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Implementation of Weighted Fair Queuing Technique along with IEEE 802.11p to Enhance Quality of Service (QoS) in VANET

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ABSTRACT: RecentlyVehicular Adhoc Networks (VANETs) are one of the emerging technologies from Mobile Adhoc Networks (MANETS) which plays a vital role in Intelligent Transport System (ITS). In addition to its impact in reducing traffic jams, it also assists driver's safety and considered as an alternative communication system for emergency situations like natural disasters. One of the main challenges in safety critical applications built using VANETs requires guaranteeing Quality of Service (QoS) like communication without delay or jitter bounds and avoiding degradation of communication channels due to congestion in dense mobile network traffic. Such guarantee can be provided by scheduling techniques. Among many congestion avoidance scheduling techniques, proposed system employs Weighted Fair Queuing (WFQ) techniques. Proposed system also demonstrates study of performance issues like throughput, packet delivery ratio (PDR), routing overhead,etc using simulation in NS2. Simulation results guarantee's that the proposed scheduling technique along with 802.11p protocol implementation provides better performance in improving throughput, PDR and congestion avoidance which are very much needed for enhancing QOS in VANET.

KEYWORDS: VANETS, QoS, WFQ, 802.11p**.**

I.INTRODUCTION

VANETS form an adhoc network with the help of vehicles equipped with advanced wireless communication devices acting as nodes to exchange messages [1]. These type of network are very much useful in safety critical applications especially for ITS and for non-safety critical applications as well. Safety applications in the sense if a vehicle identifies any road accident, it will be intimated to other neighboring nodes with the help of VANET[2]. So timely intimation about road accidents and immediate safety remedies can be taken to save human lives. These kinds of messages must be disseminated immediately to nearby vehicles with high reliability and limited time. A fraction of delay in these message deliveries may have greater impact in human life. Apart from this ITS must also periodically transmit certain messages within the VANET network about its own situations like speed, position and direction to neighboring nodes for creating awareness about their surroundings. In a highly dense traffic network, large number of vehicles will periodically try to transmit beacon messages at high frequency & concurrently via single channel, making the channel to be easily congested [3]. This congestion in channel should be avoided to reduce delay in message transmission and for increase in QoS. Such guarantees in message transmission can be provided with the help of congestion avoidance algorithm. All the earlier congestion avoidance scheduling methods have certain limitations. To improve QoS without delay bounds and for preserving other qualities in VANETS, we proposedamethod that employs WFQ technique for reducing congestion.Probably the nodes in VANET use IEEE 802.11 standard for wireless data transmission. But literature survey conveys that IEEE 802.11 protocol would not be well suitable for VANETS [4]. It contains certain issues like high vehicular mobility, requirement of high reliability, requirement of topology maintenance as network changes rapidly due to mobility of vehicles and requirement of guaranteeing low latency for safety critical/real time services. All these considerations are satisfied by the implementation of 802.11p [4] protocol and thus cause improvement of QOS in adhoc network. In section III,theexisting congestion avoidance methods and their failure to satisfy QOS in VANETS has been discussed. Then section IV explains our proposed method for improvingQoS by

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using WFQ technique and 802.11p protocol. In section V,implementation of WFQ technique with 802.11p standardusing NS2 simulator is discussed. Finally the performance of our proposed work is analyzed and compared with 802.11.

II.RELATED WORK

In [5],optimization of road traffic for implementing an advanced and intelligent transport system is shown . The method in which the VANET infrastructure helps to disseminate the needed information to neighboring nodes in the network and thereby optimizing the traffic signaling to reduce traffic congestion are discussed. In this approach the vehicleswith DSRV ensures strong link for V2V and V2I communication. But it doesn't guarantee on-time packet delivery. Moreover, the network simply broadcasts its information to the neighboring nodes and creates congestion. This traditional method fails to guarantee congestion free packet transmission inVANET. The use of AODV routing protocol for implementing ITS in VANET with authentication mechanism is shown in [6]. Here each node maintains a routing table with complete details of all the nodes in the network. But the network formed based on demand and exchanges information between nodes with the help of sequence number and broadcasts ID. These on demand route establishment causes certain delay which has greater impact in ITS and its effects on bandwidth is also compared. In[7], measurements based on congestion control algorithm in CCH channel is provided. In this algorithm, whenever the size of beacon messageexceeds certain level in the channel, the control algorithm discards a message to avoid congestion. Whenever event driven messages like emergency messages are generated, it automatically freezes all the low priority beacon message transmission to avoid congestion and delay. But in VANET, size of the information about neighboring vehicles and their geographical location, may not be fixed and also limited.

In [8], 802.11 VANET based car accident alert system collects the acceleration data and detects if an accident occurred or not. Current location of accident identified with the help of GPS and transmitted to the controller. Controller receives this information and alerts the driver with the help of speaker. Netgear WG111 wireless USB adapter that supports 802.11a were used as a transmitter. It shows that this simple alert system can help the driver to react immediately only for a non-mobile single-hop system. But VANETS have nodes that move rapidly, so careful routing protocol and topology construction are needed.Also802.11a version cannot guarantee secured data transmission as well as throughput attainment in fast changing mobile network.In [9], congestion control for disseminating uni-priority safety messages which adopts priority based EDF algorithm to schedule event-driven safety messages is provided. Here, each packet is assigned and scheduled with priority and deadline. It shows that this method incurs only 37ms delay in packet transmission and in worst case about 60ms delay. But it seems to be the best scheduling method only for dissemination of uni-priority safety messages and doesn't consider beacon message transmission in the network.In [10], priority based congestion controlcontains congestion detection unit for detecting congestion with the help of packet service ratio is discussed. Here, the available bandwidth is allocated to the nodes with the help of rate adjustment. Neighboring nodes are identified in the discovery phase, and priority is assigned by the priority decision module. High priority is given to transit data and not to the originating data. But this protocol doesn't ensure bandwidth usage by the nodes and also uses 802.11 protocols for wireless transmission which has its own limitations.All these traditional congestion control techniques and their drawbacks lead to propose a new highly reliable, congestion free and efficient bandwidth usage technique.

III.SYSTEM OVERVIEW

In Vehicular adhoc network, topology changes frequently due to mobility of the nodes, causing major issues in transmitting messages. Among the major issues in VANET, packet loss or delay due to collision in network is taken into consideration. Hence in our proposed work, a novel approach of implementing Dedicated Short Range Communication (DSRC) protocol 802.11p along with WFQ in VANET is done. By this approach we greatly expect a reliable communication by reducing the collision among transmitted packets, and thereby improving QoS.

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VANET routing protocol

The VANET is basically an adhoc network which doesn't have prior knowledge about network topology around them. Each and every node announces its presence in the network and listens about its neighboring nodes automatically by broadcasting packets. But to find its nearby neighboring node for efficient message transmission without any delay, certain routing protocols are required. One of the promising routing protocols in VANET is VANET RBC(Radio Broadcasting). Figure 1 illustrates the VANET architecture, which uses VANETRBC routing protocol. This protocol allows any node/vehicle in a network to identify its neighbor and their direction of movement with the help of hello messages. While exchanging the hello messages, the corresponding node will get details like location, movement, routing path etc., of the neighboring nodes. With the help of this information, vehicular nodes create routing table for its reference to forward packetsin the network.

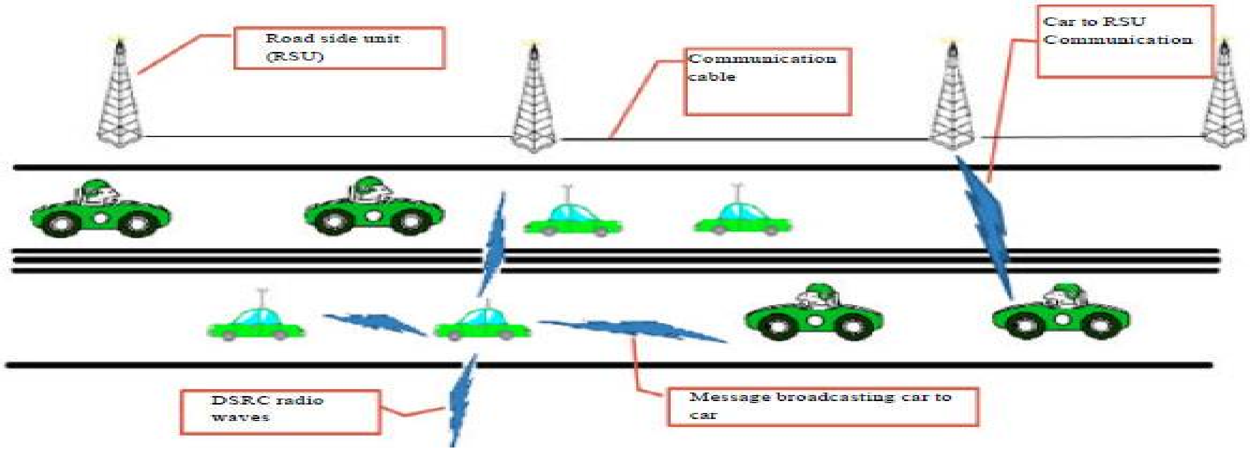

Figure 1.VANET RBC

But routing protocol helps only to identify the nearby nodes for message transmission without considering congestion and network traffic. Broadcasting these messages loads the channels and causes congestion of messages/packets. So in order to avoid the above issues of congestions, messages have to be classified by the scheduler. In ITS, event driven messages are classified as emergency messages i.e those which indicates information about any natural calamities, roadblocks/accidents, VIPs arrival & information about passage of ambulance etc. Apart from this, information about current road status that must be periodically updated to all nodes in the network in the formof beacon messages. Now the scheduler identifies the packet information as either emergency/ ordinary beacon messages and based on this it assigns priority (weight) to every packet. High priority is assigned to emergency messages for faster transmission without delay whereas low priority is given to beacon message transmission. In ITS, the driver receives information from all directions, where the system is programmed to process/transmit the packets from different flow based on the weight assigned to it. By transmitting these prioritized packets in channel concurrently leads to congestion and also affects the bandwidth utilization. So a queue is employed for buffering the traffic flow until it get processed efficiently thereby maintaining a QoS of the network[15]. This approach is referred as queuing technique. Traditionally many queuing techniques are employed for congestion avoidance and reduction. Such techniques include priority based queuing, Drop tail method, Random Early Drop(RED) and WFQ. Compared to all the above traditional techniques, WFQ shows promising features for enhancing QOS in VANETs . So the proposed system implements WFQ method for managing queues.

Weighted Fair Queue(WFQ)

WFQ supports flows with different bandwidth requirements by giving each queue a weight that assigns it a different percentage of output port bandwidth[15].WFQ also supports variable-length packets, so that flows with larger packets are not allocated more bandwidth than flows with smaller packets. This approach supports fair allocation of bandwidth by considering packet length into account. Because of this each queue receives its allocated share output port bandwidth and also transmits packet bit by bit at a time with the help of TDM network. Based on the order in which the last bit of each packet is transmitted, the packet is reassembled in the end. This is referred as packet finish time, which

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is calculated and assigned to each packet based on bit rate of output port, the number of active queues, the relative weight assigned to each of the queues, and the length of each of the packets in each of the queues. With the help of scheduler the packet with smallest finish time is selected and forwarded. The information from each vehicle is considered as a separate traffic flow and is placed inside distinct queues as shown in figure 2. The flows are placed inside Ingress ports of queue and classified as either high or low priority packets by the classifier.

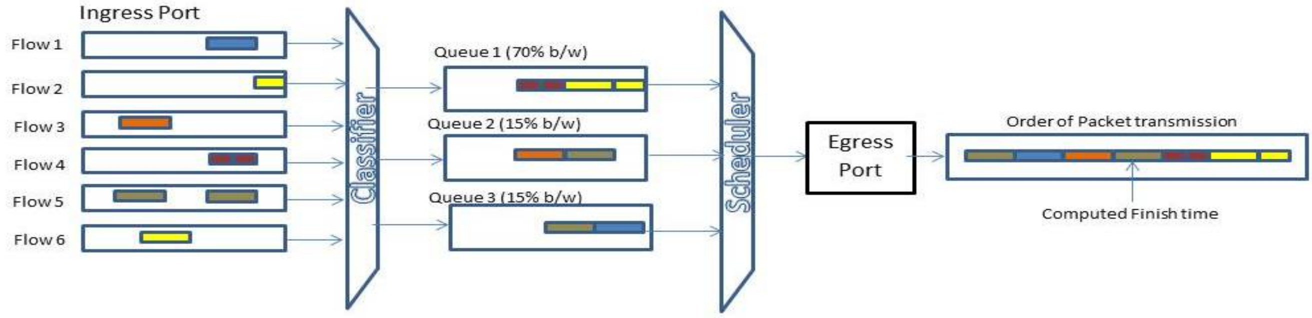

Figure 2. Separate queues for each traffic flow

Traffic flows are identified with the hash value which is generated from the following header fields.

Src&dest IP address	TCP/UDP port	IP protocol number	TOS value

Figure 3. Header fields of traffic flow

Priority is assigned based on the TOS (Type of service) in the header field. Based on the value in TOS, priority/weight is assigned to them i.e packet bearing information such as arrival of an ambulance, road accident with high priority by 11; arrival of VIPs with middle priority by 01 ; 10-above middle priority;transmission of 00-high priority. Each flow is arranged with distinct separate queues where the traffic inside queue is managed on FIFO basis and each queue is provided with minimum bandwidth guarantee. WFQ multiplexes the different priorities into data flows. Fairness in data flow is maintained efficiently by WFQ.ie when high volume traffic (greater in byte quantity) try to transmit, it will consume almost all the bandwidth arbitrarily making smaller traffic flows to starve. WFQ avoids this starvation by maintaining equity in the remaining capacity of queue for high-volume traffic. With link data rate R at any given time as shown in figure 4, the active data flows are serviced simultaneously each

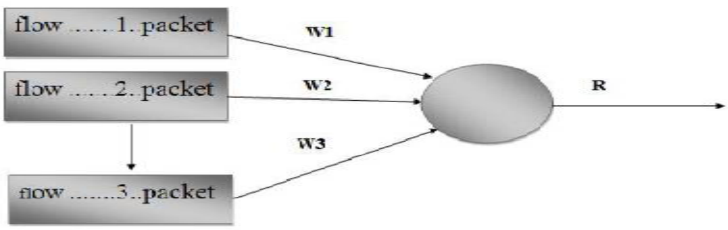

Figure 4.Weighted fair queue

at an average rate of R/N. Separate queue for each data flow is one of the added advantages so any single flow disruption will affect itself and doesn't disrupt any other sessions.

IEEE 802.11p wireless standard

IEEE 802.11p standard also called as WAVE (wireless access in vehicular environment) is one of the enhanced standard of 802.11, specially formulated to fulfill requirements of VANETS and for supporting ITS. WAVE PHY layer plays a major role in the communication process of the proposed system[7]. It operates on 9 channels working in the range of 5GHZ band and offers communication among vehicles with roadside infrastructure of around 1 km with the transmission rate of 3Mbps to 27Mbps. WAVE is considered to support dedicated short range communication (DSRV) which allows efficient and stable communication among fast moving vehicles guaranteeing information security.

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Vehicles of the proposed system are provided with on-board unit which offers DSRV. Some of the advantages of DSRV are fast network acquisition, low latency, high reliability, interoperability, security and privacy. Because of these advantages and promising features for reliable communication, this protocol is used as a wireless standard by the vehicular nodes in the proposed system.

IV. IMPLEMENTATION AND RESULT

Proposed system is implemented and simulated with the help of NS2 simulator. Mobile nodes and agent objects are created to exchange data among nodes. An UDP agent is created in source node and a null agent which acts as a traffic sink is attached to the destination node. Dump agent residing in NS2 helps the network to communicate by simply forwarding packets to the nodes. VANETRBC agent is created and linked with dump agent so forwarding of packets done through VANETRBC. A virtual road like environment and mobile nodes are created and visualized using NAM window in NS2 as shown in figure 5.

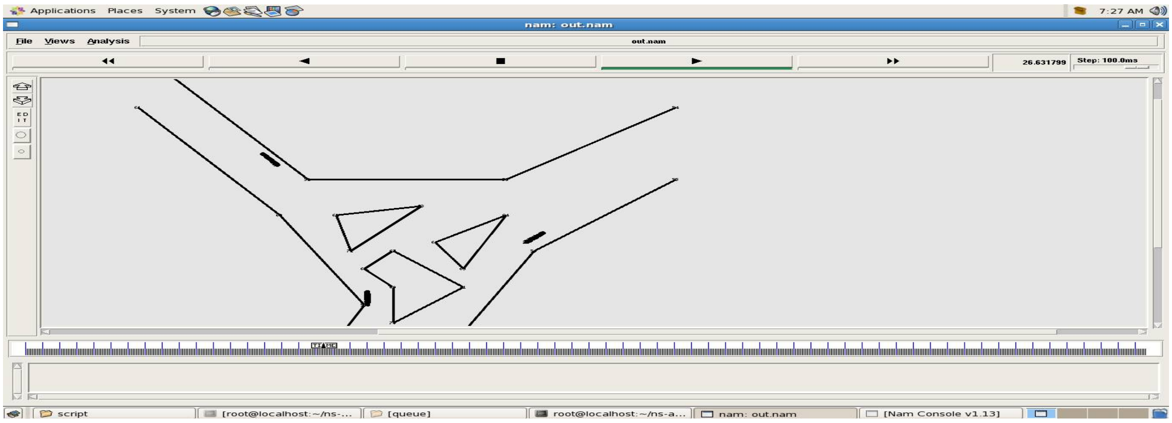

Figure 5. Virtual road and mobile nodes

Each and every data packet from the corresponding agent now classified as high/low priority depending on the values assigned in TOS. Now the classified messages are scheduled and assigned weights. Separate queue for each flow is given for reliable data transmission without collisions. To improve QOS in inter vehicle communication designed parameter for IEEE 802.11p is specified in table 1 and table 2.

Phy/WirelessPhyExt set SINR_DataCapture_	100.0;
Phy/WirelessPhyExt set freq_	5.85e+9
Phy/WirelessPhyExt set CSThresh_	3.162e-12
Phy/WirelessPhyExt set trace_dist_	1e6
Phy/WirelessPhyExt set bandwidth_	70e6
Mac/802_11Ext set CWMin_	15
Mac/802_11Ext set CWMax_	1023
Mac/802_11Ext set SlotTime_	0.000016
Mac/802_11Ext set SIFS_	0.000032
Mac/802_11Ext set ShortRetryLimit_	7
Mac/802_11Ext set LongRetryLimit_	4
Mac/802_11Ext set HeaderDuration_	0.000040
Mac/802_11Ext set SymbolDuration_	0.000008

Table 1:IEEE 802.11p design parameter in NS2

Above table describes how IEEE 802.11p is implemented in NS2, which includes distance value, bandwidth, header duration etc.

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PARAMETER	USED OPTION
Channel Type	Channel/WirelessChannel
Radio Propagation Model	Propagation/TwoRayGround
Antenna Type	Antenna/OmniAntenna
Link Layer Type	LL
Interface Queue Type	WFQ
Maximum Packet in IFQ	50
Network interface Type	Phy/WirelessPhy
MAC Type	MAC/802_11p
Routing Protocol	VANET RBC
Number of Mobile Nodes	110
Topological Area	1000 * 1000

Table 2:IEEE 802.11p specifications of proposed work

Table 2 shows the complete wireless communication specification which is implemented in the proposed system containing information about number of nodes designed for VANET architecture, protocol used for communication, propagation model provided etc. Some of the performance metrics for QOS in VANETS like PDR, routing overheads and end-to-end delay were studied and compared analysis of WFQ with other scheduling techniques has been made as shown in figure 6a,6b and 6c.

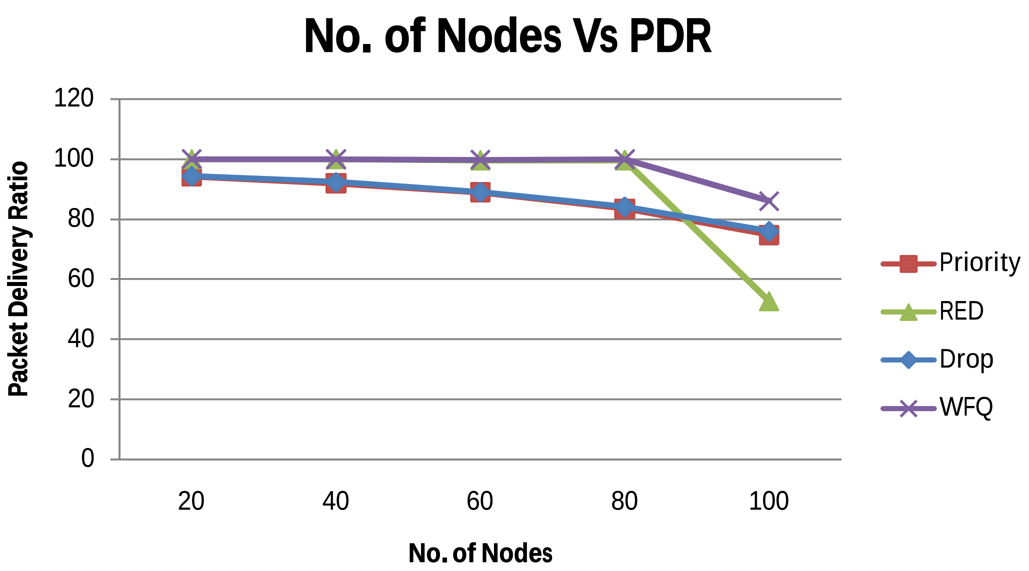

Figure6a. Comparative analysis of PDR in WFQ with other techniques

Above graph shows PDR is good in WFQ, as number of nodes increases compared to RED, drop tail and priority based queuing technique. It indicates that the PDR starts dropping when the number of nodes are increased in all the traditional methods.

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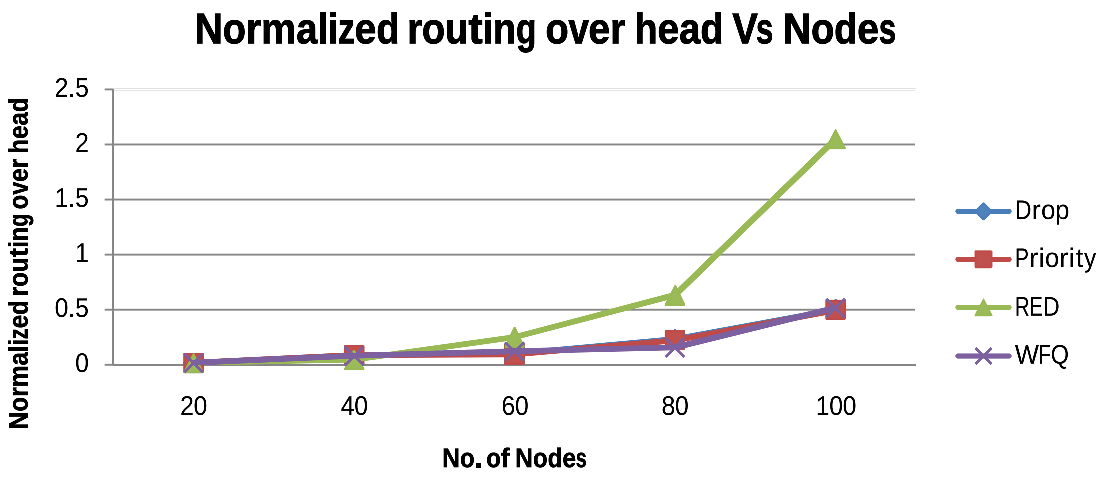

Figure6b. Comparative analysis of routing overhead in WFQ with other techniques

Figure 6b graph shows that the routing overhead is less in WFQ, as number of nodes increases compared to RED, drop tail and priority based queuing technique. In VANET, number of nodes increases or decreases very rapidly and it shows that WFQ proves efficient routing mechanism.One of the main constraint in VANET is on-time message delivery. Figure 6c graph shows WFQ provides lesser end-to-end delay in message transmission between nodes compared to drop tail method and virtual queuing method.

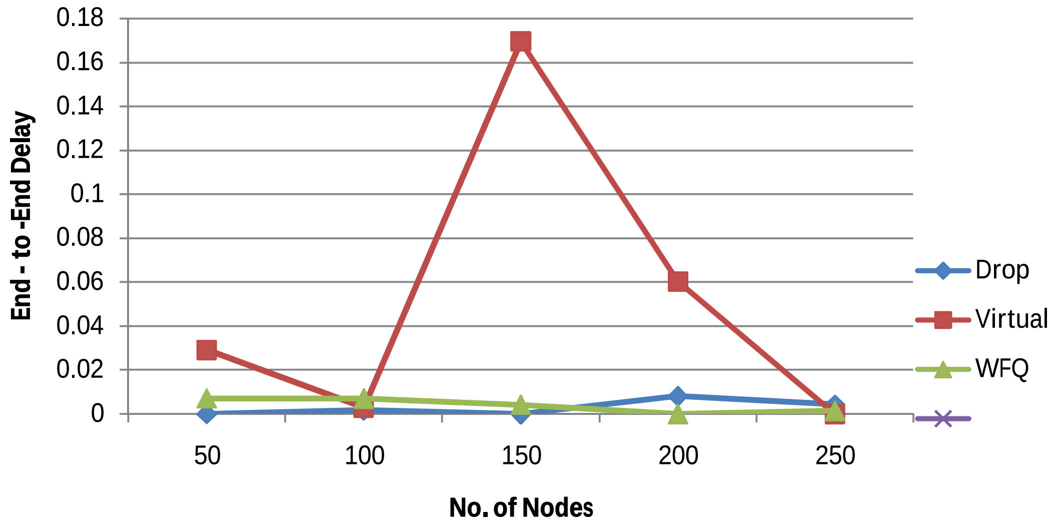

Figure 6c. Comparative analysis of transmission delay in WFQ with other techniques

So issues in VANETs like reducing delay in message delivery, reliable message transmission and delivery of messages between nodes without congestions are greatly satisfied by WFQ method compared to other methods which is graphically shown in the proposed methodology. Thus enhancesQoS in VANETs which greatly helps in developing Intelligent Transport System.

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V.CONCLUSION

This approach is based on the traffic guidance system to control traffic flow as well as to immediately report any emergency situations without delay for reducing its impact. The proposed system is responsible for reliable message transmission in VANETs and congestion control in the rapidly changing network. Usage of WFQ fairly allocates bandwidth in the different traffic flows of message and the implementation of IEEE 802.11p protocol in the vehicular node greatly enhances the throughput and the needed QOS in VANET .Performance metric parameters which actually enhances QOS was also proved by various comparisons with other traditional techniques in the proposed system.

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