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Efficient Mechanism for Congestion Control and Bandwidth Utilization of VANET

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***Abstract*—Vehicular Ad hoc Networks (VANET) play an important Vehicle to Vehicle (V to V) communication systems in which the vehicles/nodes are individually communicate with each other based on broadcast transmission scheme and deliver traffic information to each other. Due to the high mobility and the resulting highly dynamic network topology, congestion control will need to be performed in a decentralized and self-organized way, locally in each VANET node. The vehicles act directly as a sensor which measures the traffic condition at their current location. This information is analyzed and distributed within the VANET in a large area and allows each vehicle to keep track of the local traffic situation. This paper has presents a novel concept for congestion control and packet forwarding in VANET. The proposed technique is limited the broadcasting of traffic status by monitoring the number of neighbors around the radio range. It means that the traffic status is only forwarded to successor node and receives from the node which is just ahead from follower node. This technique reduces the unnecessary traffic information and reduces the possibility of congestion in network. The proposed technique performance is measured with the normal VANET scenario in V to V communication and the simulation results are shows that the performance of proposed scheme are provides the better performance and improves the network performance with efficient bandwidth utilization.**

Key words: Congestion, VANET, V to V, traffic, broadcasting, bandwidth

I. INTRODUCTION

Vehicular Ad Hoc Networks (VANETS) is one of its types. It deploys the concept of continuously varying vehicular motion. The nodes or vehicles as in VANETS [1] can move around with no boundaries on their direction and speed. This arbitrary motion of vehicles poses new challenges to researchers in terms of designing a protocol set more specifically for VANETS. VANETs allow vehicles to avoid problems, either by taking any desired action or by alerting the driver. Besides the road safety enhancements that VANETs will bring, they also open doors too many applications to enhance the driving and traveling comfort, like Internet access from a car .VANET or Intelligent Vehicular Ad-Hoc Networking provides an intelligent way of using vehicular Networking [2]. With the sharp increase of vehicles on roads in the recent years, driving becomes more challenging and dangerous. The main goal of VANET is providing safety and comfort for passengers helping drivers on the roads by anticipating hazardous. In VANETs, vehicles can communicate each other (V2V, Vehicle-to-Vehicle communications). They can connect to an infrastructure (V2I, Vehicle-to-Infrastructure) or Infrastructure to Vehicle (I2V) to get some service [3]. This infrastructure is assumed to be located along the roads. Each vehicle equipped with VANET device will be a node in the Ad-hoc network and can receive & relay other messages through the wireless network. Collision warning, Road signal arms and in place traffic view will give the driver essential tool to decide the best path along the way events or bad traffic areas. VANET has unique characteristics like high mobility with the constraint of road topology, initially low market penetration ratio, unbounded network size, infrastructure support that Differentiate it from MANET. From the above mentioned characteristics, it is evident that conventional MANET routing Protocols have difficulties from finding stable routing paths in VANET environments. Therefore, more and more researchers have concentrated on proposing suitable routing protocols to deal with the highly dynamic nature of VANET..

A. Features of VANET

- The nodes in a VANET are vehicles and road side units.
- The movement of these nodes is very fast.
- The motion patterns are restricted by road topology.
- Vehicle acts as transceiver i.e. sending and receiving at the same time while creating a highly dynamic network, which is continuously changing.
- The vehicular density varies from time to time for instance their density might increase during peak office hours and decrease at night times.

VANET are distributed, self-organizing communication networks formed by moving vehicles, and are thus characterized by very high node mobility and limited degrees of freedom in mobility patterns. There are two categories of routing protocols [4] i.e. topology-based and geographic routing. Topology-based routing uses the information about links that exist in the network to perform packet forwarding. Geographic routing uses neighboring location information to perform packet forwarding. Since link information changes in a regular basis, topology-based routing suffers from routing route breaks.

In this research, we proposed a new approach for deliver messages in city-based environments that takes advantage of the roads layouts to improve the performance of routing of vehicles in VANET.

II. CONGESTION ISSUE

The initial design was shown to result in channel congestion and scalability issues when a large number of vehicles are in range of each other [5]. The network will contain large number of vehicles represented as nodes. The vehicle communication takes into consideration only the mobility of urban traffic where vehicles often interact for relatively longer time period of time and problem of traffic congestion is usually encountered. The network dynamics will be governed by the high speed, relatively longer communication time period between neighbors and well defined vehicle routes. In vehicular networks to ensure that all vehicles in the network have similar opportunities to communicate with nearby nodes. In fact, if congestion control were obtained by sacrificing say, a specific node in the network having a limited bandwidth capacity reaches to low value, this node would not have a chance to communicate with nodes in its surrounding which will consequently impair application-level performance. Most importantly, in traffic handling related applications, every vehicle in the network should be able to receive fresh information about the status of the other vehicles in its surrounding, along with communicating its own status to the surrounding vehicles. For this reason, fairness becomes a major design goal in traffic handling related applications.

III. RELATED WORK

The In this paper [6] the Vehicular Intermittently Connected Network (VICN) scenario is considered where an isolated cell site located in a rural area is typically connected via a point-to-point microwave backhaul to a larger Metropolitan Area Network (MAN) deployed in a certain city. The MAN, in turn, is connected to the Internet. Due to the increased adoption of Internet-connected mobile computing devices and increased data consumption per device such microwave links are expected to transport remarkably large quantities of data and may frequently suffer from bandwidth insufficiencies. This situation is even worse since the U.S. Frequency Allocation Charts indicate a highly overcrowded wireless spectrum while the wireless technology is rapidly advancing and bringing on a wide variety of new services that necessitate an all-time-anywhere connectivity.

In this paper [7] we have examined the dynamic behavior of two of these algorithms to verify their stability and fairness property. It was found that for the studied algorithms controller function parameters have to meet certain restrictions in order for the algorithm to be stable. The proper ranges of parameters for achieving stability are presented for the discussed algorithms. Stability is verified for all typical highway density cases for static traffic as well as real scenarios. Cooperative vehicle safety systems are perhaps the most important and challenging application of VANETs at this time. These systems need to be robust enough in case of large scale implementation. Vehicular network size may become extremely large on congested roadways; hence scalability is an important factor in designing such systems. To achieve scalability, congestion management schemes based on adaptive rate and range transmissions have been proposed.

In this paper [8] we propose a scalable MAC protocol that is built on a TDMA configuration. Basically, the highway is divided into a number of virtual segments. Each segment contains a local coordinator that assigns time slots to vehicles for beacon transmissions. Although the MAC method of IEEE 802.11p is inefficient for safety message transmission, the PHY can be of great use as it provides data rates of up to 27 Mb/s. In our protocol, we mitigate channel congestion by reducing beacon transmission duration, which is achieved by using higher 802.11p data rates. The TDMA configuration is designed to counteract the interference effects induced by higher data rates. As far as emergency messages are concerned, the sender/forwarder is rendered immediate channel access by means of a reservation mechanism.

The purpose of this work [9] is to design a congestion control mechanism that guarantees reliable and timely dissemination of safety related messages. Currently, most of the existing works propose to reduce the transmit power level as well as the frequency of beacon transmission to release more bandwidth for safety messages transmission, and thus prevent the occurrence of a congestion state. They proposed three stages based solution in which we first assign different priority levels to the emergency messages according to their contents and the number of hops that they have traveled. Secondly, we apply a congestion detection mechanism to identify any congestion state in VANETs. As a last stage, a vehicle adjusts its transmit power as well as its beacon transmission rate, according to the result of the previous step, to facilitate the dissemination of the emergency messages.

In this title [10], we focus on message routing in both classes of applications. The main concern is whether the performance of VANET routing protocols can satisfy the delay requirements of such applications. we propose in this paper an Intersection-based Geographical Routing Protocol (IGRP) consisting of successions of road intersections that have, with high probability, network connectivity among them. Geographical forwarding is still used to transfer packets between any two intersections within the path, reducing the path’s sensitivity to individual node movements. The selection of the road intersections is made in a way that maximizes the connectivity probability of the selected path while satisfying quality of service (QoS) constraints on the tolerable delay within the network, bandwidth usage, and error rate.

The scheme proposed in [11] highlights the importance of transmit power control to avoid saturated channel conditions and ensure the best use of the channel for safety related purposes. The goal of this work is to design a new transmit power control scheme that ensures distributed fair power adjustment for vehicular environments (D-FPAV) to control the load of periodic messages on the channel.

Other researchers have applied formal verification techniques to assess the effectiveness of their congestion control schemes rather than using the conventional simulation tools. A recent and interesting work was introduced in [12], in which the authors have used the model checking technique to investigate the efficiency of the congestion control scheme proposed in [13]. This scheme is based on a combined static and dynamic priority assignment schemes. The former scheme defines a message priority as a function of its content and the source application type. In another hand, the latter scheme uses some parameters regarding VANET context such as, surrounding vehicles density, vehicle speed and message utility. Using these priorities, each message is transmitted over an appropriate channel.

In this paper [14] proposed a novel density model for urban traffic systems and employ this model for the purpose of spatial-temporal analysis of radio overlapping. To model traffic density, we consider a signalized junction and road segments linked to that junction as basic building blocks of urban traffic systems. The density model enables us to derive a framework to explain trends and critical regions of radio overlapping corresponding to VANET scenarios targeted for urban transportation systems, which cannot be derived from uniform density models widely used in existing literature. Apply the derived radio overlapping model to study channel load associated with periodic beaconing, a fundamental mechanism for safety message communication in VANETs. This study also provides a generic analytical framework to investigate other performance aspects of data and safety message communication in VANET.

IV. PROBLEM IDENTIFICATION

Broadcasting continues to be a strong research area of focus by VANET researchers because a significant number of messages transmitted in VANETs are broadcast messages. In addition, the underlying 802.11 wireless communication technology used by VANET is not well suited at handling broadcast transmissions because of frequent heavy messages of traffic information occurs the congestion and collisions leading to frequent retransmissions by vehicles. This traffic information messages congestion and collisions in turn affect the message delivery rate and increases the delivery time of the messages. This problem becomes more severe in heavily loaded networks. Finally, when the channel is not available, the nodes in are not promulgate and collect the traffic information in network and during high utilization periods this mechanism can cause the possibility for several nodes within radio range of each other, to transmit concurrently.

V. PROPOSED APPROACH

Vehicle to Vehicle communication (V to V) in Vehicular ad hoc network is a decentralized network. This kind of network does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed wireless networks and server for monitoring traffic information. Instead, each vehicle as a node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. Every node in wireless ad hoc network can become aware of the presence of other nodes within its range.

The Advance proposed research is required to investigate intelligent flooding schemes, limited traffic information approach that can efficiently handle asymmetric communications among vehicles for different transmission ranges. Providing *reliable* broadcast messages with minimal overheads for VANETs introduces several other technical challenges including the selection of the next forwarding node, the maintenance of communications among vehicles as they broadcast the traffic information of vehicles in network.

A. Proposed Algorithm

.ff The proposed algorithm is defining the steps for which the traffic status broadcasting will control and reduces traffic overhead.

Step 1: Begin
Step2: Initialization
T: Terrain Size (800*800)
V_R: Requestor Vehicle $V_{R\,1}$.................. $V_{R\,n}$
V_P: Reply Vehicle $V_{P\,1}$......... $V_{P\,m}$
D = Vehicle Destination
Routing Protocol = AODV
Step3: Execute Traffic status Request procedure
V_R sends route request
V_P sends route reply
{
Step 4 If (Requestor Vehicle (V_R) found next neighbor = = Nearest Neighbor)
{
Deliver traffic status & Receive Traffic Status (V_P)
}
{
If (Nearest neighbors in range & V_R is not reaches = = D)
{
Continue communication and reaches to Destination
\
}}
Else
{Vehicle Sends traffic request}
Step 5 Else
{Communicate with Next nearest neighbor and reaches to destination or out of range}
}
Step 6 Exit

VI. SIMULATION TOOL DESCRIPTION

In this paper we use NS-2 [14] as the basic tool for simulation. In this research the bandwidth utilization is enhanced by delivering and accepting traffic status only from neighbour vehicles. We have used the utilities given in the ns-2 such as AWK, XGRAPH, GNUPLOT, TCL and we have also used C++. During the simulation two files are generated namely trace file and nam file. NS2 consists of two key languages: C++ and Object-oriented Tool Command Language (OTcl). While the C++ defines the internal mechanism (i.e., a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events (i.e., a frontend).

A. Simulation parameters

The simulations parameters are used for V to V Communication in VANET are mentioned in table 5.1. The Simulation TCL script is designed on the basis of these given parameters.

Table 1 Simulation Parameters for Case Study

VANET Communication	Vehicle to Vehicle (V to V)
Number of signals	4
Number of nodes	30
Dimension of simulated area	800×800
Routing Protocol	AODV
Simulation time (seconds)	300
Transmission Range	250m
Traffic type	CBR 3pkts/s
Packet size (bytes)	512
Agent type	UDP
Number of traffic connections	5
Maximum Speed (m/s)	30
Nodes Mobility	Random way point

VII. RESULTS EVALUATED

The results of proposed scheme and basic V to V communication scheme are mentioned in this section. The proposed scheme is enhancing the performance of network and utilizes the limited bandwidth capacity of channel.

A. Traffic Message Overhead Analysis

The traffic message overhead is count on the basis of number of traffic requests that are delivering by vehicles and received by vehicles in network. If the numbers of request packets are delivering in network then in that case the overhead on each vehicle is increases in existence of limited bandwidth. This graph represents the traffic message overhead analysis in case of Usual V to V communication in VANET and in case of proposed communication in VANET. Here the performance of proposed scheme is better in network because it deliver the less number of request packets in network by that the bandwidth reservation status is optimal. In case of proposed scheme about less than 1700 request packets are deliver in network it means the request packets are broadcast in network in limited. But in case of usual V to V communication in VANET the request packets are deliver in huge amount, it about 2000 packets deliver in network in given simulation time it means it consumes more bandwidth and degrades performance of network.

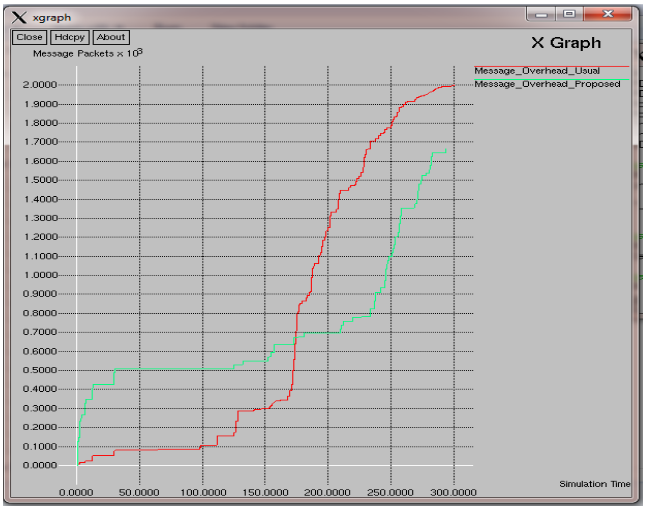

Fig. 1 Overhead Message Analysis

B. Packet Delivery Ratio (PDR) Analysis

The packet delivery ratio analysis in based on the percentage of data packets are deliver in network after the response of request packets in V to V communication in VANET. The data packets are the packets that are delivering in network to inform about the traffic status. It means the traffic information is the main data in network. This graph represents the traffic information percentage delivery analysis in case of usual V to V communication and proposed limited request deliver scheme in V to v communication in VANET. Here we clearly visualized the PDR performance of usual V to V communication. The performance of usual communication is highest about 87 % at time about 170 seconds and also the PDR are not counts at the end of simulation but in case of proposed scheme the value of PDR is about more than 95 % and also counts at the end of simulation. The proposed scheme are enhances the performance of V to V communication with minimum overhead.

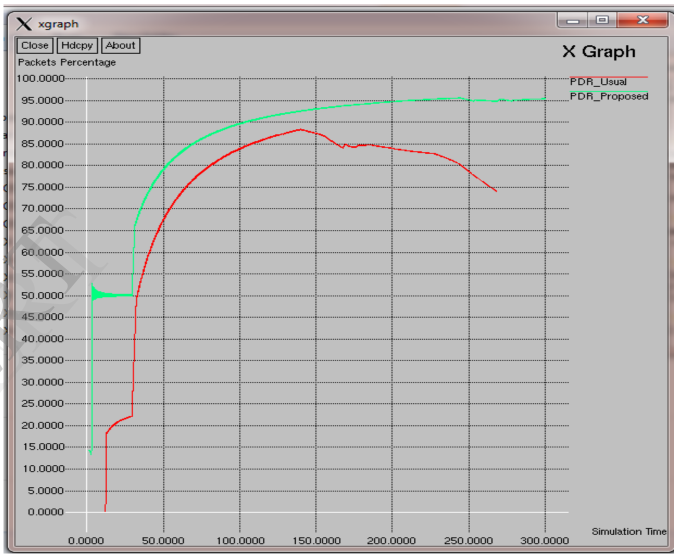

Fig. 2 Packet Delivery Analysis

C. Throughput Analysis

Throughput is also the important performance parameters to measure the performance of data packets received at destination in network in per unit of time. The number of data packets are delivery in network is completely based on the available bandwidth in network. It means if the bandwidth is more consume in network for deliver the request of traffic information, in that case the throughput degrades. In this graph the through is measured in case of usual communication and proposed communication. The throughput performance of usual communication is not showing the continuous flow of data packets / time and also unexpected more through put is shows in between time 130 to 240 but in foam of up and down but not countable at the end of simulation. However in case of proposed scheme the throughput is enhancing continuously and count at the end of simulation, it means throughput performance is better as compare to usual communication in VANET.

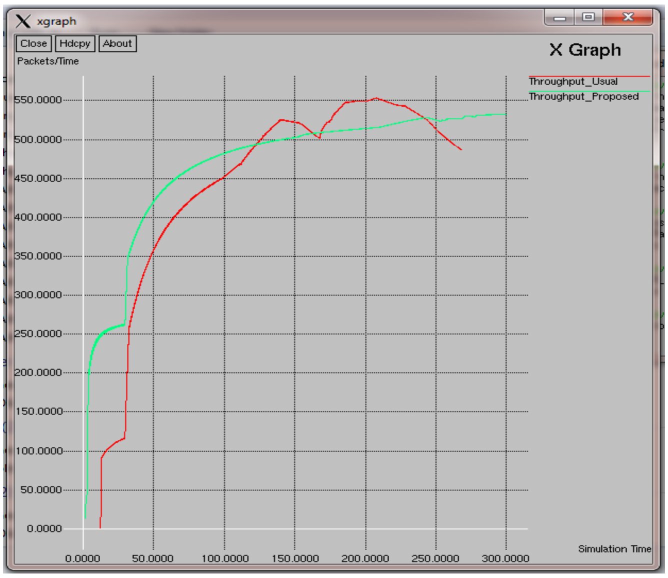

Fig. 3 Throughput Analysis

D. Summery of Traffic in case of Usual Communication and Proposed Communication

The overall network performance of both the scheme in V to V communication is mentioned in table 5.2. Here every performance parameter of proposed scheme is showing the better performance and improves the traffic information data with minimum bandwidth consumption. However the overall performance of usual communication is showing the degradation in network.

Table 2 Overall Performance Analyses

Constraint	Usual	Proposed
Send	9564.00	9564.00
Receive	6334.00	9124.00
Routing Pkts	2001.00	1666.00
PDF	66.23	95.40
NRL	0.32	0.18
No. of dropped data	3230	440
Actual Performance	17899 (79.59%)	20354 (96.51%)

E. Packet Drop Analysis

The all type packet drop analysis of both the scheme is mentioned in table 5.2. Here we clearly visualized the different reasons of packet dropping and also know about how many packets are dropped in network for a particular reason and also how much percent of data is it of total in network is dropped. In this table the major reason of packet dropping is congestion in usual communication in VANET but in proposed scheme it minimizes and provides about 9 times degradation in network. Rests of the reasons are showing the better performance in case of proposed scheme and improves the V to V communication in VANET.

Table 3 All Type packet Drop Analysis

Drop Reasons	**Usual**	**Loss %**	**Proposed**	**Loss %**
Drop from ARP	25	0.11%	34	0.16%
Drop from IFQ	73	0.32%	45	0.21%
Drop from CBK	116	0.52%	74	0.35%
Drop from TOT	0	0.00%	0	0.00%
Drop from NRT	1143	5.08%	135	0.64%
Drop from END	2	0.01%	8	0.04%
Drop from DUP	0	0.00%	0	0.00%
Drop from RET	0	0.00%	0	0.00%
Drop from BSY	0	0.00%	0	0.00%
Drop from SAL	0	0.00%	0	0.00%
Drop from ER	0	0.00%	0	0.00%
Total Drop Via Congestion	3230	14.36%	440	2.09%
Total Drop	4589	20.41%	736	3.49%

VIII. CONCLUSION & FUTURE WORK

The proposed approach is not restricted to traffic information delivery only on limited neighbors but their aim is only to utilize the limited available bandwidth for communication the nearby vehicular nodes. To achieve scalability, traffic information status is most important. The proposed scheme is completely based on the transmission ranges that have been proposed and the number of vehicles that receive the traffic status and deliver the traffic status in network. In this research we have examined the dynamic behavior of two VANET scenarios verify their stability and fairness performances. It was found that for the studied scheme and proposed scheme parameters have to meet no restriction in order for the algorithm to be stable. The performance is measured through performance matrices and the proposed scheme is showing the better results and reduces the possibility of congestion and other drops reasons in network.

In future we will try to proposed the scheme that estimate the traffic status and take the decision to pass the fast vehicles first in network on the basis of their speed and location information in V to V communication and also try if the traffic is heavy then to divert the route of follower vehicles to reduces the possibility of traffic jamming conditions.

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