersections, parking heaps or gas stations. they will play a big role in several applications like a gate to the net.

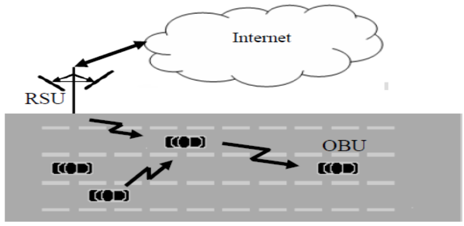



**Fig.(1) Node types in VANETs**

Congestion is a very important issue which will arise in packet switched network. Congestion could be a state of affairs in CommunicationNetworks duringwhich too several packets ar gift during a part of the subnet, performance degrades. Congestion during a network could occur once the load on the network (i.e. the amount of packets sent to the network) is bigger than the capability of the network (i.e. the amount of packets a network will handle.) In different words once an excessive amount of traffic is obtainable, congestion sets in and performance degrades sharply.

## II. Literature Review

S.Sridevi, M.Usha & G. Pauline Amertha Lithurin (Jan 10, 12, 2012)[1]
Congestion happens once too several sources are causing an excessive amount of of knowledge for network to handle. Congestion during a wireless detector network will cause missing packets, low energy potency and long delay. A detector node could have multiple sensors like light weight, temperature etc., with totally different transmission characteristics has different characteristics and necessities in terms of transmission rate, bandwidth, delay, and packet loss. Differing types of knowledge generated in heterogeneous wireless detector networks have totally different priorities. In multi path wireless detector networks, the info flow is forwarded in multiple ways to the sink node. It's vital to attain weighted fairness for several WSN applications. During this paper they proposes priority primarily based congestion management for heterogeneous every application traffic in multi path wireless detector network.
Muhammad Mostafa Monowar, Md.Obaidur Rahman,Al-SakibKhan Pathan, and Choong Seon Hong (2008,)[2]
Heterogeneous applications may well be assimilated among constant wireless device network with the help of recent motes that have multiple device boards on one radio board. Differing types of information generated from such forms of motes might need totally different transmission characteristics in terms of priority, transmission rate, needed information measure, tolerable packet loss, delay demands etc. Considering a device network consisting of such multi-purpose nodes, this paper proposes Prioritized Heterogeneous Traffic Oriented Congestion Control Protocol (PHTCCP) that ensures economical rate management for prioritized heterogeneous traffic. This protocol uses intra-queue and inter-queue priorities for guaranteeing possible transmission rates of heterogeneous knowledge. It conjointly guarantees economical link utilization by victimization dynamic transmission rate adjustment. Elaborated analysis and simulation results square measure bestowed along side the outline of our protocol to demonstrate its effectiveness in handling prioritized heterogeneous traffic in wireless device networks.

Cheng Tien Ee, Ruzena Bajcsy (Nov 2004) [3] This paper proposes a distributed and scalable algorithmic rule that eliminates congestion inside a sensing element network, which ensures the truthful delivery of packets to a central node, or base station. Fairness is achieved once equal numbers of packets area unit received from every node. Here they take into account the situation wherever we've many- to-one multihop routing. This algorithmic rule exists within the transport layer of the normal network stack model, and is intended to figure with any multihop protocol within the data-link layer with minor modifications. This answer is scalable; every sensing element molecule needs state proportional to the amount of its neighbors. Finally, they demonstrate the effectiveness of this answer with each simulations and actual implementation in UC Berkeley's sensing element motes. However this answer isn't applicable for several to several routing in sensing element network .in several to several routing sensing element network this answer can have a lot of congestion.

Muhammad Mostafa Monowar, Md.Obaidur Rahman and Choong Seon Hong (2008) In this paper they propose an efficient scheme to control multipath congestion so that the sink can get priority based throughput for heterogeneous data. They have used packet service ratio for detecting congestion as well as performed hop-by-hop multipath congestion control based on that metric. Finally, simulation results have demonstrated the effectiveness of their proposed approach**.** In this paper, they have presented an efficient multipath congestion control mechanism for heterogeneous data originated from a single sensor node. But using this method they have some disadvantages for multiple node .hence to avoid the problems fairness must be improve , analysis of the impact of other parameters on the proposed scheme's performance and implementing this scheme on a real sensor test-bed.

## III. Aim Of The Paper

The main objective of this synopsis is priority based congestion control for VANET.
- Design a model using master and slave sensor nodes.
- Transmission of data packet from node to node based on priority.
- Comparing the result in terms of data transfer with earlier work.

## IV. Working Methodology

Based on the on top literature review it's clear that a congestion occurring throughout the information transfer in an exceedingly specific network inflicting a packet loss and long delay. Therefore we have a tendency to attempting to improvise this on mistreatment priority based mostly technique and management the congestion supported priority. Vehicular ad hoc Network (VANET) permits the communication between vehicles on the road network that falls in a pair of categories: 1) Vehicle to Vehicle (V2V) Vehicle to Infrastructure (V2I). Varied approaches of information dissemination in transport Network. In this paper we are using vehicle to infrastructure category. In which there is one master node which is connected to the personal computer (PC) while other nodes will act as a slave which is shown in fig.(2).Here Bluetooth (IEEE 802.15.1) is use as wireless module for communication purpose in localised network . And for sending data we have to take data from some where so we are using temp sensor. Here temp sensor, microcontroller, wireless module and battery showing one single wireless node.

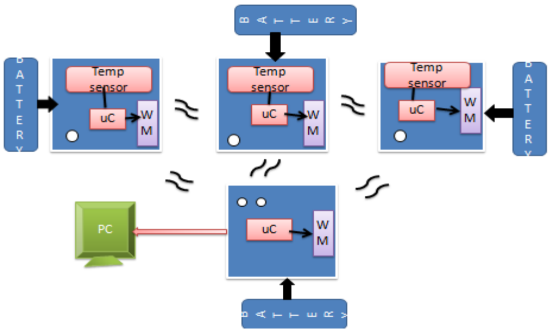



**Fig.(2) General block diagram of VANET**

Fig.(2) shows general block diagram of VANET. It is consists of four nodes one node is master which is connected to the personal computer and other three nodes are the slave nodes connected with wireless module which is Bluetooth .and these three nodes also connected with temperature sensors

First we have a tendency to don't seem to be victimisation any protocol for congestion management simply to indicate however congestion happens .in which at a time two or additional devices hiring one single device .because of that there's a loss of packet and time delay. if one device causing knowledge to a different device which device isn't causing acknowledgment at intervals the edge price that what we've set before then it shows that there's delay. Hence to boost this we have a tendency to area unit victimization the priority primarily based congestion control protocol within which we are going to set the priority in line with there importance so packet loss ratio are minimize and time delay ratio also will minimize.

**1) System models**

This paper addresses upstream congestion control for a WSN that supports single-path routing.

In Fig.(3), sensor nodes generate continuous data and form many-to-one convergent traffic in the upstream direction. They are assumed to implement BLUETOOTH-like VANET protocol. Each sensor node could have two types of traffic: source and transit. The former is locally generated at each sensor node, while the latter is from other nodes. Therefore each sensor node can be a source node and/or intermediate node. When a sensor node has offspring nodes and transit, it is a source node as well as an intermediate node. On the other hand, it is only a source node if it has no offspring nodes, and therefore only has source traffic. The offspring node of a particular node is defined as the node whose traffic is routed through this particular parent node. If an offspring node directly connects to its parent node, this offspring node is called child node and its parent node is called parent node.

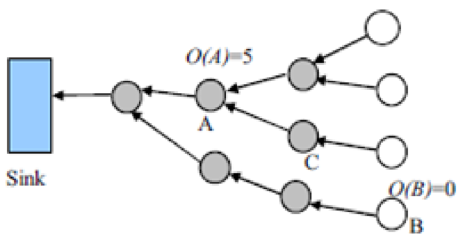



**Fig. (3) Network model-logical topology established by routing protocol.**

**2) Node model**

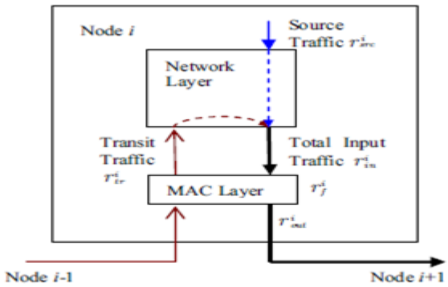



**Fig.(4) General node model**

Fig.4 above presents the queuing model at a particular sensor node i with single-path routing. The transit traffic of node i ( irtr ) is received from its child nodes such as node i  1 through its VANET layer. The source traffic is locally generated with the rate of rsirc . Both the transit traffic and the source traffic converge at the network layer before being forwarded to node i + 1, which is the parent node of node i . Packets could be queued at the VANET layer if total input traffic rate (r iin = rsirc + rtir ) exceeds packet forwarding rate at the VANET layer ( irf ). The packet forwarding rate Irf depends on the VANET protocol itself. With the assumption of BLUETOOTH-like protocol, the number of active sensor nodes as well as their traffic density influences irf . In Fig. above, irout is the packet rate at the node i towards node i + 1. If ir in is smaller than irf , rout will equal irin . Otherwise if irin > ir f , then irout will be close to irf . Therefore, min( i, i) irout = rin r f .This property can be utilized to indirectly reduce irout through reducing irin . In fact, the output traffic at node i is part of transit traffic at the node i + 1 Therefore reduction of irout implies a decrease of irtr+ . If packet input rate irin exceeds packet forwarding rate irf , then there will be backlogged packets inside node i and node-level congestion takes place. At this time, we need to reduce irin and/or increase irf . While irf can be increased through adjusting VANET protocols, it is much easier to lower irin through throttling either is r , irtr or both of them. The source rate rsirc can be reduced locally by changing sampling (or reporting) frequency. The transit traffic Irtr can be indirectly reduced through rate adjustment at the node i+ 1 . On the other hand, if there is collision on the link around the node i , then node i and its neighboring nodes should reduce channel access in order to prevent further link-level congestion. Although this task may be performed through VANET, yet it is easier to reduce irin . This paper designs a novel congestion control approach through flexible and distributed rate adjustment in each senor node as shown in fig above. It introduces a scheduler between network layer and VANET layer, which maintains two queues: one for source traffic and another for transit traffic. The scheduling rate is denoted as rsivc . A Weighted Queuing (WQ) algorithm can be used to guarantee fairness between source and transit traffic, as well as among all sensor nodes. The priority index of source traffic and transit traffic, which will be defined in next section, is used as the weight, respectively, for source traffic queue and transit traffic queue. By adjusting the scheduling rate rsivc , PCCP realizes an efficient congestion control while maintaining the VANET protocol parameters unchanged and therefore works well with any BLUETOOTH like VANET protocol.

**2) Generating the PCCP:-**

PCCP is designed with such motivations:

1) In WSNs, sensor nodes might have different priority due to their function or location. Therefore congestion control protocols need guarantee weighted fairness so that the sink can get different, but in a weighted fair way, throughput from sensor nodes.
2) Congestion control protocols need to improve energy-efficient and support traditional QoS in terms of packet delivery latency, throughput and packet loss ratio.

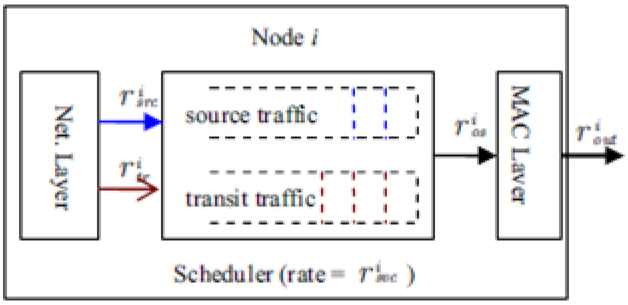



**Fig. (5) Node model in PCCP**

PCCP tries to avoid/reduce packet loss while guaranteeing weighted fairness and supporting multipath routing with lower control overhead. PCCP consists of three components: intelligent congestion detection (ICD), implicit congestion notification (ICN), and priority-based rate adjustment (PRA). ICD detects congestion based on packet inter-arrival time and packet service time. The joint participation of inter-arrival and service times reflect the current congestion level and therefore provide helpful and rich congestion information. To the best of our knowledge, jointly use of packet inter-arrival and packet service times as in ICD to measure congestion in WSNs has not been done in the past. PCCP uses implicit congestion notification to avoid transmission of additional control messages and therefore help improve energy-efficiency. In ICN, congestion information is piggybacked in the header of data packets. Taking advantage of the broadcast nature of wireless channel, child nodes can capture such information when packets are forwarded by their parent nodes towards the sink. Finally, PCCP designs a novel priority-base rate adjustment algorithm (PRA) employed in each sensor node in order to guarantee both flexible fairness and throughput, where each sensor node is given a priority index. PRA is designed to guarantee that:

(1) The node with higher priority index gets more bandwidth.
(2) The nodes with the same priority index get equal bandwidth.
(3) A node with sufficient traffic gets more bandwidth than one that generates less traffic.

The use of priority index provides PCCP with high flexibility in weighted fairness. For example, if the sink wants to receive the same number of packets from each sensor node, the same priority index can be set for all nodes. On the other hand, if the sink wants to receive more detailed sensory data from a particular set of sensor nodes, such sensor nodes can be assigned a higher priority index and therefore allocated higher bandwidth. The following provides three definitions
related to the priority index:

**Definition 1:** Source Traffic Priority (SP (i)) – The source traffic priority at sensor node i is used to represent the relative priority of local source traffic at node i . SP (i) is independent of the offspring node number of the node i .

**Definition 2:** Transit Traffic Priority (TP (i))– The transit traffic priority at sensor node i is used to represent the relative priority of transit traffic routed through node i . TP (i) equals the sum of source traffic priority of each offspring node and depends on source traffic priority at all offspring nodes of node i. TP(i) equals zero when node i has no offspring nodes.

**Definition 3:** Global Priority (GP(i) ) – The global priority refers to the relative important of the total traffic at each node i . The global priority equals the sum of source traffic priority and transit traffic priority, or GP(i) = SP(i) +TP(i) . GP (i) equals SP (i) when node i has no offspring nodes.

**6) Intelligent congestion detection (ICD)**

In the traditional transport protocol such as TCP, congestion is often inferred at the end-points based on duplicated ACK messages or timer or ECN (Explicit Congestion Notification) bit in the header of packets. In sensor networks, intermediate nodes participate in detecting congestion based on queue length, buffer increment, wireless channel status, or combination thereof. A single bit can be used to induce such information. The approach in uses local packet service time to calculate sustainable service rate and in turn throttle node transmission rate. However these techniques cannot precisely reflect congestion level either at the node or at the link. In order to precisely measure local congestion level at each intermediate node, we proposes intelligent congestion detection (ICD) that detects congestion based on mean packet inter-arrival ( iat ) and mean packet service times ( ist ) at the VANET layer. Here packet inter-arrival time is defined as the time interval between two sequential arriving packets from either source or for the transit traffic, and the packet service time is referred to as the time interval between when a packet arrives at the VANET layer and when its last bit is successfully transmitted. ist covers packet waiting, collision resolution, and packet transmission times at the VANET layer. iat as well as ist can be easily measured at each node i on a packet-by-packet basis. Based on the iat and ist , ICD defines a new congestion index, congestion degree d(i) , which is defined as the ratio of average packet service time over average packet inter-arrival time over a pre-specified time interval in each senor node i as follows:

d (i) = tsi /tai ……….. (1)

The congestion degree is intended to reflect the current congestion level at each sensor node. When the inter-arrival time is smaller than the service time, the congestion degree d (i) is larger than 1 and the node experiences congestion. Otherwise when the congestion degree d (i) is smaller than 1, the incoming rate is below the outgoing rate, and hence congestion abates. Therefore congestion degree can adequately represent congestion condition and provide helpful information in order to realize efficient congestion control. The congestion degree d (i) can inform the child nodes about the traffic level to be increased or decreased by adjusting their transmission rate.

In Eq. (1), iat and ist at each node i are measured using WMA (weighted moving average) algorithm. In the process of determining the congestion degree, iat is updated periodically whenever there are N p (=3 in PCCP) new packets arriving as follows:

$$t_a^i = (1 - w_a) * t_a^i + w_a * T_{N_p} / N_p \,, \qquad \text{………..(2)}$$

Where 0 < wa < 1 is a constant (= 0.1 in PCCP examples to be discussed later), TNp is the time interval over which the measurements are performed, and within which the N p new packets arrive. Also, is t is updated each time a packet is forwarded as follows:

$$t_s = (1 - w_s) * t_s + w_s * t_s^{'} \,, \qquad \text{…………(3)}$$

Where 0 < ws < 1 is a constant (again 0.1 in the future examples), ist is the service time of the packet just transmitted.

**7) Implicit Congestion Notification (ICN)**

There are two approaches to propagate congestion information: Explicit Congestion Notification (ECN) and Implicit Congestion Notification (ICN). The explicit congestion notification uses special control messages and inevitably introduces additional overhead. In contrast, implicit congestion notification piggybacks congestion information in the header of data packets. Taking advantage of the broadcast nature of wireless channel, child nodes listen to their parent node to get congestion information. In the implicit congestion notification, transmission of an additional control message is avoided. PCCP uses ICN at each sensor node i to piggyback congestion information in the header of data packets to be forwarded. Notification is triggered by either of the two events:

(1) The number of forwarded packets by a node exceeds a threshold (=O(i) □ N p in PCCP);

(2) The node overhears a congestion notification from its parent node.

A node then computes its global priority index by summating its source traffic priority index and all the global priority index of its child nodes.

**8) Priority-based Rate Adjustment (PRA)**

As shown in Fig. 3, we introduce a scheduler with two sub-queues between the network layer and the VANET layer. If the scheduling rate rsivc is kept below the VANET forwarding rate irf , the output rate will approximately equal the output rate irout . Therefore, through adjusting the scheduling rate r sivc , congestion could be avoided or mitigated. There are generally two ways to perform this task. At this time, congestion information indicates whether there is congestion or not which can be transferred using a binary congestion notification (CN) bit. However when nodes are specifically informed as to how much to increase or decrease their rates, exact rate adjustment becomes possible. Congestion degree d(i) and priority index (TP(i) and GP(i) ) introduced here provides more information than the CN bit and enables exact rate adjustment.

PRA needs to adjust the scheduling rate r sivc and the source rate rsirc at each sensor node after overhearing congestion notification from its parent node, in order to control both link-level congestion and node-level congestion.

In the next section hardware software interactive modelling is presented to explain how this priority based control can be effectively used to reduce data congestions in system.

## V. Implementation and Result

**A: software simulation result:-**

First we have shown software simulation which will show both the result for normal mode (without priority) and priority mode which will show how congestion is controlled by using priority based congestion control algorithm.

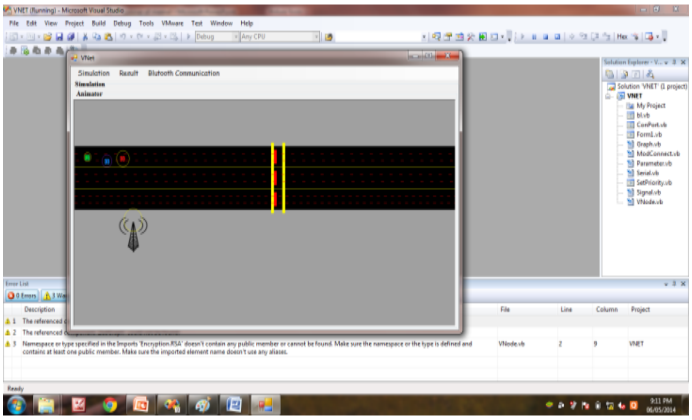


**Fig (6.1)Initalization of nodes**

Above fig shows the senirio of VANET. Here we initialize the nodes (i.e no of class ).

- Red indicates class1 traffic.
- Blue indicates class2 traffic.
- Green indicates class3 traffic.

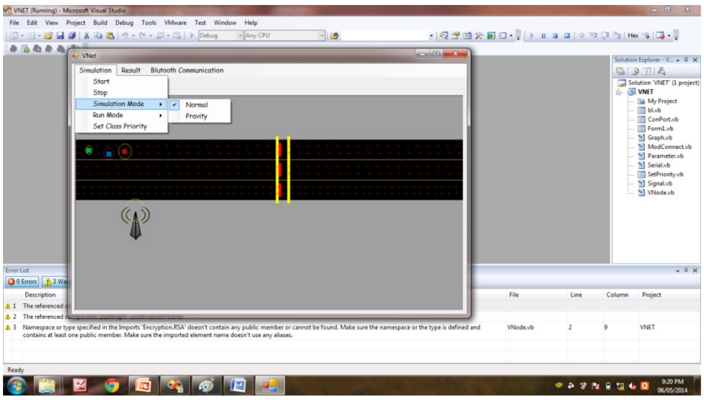
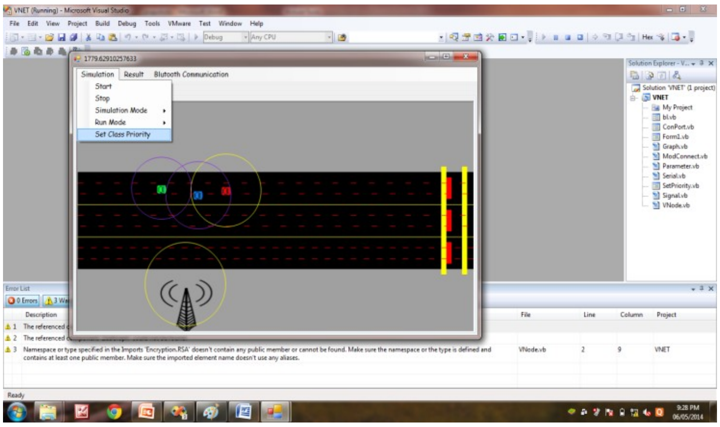


**Fig (6.2) Simulation in normal mode (without priority)**

As we have initialized the nodes now in the above figure we select the normal mode (without priority) and then start the simulation. In this normal mode all the nodes will moves in the normal way. They will travel from the same path from where they are started travelling and because of this travelling time will be more to reach the destination and also end to end delay will be more .




**Fig(6.3)set class priority**

Above figure we select the class priority which will allow the nodes (class traffic) to change their path according to the priority.

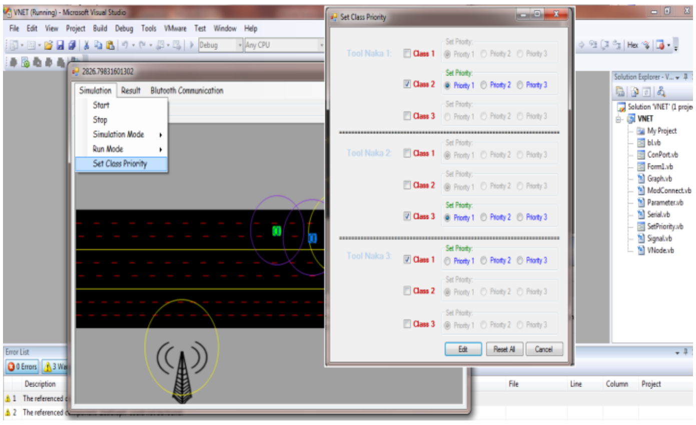



**Fig (6.4) setting class priority.**

Above figure shows in first path we set class2 traffic as first priority and for second path we have set class 3traffic and for third path we have set class1 traffic. So that it will make easy to control the congestion in the vanet.

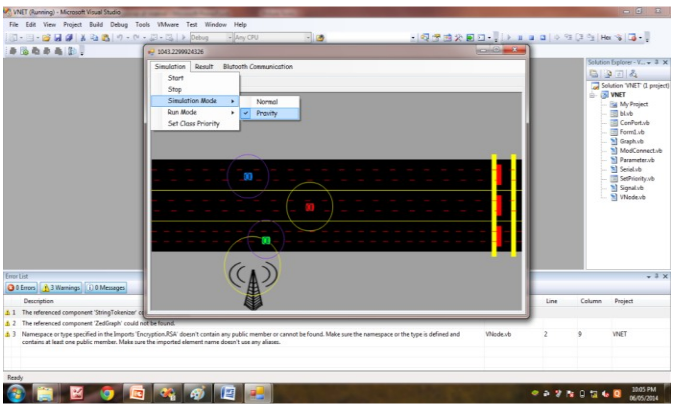



**Fig (6.5) Simulation in priority mode**

Above figure shows the simulation in the priority mode , as we have set the priority according to that all the nodes (class traffic ) will change there travelling path according to the priority .so that time required to reach the destination will become less so that end to end delay will also become less .and also the congestion occurring between the data packets will be controlled. And also the normalized throughput will also be better than the previous method .

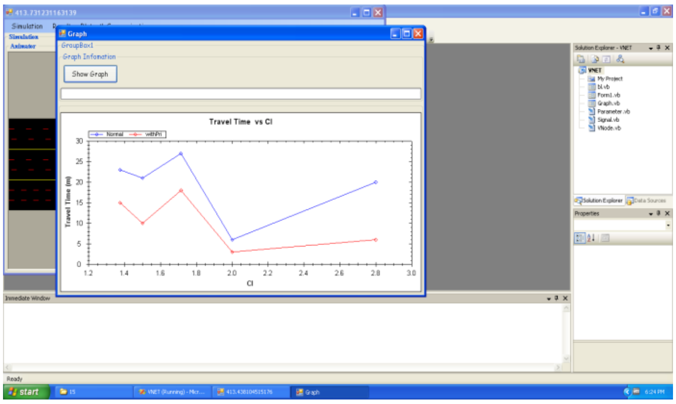



**Fig (7.1) Travel time vs. congestion index to reduce the time complexity**

Fig.(7.1) shows graph of travel time vs congestion index. Which shows result for normal mode and priority mode .in the above fig.23 travel time required for the vehicles from start point to the end point is shown according to congestion index.

Blue line shows the result for normal mode and red line shows the result for priority mode .It is clear from the above graph travel time required for priority mode is less than the normal mode.

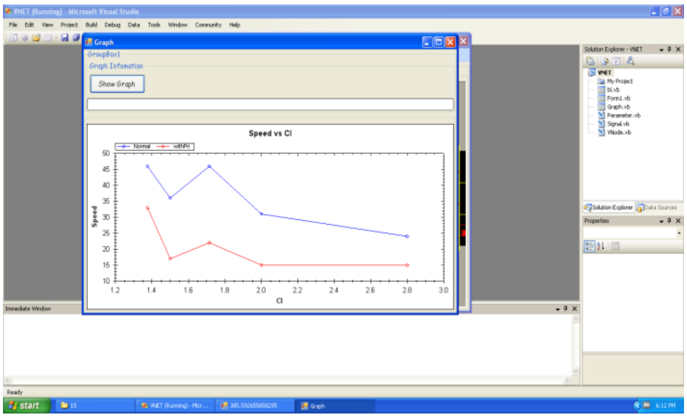



**Fig .(7.2)Improving the performance by controlling Delay and Congestion index**

Fig.(7.2) shows graph for speed vs congestion index. In above graph blue line shows speed of the modes for normal mode and red line shows speed of the for priority mode.

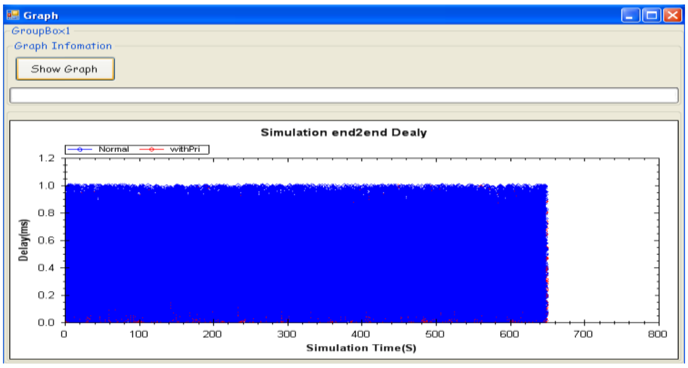



**Fig (7.3)Simulation end to end delay for normal mode and priority mode .**

Above fig.(7.3) shows graph for simulation end to end delay. Simulation end to end delay for normal mode more and after giving priority in priority mode is simulation end to end delay is suppressed .which is very less as compared to normal mode.

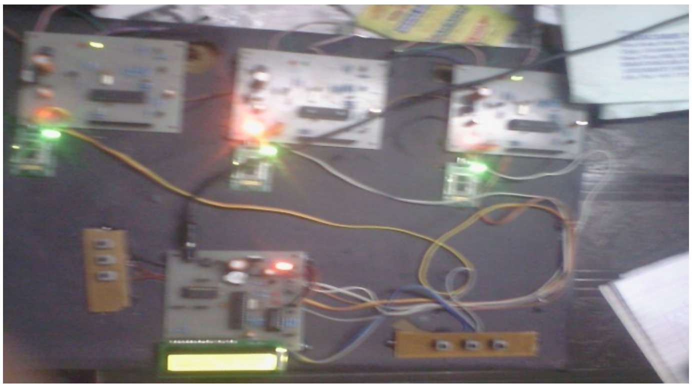


**Fig (8). Hardware implementation**

| Case | Normal mode | | Priority mode | |
|---|---|---|---|---|
| | End to End delay | Congestion index | End to End delay | Congestion index |
| 001 | 22ms | 1.96 | 20ms | 1.78 |
| 010 | 9ms | 0.80 | 4ms | 0.35 |
| 011 | 21ms | 1.87 | 18ms | 1.60 |
| 100 | 20ms | 1.78 | 15ms | 1.33 |
| 101 | 20ms | 1.78 | 17ms | 1.51 |
| 110 | 19ms | 1.69 | 16ms | 0.80 |
| 111 | 21ms | 1.87 | 20ms | 1.78 |

**Table.1Run time results for normal mode and priority mode.**

From table .1end to end delay and congestion index for normal mode is more and for priority mode that is for purpose method is decreasing as compare to normal mode.

| Case | Class 3 | Class 2 | Class 1 | Normalize throughput | |
|---|---|---|---|---|---|
| | | | | Purpose method | Previous method |
| Case1 | 0 | 0 | 1 | 0.053 | 0.0769 |
| Case2 | 0 | 1 | 0 | 0.05 | 0.0513 |
| Case3 | 0 | 1 | 1 | 0.049 | 0.1282 |
| Case4 | 1 | 0 | 0 | 0.0175 | 0.0256 |
| Case5 | 1 | 0 | 1 | 0.047 | 0.0769 |
| Case6 | 1 | 1 | 0 | 0.056 | 0.0769 |
| Case7 | 1 | 1 | 1 | 0.038 | 0.1539 |

**Table.2 Comparison table**

As the time is inversely proportional to the throughput, when the time decreases the throughput of a process always increases. From table.1 it is clear that end to end delay is decreasing means the time is also decreasing hence the throughput of the purpose system is better than the previous method.

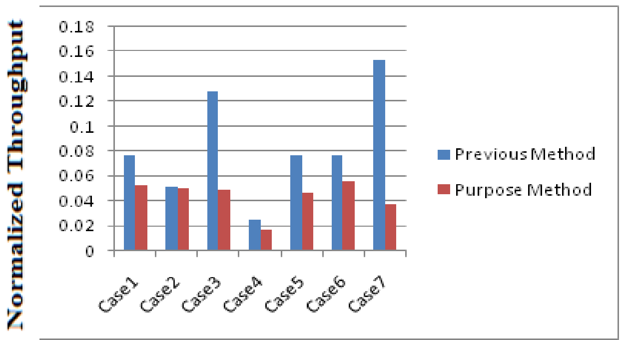



**Fig.(9) Graph for normalized throughput**

In above fig.(9) graph shows the normalized throughput of the purpose method is very less as compare to previous method .

## VI. Conclusions

PCCP is a hop-by-hop upstream congestion control protocol for VANET. From the research we can say that it has following properties:

(1) Uses packet inter-arrival and service times to accurately measure congestion at each sensor node;
(2) Introduces node priority index and realizes weighted fairness.

Simulation results show that:

(1) PCCP achieves high link utilization and flexible fairness;
(2) PCCP achieves small buffer size, therefore it can avoid/reduce packet loss and therefore improve energy-efficiency, and provide lower delay with the improvement in Normalized throughput capabilities for VANET.

We have also demonstrated through simulation results and analysis that PCCP achieves,

i) Desired throughput for diverse data according to the priority specified by the base station,
ii) High link utilization,
iii) Moderate queue length to reduce packet loss,
iv) Relatively low packet drop rate.

Therefore PCCP is energy efficient and provides lower delay. It is also feasible in terms of memory requirements considering the configurations of today's multi-purpose motes. Thus in future this work can be greatly useful on integrating end-to-end reliability mechanism and further improvement in fairness for PCCP.

## Acknowledgment

I would like to express heartfelt gratitude towards my faculty guide , Prof. Shubhangini R. Ugale Faculty, Electronics & Communication Engineering Department, for there support and guidance.

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