Study of VANET Connectivity Issues

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***Abstract*— Recent survey confirms that Highway congestion and accidents are series problems world-wide and leading to more than 50% of accidents. Safety applications using expensive sensors, radars, cameras and other state of art technologies are interpreted into vehicles to overcome these unexpected incidents. Due to lower manufacturing cost [2, 4, 9, 10, and 11] communication based safety applications are also developed. The development of Intelligent Transport System (ITS) is one such enhancement. These enhancements help the public to avoid accidents on the road side.**

In US, the federal government has recognized the importance of having a dedicated wireless spectrum for improving traffic safety and highway efficiency [1]. The Federal Communication Commission (FCC) has allocated 75 MHz of licensed spectrum in the 5.9 GHz as the Dedicated Short Range Communication (DSRC) band for ITS [3] and its deployment is supported under major department of transportation i.e., (USDOT) initiates [5, 6] the medium access control of DSRC's standard and is addressed by IEEE 802.11p working group [7, 8]. This is considered to be the leading technology for communication based automotive applications.

***Keywords*— ITS, RVC, IVC, VANET.**

I. INTRODUCTION

Vehicular Ad-Hoc network (VANET) is a new emerging technology that is used to predict and avoid accidents mainly in roadsides and highways. VANET uses moving cars as forwarders to establish their network. VANET or Intelligent Vehicular Ad-Hoc Networks defines an intelligent way of using Vehicular Networking. VANET integrates on multiple ad-hoc networking technologies such as Wi-Fi IEEE 802.11p, WAVE IEEE 1609, WiMAX IEEE 802.16, Bluetooth, IRA, and ZigBee for easy, accurate, effective and simple communications between vehicles on dynamic mobility. Effective measures such as media communication between vehicles can be enabled as well as methods to track the automotive vehicles. VANET helps in defining safety measures in vehicles, streaming communication between vehicles, infotainment and telematics. VANET's are expected to implement a variety of wireless technologies such as DSRC which is a type of Wi-Fi. Other candidate wireless technologies are Cellular, Satellite, and WiMAX. VANET's can be viewed as component of the Intelligent Transportation Systems (ITS). As envisioned in ITS, vehicles communicate with each other via Inter-Vehicle Communication (IVC) as well as with roadside base stations via Roadside-to-Vehicle Communication (RVC). The optimal goal is that vehicular networks will contribute to safer and more efficient roads in the future by providing timely information to drivers and concerned authorities.

VANET is a completely mobile network whose nodes consist of vehicles equipped with wireless routers and a human machine interface that acts as a heads-up display for warnings and as a display monitor for business/infotainment services. Also, VANETs consist of wireless equipped roadside units that provide motorists with information about their immediate area and can provide communication with other infrastructures, such as the Internet. Roadside units can be any certified packet forwarding equipment such as GSM, WLANs, and WiMAX towers. These roadside units are most useful when a single motorist is isolated from other VANETs because the motorist will still be able to receive the vital information so long as they are within range of the roadside unit. The main objective of these networks is to further improve road safety by providing real-time alerts to drivers about hazards in their projected path and their immediate area. This is possible through the intercommunication with other vehicles and roadside units by transmitting safety information. Examples include lane merge warning, blind spot warning, and curve speed warning. Vehicle to Vehicle is an automobile technology designed to allow automobiles to "talk" to each other. The systems will use a region of the 5.9 GHz band set aside by the United States Congress in 1999, the unlicensed frequency also used by Wi-Fi. V2V is currently in active development by General Motors, which demonstrated the system in 2006 using Cadillac vehicles.

In communication and computer network research, **network simulation** is a technique where a program models the behavior of a network either by calculating the interaction between the different network entities (hosts/routers, data links, packets, etc.) using mathematical formulas, or actually capturing and playing back observations from a production network. The behavior of the network and the various applications and services it supports can then be observed in a test lab; various attributes of the environment can also be modified in a controlled manner to assess how the network would behave under different conditions. When a simulation program is used in conjunction with live applications and services in order to observe end-to-end performance to the user desktop, this technique is also referred to as network emulation.

II. RELATED WORKS

The goal of this paper is to detect the various connectivity issues of Vehicular Ad-Hoc Networks. When a message has to be sent from a source to a destination, the sender and the receiver should have a clear picture about the time taken and the route that the message or node travels. Generally in wireless communication air is used as a medium of communication. Thus it is not reliable as we have security related issues and connectivity issues. The Re-Healing time plays a vital role in connectivity analysis.

Re-Healing Time is the time taken for a node to re-establish its disconnected nodes. The delay that takes place for this process is known as rehealing delay. The connectivity between various nodes plays a vital role in VANET. Let us consider the various connectivity issues and also the ways to overcome it. In rural areas or on the highways, the installations of more number of RSU's are not possible. In this paper we have a solution for this issue. Instead of placing more number of RSU safety messages can be sent to the nearest Base Station having very high Broadcasting Power. Thus the loss of messages can be greatly reduced.

The Packet loss and delay constraints are seen clearly in [12]. Here the ARP (Address Resolution Protocol), RARP (Reverse Address Resolution Protocol) and NDP (Neighbour Discovery Protocol) are seen at the link layer level. The NDP helps us to find out the nearest neighbour to broadcast the messages. Anyhow too many broadcast messages may lead to broadcast storm problem.

In [13], we have two special behaviours i.e. bipolar behaviour. The first one is that the nodes are connected fully and the second one is that the nodes are sparsely connected. They use DSR and AODV. DSR is similar to AODV. It forms a route whenever requested or demanded. Source routing mechanism is followed here. (Source Routing- Allows a sender to partially or completely specify the route so that the route gets completed). AODV is similar to DSR. The network is silent until a connection is needed. While a connection is to be established and then it demands a request message. The messages that are broadcasted should be saved in a buffer until the vehicle or the node acknowledges.

In [14], we give importance only to the highway scenario. Here we implement a new distributed vehicular multihop broadcast protocol. Here we overcome the above mentioned problem i.e. broadcast storm problem and disconnected network problem. The messages are sent through store-carry-forward mechanism and spray and wait mechanism. Here we use DV-Cast protocol which maintains a list of one-hop neighbourhood nodes. The major disadvantage here is that 'Hello Update Frequency' and 'GPS drift'. In hello update the vehicle updates its location at a very high frequency, so congestion in channel takes place which leads to MAC delay and high packet loss.

MAC Delay is the time period needed for a packet to be successfully transmitted after it is placed in the transmission buffer. Similarly the other factor is the GPS Drift. It is due to different receivers from different vendors. Bad GPS reception, performance of GPS antenna could deteriorate over time.

In [15], we consider the usage of internet and various services such as VOIP and Video Streaming. Here we consider placing of a gateway to minimize the average number of hops. There is no security since it is transparent and moreover lot of bandwidth is wasted for streaming of videos. Thus it is not suitable for safety application. Sometimes the Access point to gateway connection fails. Thus delay occurs in this type of situation.

In [16], we use dynamic transmission range assignment algorithm that adjusts a vehicles range according to the local traffic range according to the local traffic conditions. The location of the vehicle is not considered here, But in Real-Time the location of the vehicle should be considered in order to find out the transmission range.

In [17], the DSRC or WAVE (Wireless Access for Vehicular Environment) is used to exchange information either vehicle to vehicle or vehicle to infrastructure. The communication radio used here uses the OFDM technology for broadcasting. Here also due to congestion in shared channel the packet loss takes place.

In [18], we consider safety related communication such as periodic messages and event-driven messages. Here we give priority to safety messages and the beacons are also given equal rights. The problem in here is channel saturation and dissemination.

Channel Saturation is the maximum traffic handling capacity of a channel.

Dissemination is broadcasting to public without direct feedback from the vehicle.

In [19], we use Co-Operative Collision Avoidance System. In this when the vehicle meets an emergency event; it sends the wireless collision-warning message. The major disadvantage here is that the hop-unfairness problem due to MAC protocol stability. In order to reduce delay we introduce TDMA based time slots. Here we also consider two ID's i.e. the origin_vehicle_id and event_id. These are used to find out what originally happened to the vehicles or which vehicle is in emergency.

In [20], the DSRC will have six service channels and one control channel. The Control Channel is used to broadcast safety message only. Safety messages are time sensitive. When travelling at a high speed the probability is less and the delay is high. This is the major disadvantage here. The message inside the channel is seen step by step in here.

In [21], the dynamic source routing mechanism is seen here. The DSR follows the mechanism of on-demand routing. Thus it first finds the route, then maintains it and finally establishes it. In maintaining the route each node is responsible for conforming that the packet has been received or else retransmission has to be performed before next hop. The node also searches for additional routes, in case of the original route which has too many hops or the route is disconnected. It also has the copy of routes that it sends often. It responds to such routes immediately. Here automatic route shortening also happens. This takes place when one or more intermediate hops in the route become no longer necessary. It in on-demand and not a periodic one. This is its major disadvantage.

In [22], we consider the Base Stations along the road sides. The vehicles are used as hops. The message is sent from base station to the vehicle or vise-versa via multiple hops. The safety messages are broadcasted to many vehicles from the base station. The region between two base stations is taken care by the vehicle which serves as the forwarders.

In [23], we broadly see about the link duration, connection duration and rehealing time. All the vehicles are in a cluster i.e. Largest Connected Cluster (LCC). Whenever they get disconnected due to the transmission range limitations. Then the vehicle searches for neighbouring cluster. Thus if the member of that cluster allows then it gets connected. The major disadvantage here is that the paper does not believe in Telecommunication infrastructure.

In [24], we consider the VANET connectivity in urban areas which is a challenging task. Here the safety messages are sent through the network by a routing protocol called Post Collision Notification (PCN) and Road Caution Hazard Notification (RCHN). The messages sent are received by all recipients with very small delay. Moreover the network connectivity and path redurancy is clearly evaluated to avoid drop of messages.

Network Connectivity is defined as the number of nodes that are connected to the network at that time.

Path Redurancy is defined as the maximum number of disjoint paths between two well-connected vehicles.

Inspite of these solutions we again find broadcast storm and disconnected network here.

In [25], we discuss about the position of the vehicle. It tells about the car to car communication in highways. The guard channels helps to find out the location of the vehicle. The CAR Protocol follows the Geographic Routing (GR) in which the nodes are uniformly distributed. Here initially the beacon messages are sent to check the path. Then the path maintenance and recovery error are taken care of. Bulky data's cannot be sent in this protocol.

For.Eg. In a four way lane where vehicles cross here and there with high speed, thus the route gets disconnected or destroyed. This is its advantage.

In [26], we clearly see the communication between vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) i.e. Base Station. Base Station is capable of broadcasting messages to a larger extent. Thus here the access probability and connectivity probability is rectified by single hop (direct access) or multi-hop (relays). Theorems have been developed here to measure the adjacent vehicle, Intervehicle distance etc. The limitation is that there are many vendors with different sets of access guarantee.

In [27], we use the wireless base stations which are also known as nodes. The base stations are generally expensive and are to be erected in small numbers. The transmission range of the base station is higher due to their special antennas. Here we see the 'infinite server queuing model'. In this the number of vehicles served at the busy hours, the connectivity in ad-hoc network are seen in order to determine the transmission capability range between vehicles. The speed of the vehicles doesn't matter. The transmission range is the major drawback here.

In [28], we come across the 'Periodic' and 'Event Driven Messages'. The periodic message is nothing but the 'HELLO' message. The event driven message is that when a hazardous situation takes place or the adjacent vehicle moves at a very great speed. The highway consists of many entry points and exit points. The node follows the highway point's entry till the exit. The arrival rate and the departed rate of the nodes in the cluster must be maintained correctly. This is very effective for only 1-D system.

In [29], the 'Road Side Units' are used which is a transceiver. The RSU may be a Wi-Max, Wi-Fi or Bluetooth. The Road Side Units are very expensive and are used in large numbers only in urban areas. The density of the vehicles is taken into account here.

III PROPOSED WORK

In this project alarm messages are generated whenever a hazardous situation occurs. In this the vehicles move in opposite direction to each other in their respective lanes. The vehicles or the node sends periodic hello messages to the RSU frequently. Whenever an emergency situation occurs or the node senses an accident situation it immediately forwards alarm message to its neighboring nodes. The following parameters are of great importance in this project they are Critical Distance Measure, Emergency event occur, Re-route or Stop RBC.

Consider the scenarios depicted in Fig.3.1, where all vehicles are equipped with DSRC radios so that they can communicate within the wireless communication range. In scenario I, during the directional broadcast, the safety message that is issued by vehicle **V0** can successfully be delivered to vehicles **V1**–**V3** through direct forwarding (i.e., all involved nodes are destination nodes). In scenario II, because the spacing between **V3** and **V4** is larger than the maximum communication range, the safety message cannot be delivered across the cluster boundary. In scenario III, we employ the store–carry–forward mechanism, to solve the disconnected network problem; therefore, the safety message can be delivered from the preceding cluster tail **V3** to the succeeding cluster head **V4** through an opposite vehicle **X** that acts as a message forwarder. The message delivery path thus becomes **V3** → **X** → **V4**. Although the store–carry–forward scheme can handle the disconnected network problem without additional hardware cost, its performance highly depends on the time when the preceding cluster tail **V3** can designate the message delivery to a neighbouring vehicle **X** that travels in the opposite direction. Hence, the rehealing time that is taken to deliver a message across two adjacent clusters cannot be guaranteed, which is a major concern in the design and implementation of several safety applications.

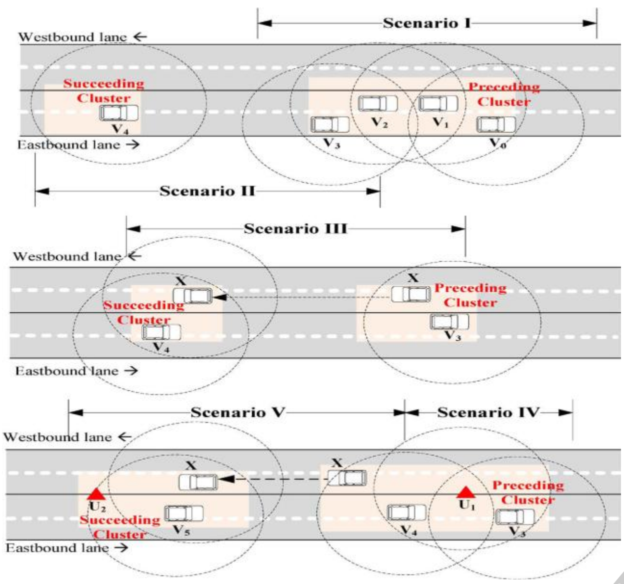

Fig.1.1 Different scenarios for broadcast message transmission on a highway

To guarantee the rehealing time for a sparse VANET, we can deploy low-cost ad-hoc-based RSUs as message relays to improve the traffic safety messaging, which aims to enhance VANET connectivity and increasing the delivery options. In scenario IV, RSUs are deployed on the road section, in which RSU **U1** is located between vehicles **V3** and **V4**. The safety message that is issued by **V3** can be delivered to **V4** through **U1**, which acts as a message relay. The message delivery path in this case becomes **V3** → **U1** → **V4**. In this paper, we regard a forwarder (such as vehicle **X** in scenario III) and a relay (such as RSU **U1** in scenario IV) as a mobile and a fixed node, respectively. Consider the VANET architecture that is shown in scenario V. Because only a limited number of RSUs is deployed, vehicles **V4** and **V5** may not directly be connected; hence, we still need to designate an opposite vehicle **X** as a forwarder. The message delivery path now becomes **V4** → **X** → **V5**. Based on the aforementioned observations, the store–carry– forward scheme in conjunction with RSU deployment on highways can provide more delivery options and reduce the delivery delay. In this paper, we propose an RSU-advertising model to improve the routing and disconnected problem in diverse network topologies by deploying only a limited number of RSUs. We aim at reducing the amount of broadcast traffic incurred for an event-based safety message delivery in a highway scenario. This is because the information that is contained in an event-based safety message is more time critical and has a longer lifetime than in a periodic safety message. However, the periodic message delivery can also benefit from RSU deploy deployment, because RSU nodes enhance VANET connectivity. The problem that arises is how one can properly deploy the RSUs on a highway.

IV SIMULATION RESULTS

Initially a road scenario of dimension 2100 x 300 is created using .h file using NS-2 Simulator. Nodes are created in the scenario which has wireless characteristics. These nodes are created in .cc file. The Node deployment is seen in the .tcl file. The first 40 nodes are considered as vehicles and the other 5 nodes are considered as RSU in this simulation environment (Fig 4.1).

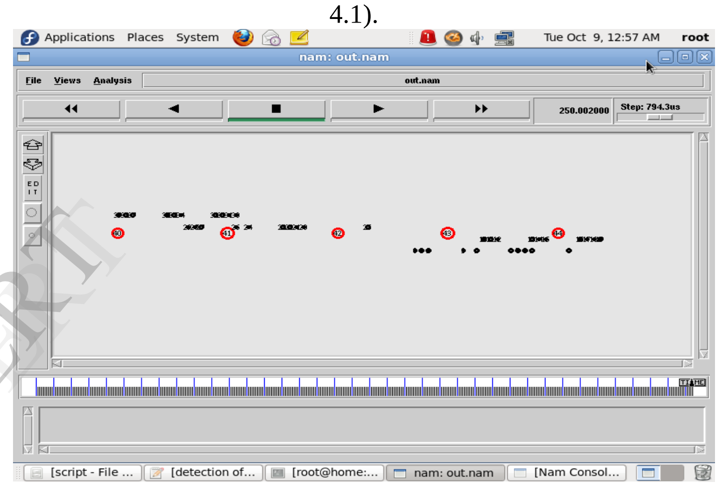

Fig 4.1 Simulation Layout

Whenever a hazardous situation takes place the node behind the hazardous node re-routes and sends warning to its neighbouring vehicles as shown in figure 4.2.

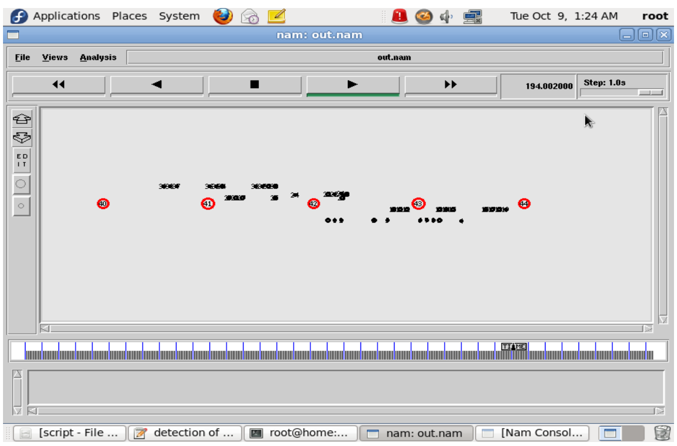

Figure 4.2 Accident Detection

V CONCLUSION

In VANET safety applications, the source vehicle that detects an accident can generate a warning message and propagate it to the following vehicles to notify other drivers before they reach the potential danger zone on the road. To reduce the rehealing time for a sparse VANET and to decrease the number of rehealing hops for a dense VANET, we can make use of the RSUs to assist the traffic safety messaging. Based on highway scenarios, we have investigated the rehealing delay and the number of rehealing hops needed to propagate a traffic safety message to a rehealing node. A comprehensive analytical framework is developed to determine the benefits of deployment of RSUs on the performance of a VANET in a highway scenario. We have also validated the results of our analytical framework through extensive simulations. The following observations summarize our main findings. 1. On a 300-km highway, for example, the rehealing delay is reduced by 70%, whereas the average number of rehealing hops is reduced by 68.4% when deploying 50 RSUs compared to an operation with no RSU. Therefore, deploying a small number of RSUs can achieve a substantial improvement when the vehicular network is sparse. 2. Even when 50 RSUs are deployed on a 300-km highway, the broadcast traffic will effectively stop when a succeeding RSU receives the message; therefore, we can prevent a broadcast storm that is induced by the broadcast of the traffic safety message. 3. For a 300-km highway, the number of hops required for rehealing is less than 5 in all cases for $Nu > 100$. 4. We have examined the RSU performance when important issues such as vehicle deceleration, channel congestion, different beacon frequencies, hidden node problem, and multilane traffic are considered. We observe that RSU deployment can significantly improve the message penetration time, packet delivery ratio, and the delivery delay of a rehealing node.

As a final remark, we note that, although this paper has investigated the impact of RSU deployment on the performance of safety applications for VANETs in highway scenarios, further research is needed to extend this model to urban scenarios, where the accident occurrences are not uniformly distributed on the road, because the intersection traffic is more complicated, and more prone to accidents. Our current research is focused on these extensions.

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