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Alternative Path Selection through Density Based Approach for Controlling the Traffic in VANETs

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Abstract: Vehicular Ad-Hoc Networks (VANETs) are receiving a lot of attention due to the wide variety of services they can provide. Their applications range from safety, crash avoidance Internet access and multi media. VANETs are the most important component of Intelligent Transportation System (ITS). One of the main goals of the ITS is to improve safety on the roads, and reduce traffic congestion, waiting time, and fuel consumption. A lot of work and research around the globe is being conducted to define the standards for vehicular communication. Technical challenges in vehicular ad hoc network development include network discovery, conjunction control, routing, collaborative signal, information processing, querying and security. Vehicular traffic is the primary problem of many developing countries. Vehicular traffic occurs when the volume of traffic flow demand for space greater than the available road capacity. One of the main issues in this type of system is to control the vehicular traffic signal at the intersection of the roads. But in the traditional signalling of road scenarios this will not fully help for the control of the traffic and will be unable to adjust the timing pattern. In this paper we propose dynamic signalling which is based on the density of the vehicles in the road scenario. Suppose if the density increases in the vehicle then an alternative path has to be selected. So this work prevents the vehicles traffic at the inter section and also reduces the time of the passengers.

Keywords: Inter-Vehicle Communications (IVC), Roadside-to-Vehicle Communications (RVC), Vehicular Networks. Vehicular Ad Hoc Networks (VANETs), Mobile Ad Hoc Networks (MANET), Wireless Access for Vehicular Environment (WAVE), On-Board Units (OBU), Road Side Units (RSU).

1. INTRODUCTION

VANET is a kind of vehicular communication which is based on wireless network technology [Fig.1]. In 1999, the Federal Communication Commission (FCC) allocated a frequency spectrum for vehicle-vehicle and vehicle-roadside wireless communication. The Commission then established Dedicated Short Range Communications (DSRC) Service in 2003. DSRC is a communication service that uses the 5.850-5.925 GHz band for the use of public safety and private applications. The allocated frequency and newly developed services enable vehicles and roadside beacons to form Vehicular Ad Hoc Networks (VANETs), in which the nodes can communicate wirelessly with each other without central access point. Vehicles are becoming “computers on wheels”; or rather “computer networks on wheels”. In this type of networks, the vehicles are the mobile nodes of the network. VANETs are start-of-the-art technology integrating ad hoc network, wireless LAN (WLAN) and cellular technology to achieve intelligent Inter-Vehicle Communications (IVC) and Roadside-to-Vehicle Communications (RVC). VANETs have some important characteristics such as vehicles which are forming the networks are nodes, high mobility of vehicles, rapid changes in topology and time-varying vehicle density.

Recent advances in wireless networks have led to the introduction of a new type of network called Vehicular Networks. Vehicular Ad Hoc Network (VANET) is a form of Mobile Ad Hoc Networks (MANET). VANETs provide us with the infrastructure for developing new systems to enhance drivers, passenger’s safety and comfort. VANETs are distributed self-organizing networks formed between moving vehicles equipped with wireless communication devices. This type of networks is developed as part of the Intelligent Transportation Systems (ITS) to bring significant improvement to the transportation system performance. One of the main goals of the ITS is to improve safety on the roads, and reduce traffic congestion, waiting time, and fuel consumptions.

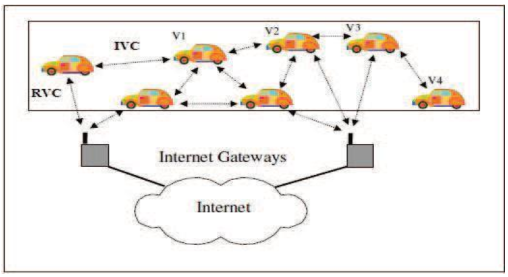

Fig 1: Vehicular Communication Scenario

VANETs are getting attention due to various applications which are related to control traffic and road safety. Smart cities which are full of traffic would like to minimize their transportation problems due to the increasing population that results in congested roads. VANET helps us to solve this issue by improving the mobility of the vehicles. It also helps to keep the city more safe and sophisticated. At the beginning of the development of vehicular technologies, more focus was on building efficient and safer roads. But

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nowadays due to the huge development of wireless technologies and their application in vehicles, it has become possible to use Intelligent Transportation System (ITS) that will change our way to drive and help emergency critical services. VANETs provide easier communication facility among vehicles and also with fixed infrastructure. This will not only improve the road safety, but also provides benefits commercially.

In this paper we provide an overview of the technologies and Density based approach to control vehicular traffic. The remainder of this article is organized as follows. In section 2 we provide the System Architecture and Communication Standards on VANETs and also the related research problem. Section 3 describes the proposed work. In Section 4 describes the Simulation Environment and finally, concludes the paper.

2. SYSTEM ARCHITECTURE AND THE COMMUNICATION STANDARDS

System architecture can be divided into different forms according to different perspective in VANETs. From the vehicular communication perspective, it can be categorized into three layers. The upper layer is the Infrastructure Domain consisting of base station, servers, gateways, and the Road Side Units (RSU). The middle layer is the Ad-Hoc Domain, lower layer is the In-Vehicle Domain (field layer), consisting of On-Board Units (OBU). In VANETs five kinds of communication are supported Vehicle to Vehicle ,Vehicle to Road Side Unit(RSU), Road Side Unit(RSU) to Road Side Unit(RSU), Road Side Unit(RSU) to Base Station(BS), Base Station(BS) to Base Station(BS) as shown in Fig2. But from the point of view of network architecture, the VANET architecture is divided into five layers: Physical Layer, MAC Layer, Network Layer, Transport Layer, and the Application Layer.

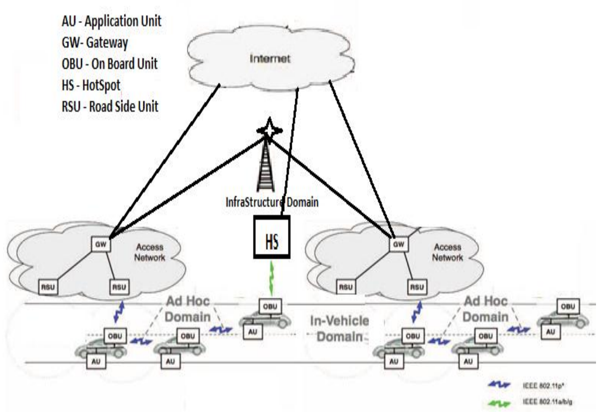

Fig 2: System Architecture for VANETs

IEEE Architecture and WAVE standards

For Vanets the following IEEE standards IEEE P1609.1, P1609.2, P1609.3 and P1609.4 were prepared. P1609.1 is the standard For Wireless Access for Vehicular Environment (WAVE) Resource Manager. P1609.1 defines the messages and Data formats along with the services and interfaces of the WAVE resource manager application. Apart from the above, P1609.1 standard also provides access for applications to the rest of the architecture. The IEEE standard P1609.2 defines the following: security, secure message formatting, processing, and message exchange.

The IEEE standard P1609.3 takes care of routing and transport services, the alternatives for IPV6 can also be achieved with this standard along with it also defines the management information base for the protocol stack. P1609.4 focuses mainly on how the multiple channels specified in the DSRC standard should be used. The WAVE stack uses a modified version of IEEE 802.11a for its Medium Access Control (MAC) known as IEEE 802.11p. The protocol architecture defined by IEEE standards and the WAVE standards are shown in Fig 3.

The IEEE 802.11p/WAVE (Wireless Access Vehicular Environment) has been proposed as standard use for VANETs. The function of WAVE is to provide safety messages which are carried over a dedicated control channel (CCH), while non-safety messages can be delivered over a set of available service channels (SCHs).

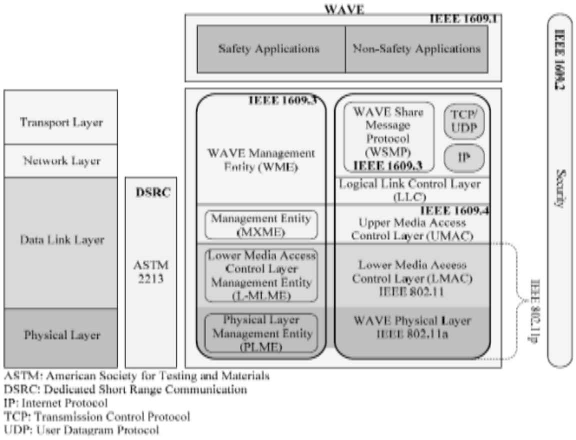

Fig 3: Wireless Access in Vehicular Environments (WAVE), IEEE 1609, IEEE 802.11p and the OSI reference model.

The IEEE 802.11p physical layer is based on OFDM (Orthogonal Frequency-Division Multiplexing) which is used for multichannel access scheme. The channels access provided for multichannel operation is used to deliver various safety messages and non-safety messages to vehicles on the roadway. The IEEE 802.11p MAC layer has the same core mechanism of the Enhanced Distributed Channel Access (EDCA) specified in 802.11e, which is based on the CSMA/CA scheme. In CSMA/CA, as soon as a node receives a packet that is to be sent, it checks to be sure the channel is idle or not. If the channel is idle, then the packet is sent. If the channel is busy, the node defers its transmission until it becomes idle.

However, owing to the nature of contention based channel access scheme, the IEEE 802.11p system suffers from Quality of Service (QoS) degradation for applications caused by the channel congestion in dense network. In dense network, vehicles are supposed to issue high numbers of periodic safety messages periodically to announce other vehicles about their situations (e.g. speed,

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positioning and direction) and the CCH channel will easily get congested. In many VANET's, the vehicle carries the packet until it finds any other vehicle in its range which is moving towards the direction of the destination and then it forwards the packet to that vehicle. We can only calculate the probabilistic estimate with which path should be followed for minimizing delay so that limited available bandwidth can be efficiently utilized.

3. RELATED WORK

Vehicular congestion is the primary problem of many developing countries like India. Vehicular congestion occurs when the volume of traffic generates demand for space greater than the available road capacity. Heavy traffic jams or congestions lead to accidents which results in injuries to passengers, cause damage to vehicles and as well as their life.

Flow Chart:-

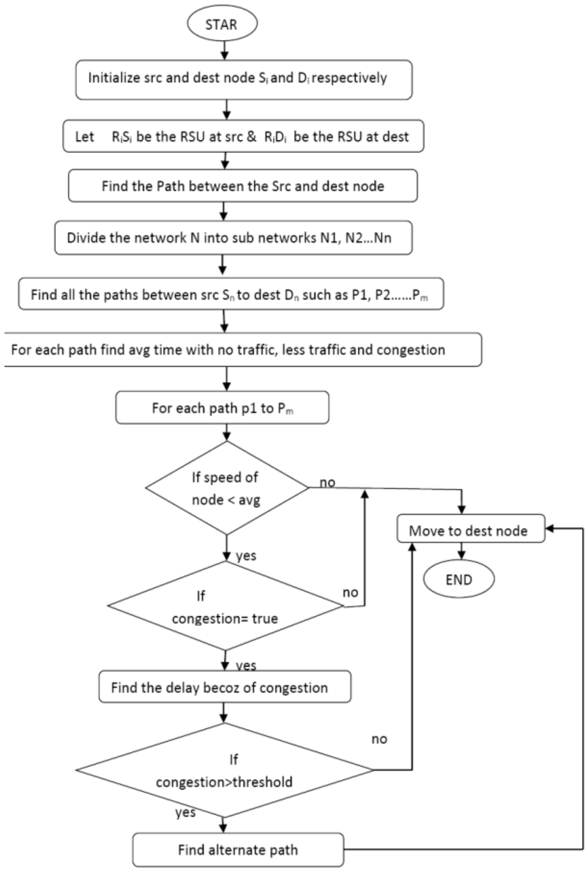

Fig 4: Flowchart

Block1: Before a vehicle enters the way for its destination, information about the destination is given to the on board unit, which in return is given to the RSU (Road side unit).

Block2: Information about the destination received by RSU is given to the base station every minute.

Block3: Assumption of the density is made in the base station if the density is more than 70% then block 4 and block 6.

Block4: When the density is more than 70% the base station has to search for the alternative path.

Block5: Alternative path given by the base station is than sent to the road side unit, which is then passedto the on board unit which could be viewed by the person.

Block 6: If the density is not less than 70% then base station sends the information to RSU, then to the onboard unit saying there is no congestion in the path(traffic) and can remain in the same state.

Once the process is done for one vehicle same process is continued for the rest of the vehicles entering the path.

Alternative path selection Algorithm (BS, RSU,OBU)

Step1: Set Destination info in OBU and Send to BS through RSU.
Step2: Calculate Density of all RSUs in BS every minute.
Step3: If (Density >Threshold) then
Search for alternative path or Select second best path.
(Alternative path Selection algorithm)
Else
Maintain the same state
Step4: Stop

Consider the VANET scenario, the RSU will calculate the density of the vehicles on the road. If the density exceeds then broadcast the density message to the vehicles i.e. OBU, then vehicles check for the alternative path. Suppose when the density exceeds the maximum limit and if there is no alternate path found, then send the density information to the signal i.e. Base station (BS).The base station makes the decision and informs the vehicles i.e. the OBU.

4. SIMULATION ENVIRONMENT

NS2 simulator is used to carry out the simulation experiments which are basically used for the simulation of networking scenarios. Ns is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. The goals of NS2 are : To support networking research and education – Protocol design, traffic studies, etc. – Protocol comparison; – New architecture designs are also supported. To provide collaborative environment – Freely distributed, open source; – Increase confidence in result. Undoubtedly, NS2 has become the most widely used open source network simulator, and one of the most widely used network simulators.

Simulation Results and Analysis

This paper is implemented using the network simulator NS2.The details regarding NS2 is defined in the previous section. The implementation details are as follows. Here the nodes behave like vehicles. Initially 40 nodes have been created. To establish a communication link each node sends hello messages to its neighbours. After the completion of sending hello messages the source node sends data packets to its receivers. If the queue size exceeds the maximum limit the packets will be dropped .During the packet transfer if congestion occurs then an alternative path has to be selected. The snapshot for each condition is shown below.

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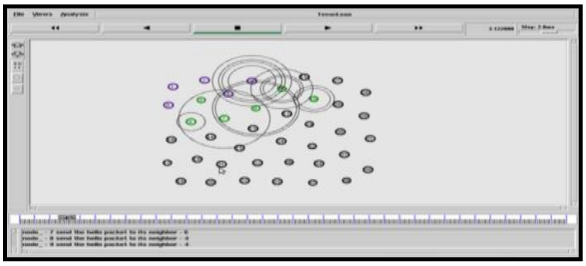

Fig 6:Node sends hello packets to its neighbours

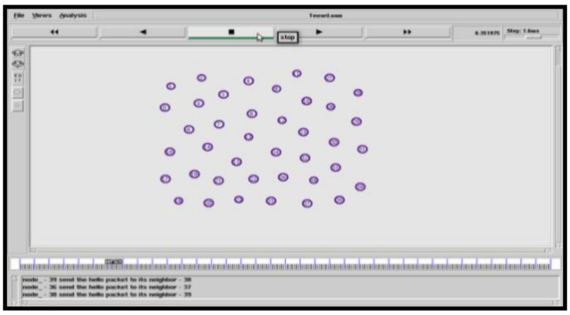

Fig 7:Node completes sending hello messages

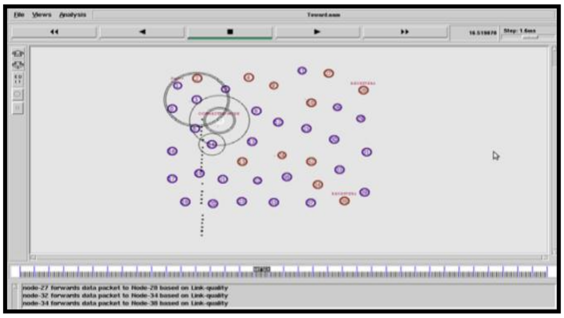

Fig 8:Source node sends data packets to its receivers

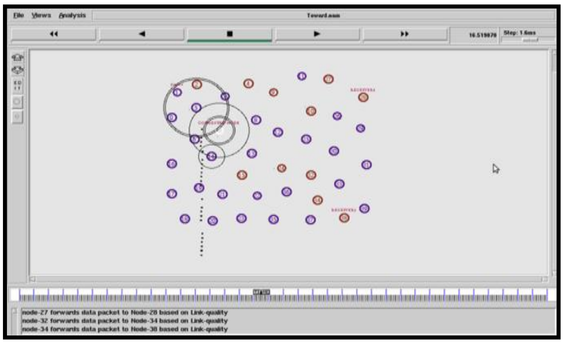

Fig 9:Representation of packet drop

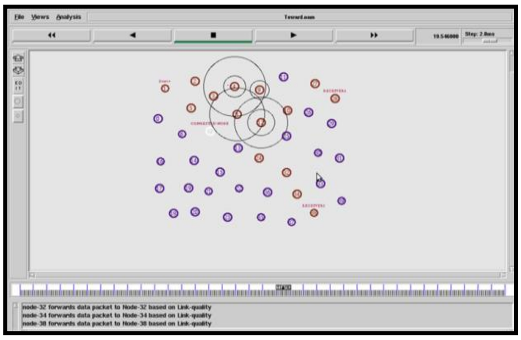

Fig 10:Alternate path selection due to congestion

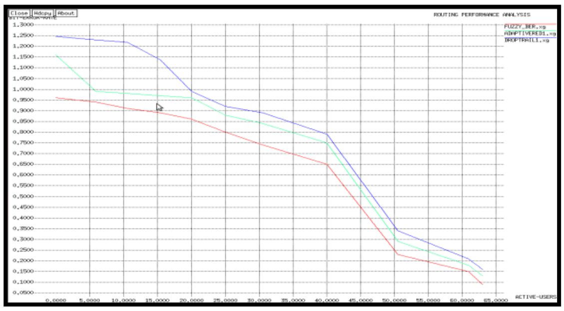

Fig 11: Routing performance level

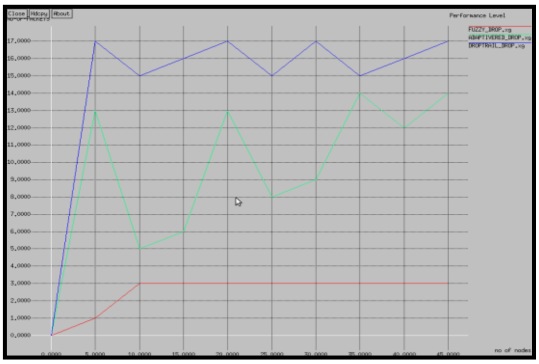

Fig12: Represents the performance level

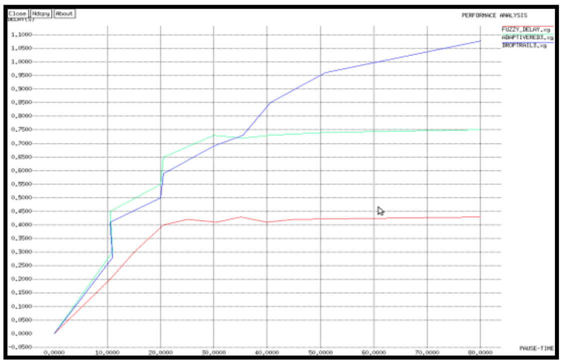

Fig 13: Performance analysis

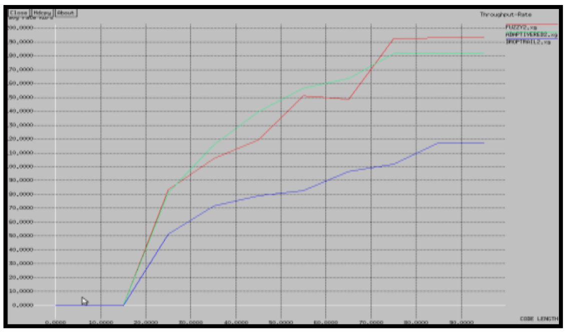

Fig 14: Throughput rate

5. CONCLUSION

The controlling of the vehicular traffic in road scenarios is the crucial problem. The main goal of VANETs is achieved by providing safety and comfort for passengers. Here we mainly discussed how the alternate path will be selected by the vehicles when congestion occurs. The proposed system reduces the congestion of vehicles

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thereby improving the effective travelling time. Hence, it can be concluded that the alternate path selection based on the density value holds a good potential for improving the traffic conditions at the intersection.

Future Work

In this paper we had implemented the VANET scenario using the network simulator NS2.There are few limitations of NS2 such as it does not have good GUI support, you will have to analyze through trace file and filter the required data using AWK scripts and there is no good support for debugging in NS-2.Due to these limitations we can implement the same scenario using the road traffic simulation package i.e. SUMO. "**S**imulation of Urban Mobility" is an open source, highly portable, microscopic and continuous road traffic simulation package designed to handle large road networks

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