Time Critical Emergency Message Dissemination in VANETs

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Abstract: Here we propose a multi-hop broadcasting protocol for time critical emergency message dissemination in Vehicular ad hoc networks (VANETs). Here we use a partitioning protocol which consists of three mechanisms. First, Selection of emergency message using different mechanisms (e.g cross layer broadcast protocol). Second is multiple sectoring, partitioning the total region into different sectors (number of sectors depending on the density of vehicle in particular region). Third, transfer this emergency message into nearby sectors and Road Side Unit (RSU).It enables a faster and more reliable emergency message dissemination by shortening the channel access time and reducing the contention period jitter. VANET is not restricted up to Vehicle-to-Vehicle communication, it also takes advantages of road side units. Using directional antennas as road side units it influence the system performance. Antenna positioning related to road geometry is also important.

Keywords: VANETs, Inter vehicle communications, Emergency Message, Road side units (RSU), On Board Unit (OBU), Mutiple Sectoring, Dedicated Short Range Communication (DSRC),Cross Layer Broadcast Protocol (CLBP).

INTRODUCTION

The number of vehicles rapidly increased in several countries, the rate of growth of new roads is much lower than that of vehicles. For these reasons number of accidents will increase and also traffic congestion. It becomes more severe if an accident occurs. One possible solution for reduce these problems is to use wireless communication among vehicles. Due to recent advances in wireless communication now a days, inter vehicle communication becomes a realistic solution.The vehicular ad hoc network (VANET) is a kind of wireless ad hoc network which deploys the concept of continuous varying vehicular motion. Here, the moving vehicles act as nodes. Vehicular networks are composed of mobile nodes, vehicles equipped with On Board Units (OBU), and stationary nodes called Road Side Units (RSU) attached to infrastructure that will be deployed along the roads. Both OBU and RSU devices have wireless/wired communications capabilities [1]. OBUs communicate with each other and with the RSUs in ad hoc manner. Vehicular Ad-hoc Networks are expected to implement a variety of wireless technologies such as Dedicated Short Range Communications (DSRC) which is a type of Wi-Fi. Other Wireless Technologies are Cellular, Satellite and Wi-MAX. Vehicular Ad-hoc Networks can be viewed as component of the Intelligent Transportation Systems (ITS) [2].

The main objective of VANET is to help a group of vehicles to set up and maintain a communication network among them without using any central base station or any controller. The most prominent feature of VANETs is the high mobility of the nodes. A vehicle can communicate with another vehicle directly which is called Vehicle to Vehicle (V2V) communication, or a vehicle can communicate to an infrastructure such as a Road Side Unit (RSU), known as Vehicle-to-Infrastructure (V2I). If the network has very less vehicle then it becomes more challenging to send a packet from source to destination. There is a need for faster and more practical solution for emergency message dissemination. Here we propose a multi-hop broadcast protocol for time critical emergency message dissemination in VANETs. This mechanism involved is spread the message in its communication range of vehicles and identify emergency situation gave priority to the particular one .Next is sectoring the communication range for the convenience of message transmission. Last step is , send this message through RSU in a wide range. In this technique it is important to cover at least one sector in a particular region. In reality direct communication is susceptible to interference and blocked by physical obstacles such as large buildings and mountains. Vehicles takes on the role of sender, receiver, and router to broadcast information to the vehicular network. Every vehicle that is participating in the VANET turns into wireless router. When any vehicle goes out of the particular signal range the connection drop out and in place of that new connection is established. The vehicles in this model is equipped with On Board Communication devices(OBU) and a data base unit, which use sensors for communication and sensors for GPS. A broadcast service is used to inform the drivers about an emergency situation. The data rate is not an important issue here because each vehicle wants to receive only warning alert messages.
As a cooperative approach, vehicular communication systems can be more effective in avoiding accidents and traffic congestions than if each vehicle tries to solve these problems individually. Generally vehicular networks are considered to contain two types of nodes;

vehicles and roadside stations. Both are Dedicated Short Range Communications (DSRC) devices. DSRC works in 5.9 GHz band with bandwidth of 75 MHz and approximate range of 1000m.The primary goal of VANET is to provide road safety measures where information about vehicle's current speed, location coordinates are passed with or without the deployment of infrastructure.

RELATED WORK

Trinary Partitioned Black-Burst Based Broadcast Protocol: Existing work consists of trinary partitioned black-burst-based broadcast protocol (3P3B) ,it consists of two primary mechanisms. First, a mini distributed inter-frame space (DIFS) in a medium access control (MAC) sublayer is introduced to give the time-critical EMs a higher access priority to the communication channel compared with other messages. Second, a trinary partitioning is designed to iteratively partition the communication range into small sectors. The trinary partitioning mechanism allows the farthest possible vehicle in the farthest sector from the sender node to perform forwarding to increase the dissemination speed by reducing the number of forwarding hops.

Binary-Partition-Assisted Broadcast Protocol: Binary partition assisted broadcast protocol (BPAB) aims to reduce and stabilize the broadcast delay. BPAB achieves a good message progress speed by selecting the farthest forwarder [3]. This protocol deploys a combination of a binary partitioning and a novel contention mechanism. The binary partitioning scheme constantly divides the communication area into multiple partitions. The binary partition of this scheme stems from a similar concept compared with that of OB-VAN, but it introduces fewer time slots than OB-VAN during the selection of the next-hop forwarder. Only vehicles in the farthest partition contend with each other during the forwarding phase in this scheme. Thus, the collision rate is reduced, and the contention duration is stabilized. It is also shown that BPAB demonstrates a good performance in terms of the average dissemination speed compared with the other protocols, such as UMB and SB.

SYSTEM MODEL

The vehicle in the model is equipped with on board communication devices (On Board Units) and a data base unit, which contain control information. Here we use sensors for communication and sensors for GPS. Vehicles in the road can directly communicate themselves or through road side units. The figure shows detailed view of system model.The vehicle-to-roadside communication configuration represents a single hop broadcast where the roadside unit sends broadcast information to all vehicles in its surrounding area. The vehicle communicates with RSU for sending, forwarding and receiving information from one node to another. RSU is further connected to infrastructural network and therefore allows the vehicles to access the internet for non-safety applications. Vehicle-to-roadside communication provides a high bandwidth link and enables high data rate transmission between vehicles and roadside units. GPS to identify location and speed of a vehicle, or vehicle based sensor data wherein the location and speed data is derived from the vehicle's computer and is combined with other data such as latitude, longitude, or angle to produce a richer, more detailed situational awareness of the position of other vehicles.

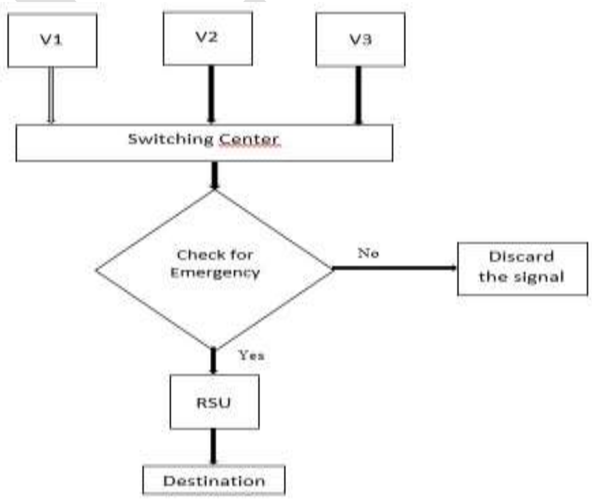

Fig.1 Basic Operations

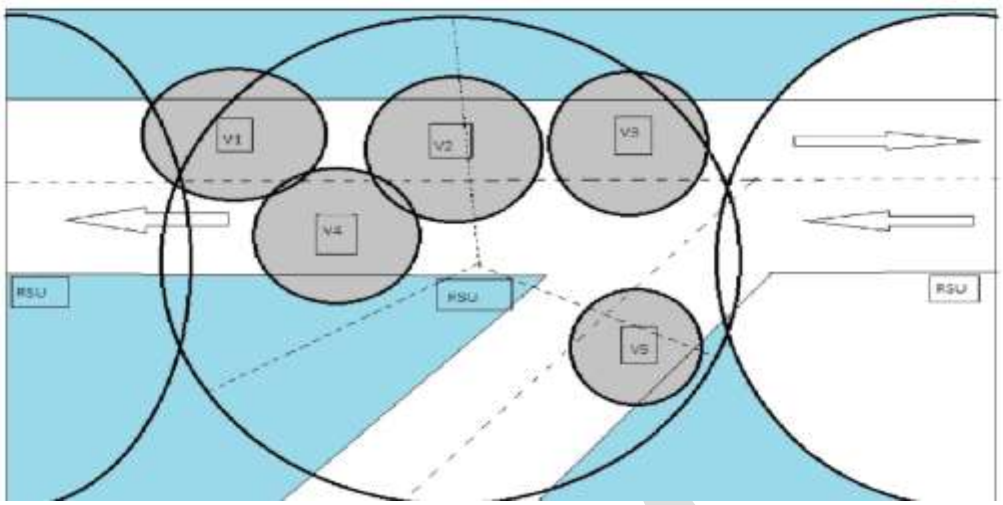

Fig 2.System model: Network Specifications

CROSS LAYER BROADCAST PROTOCOL

Cross Layer Broadcast Protocol (CLBP) is used for emergency message dissemination in VANETs. It is aiming to improve transmission reliability, minimizing the message redundancy, and to reduce the transmission delay. Here we use request-to-send/ clear-to-send (RTS/CTS) scheme to select an appropriate relaying node. Specifically, after receiving a broadcast RTS (BRTS) frame, each relay candidate starts its back-off timer to reply a broadcast CTS (BCTS) frame based on the calculated relaying metric. After a successful BRTS/BCTS handshake, one node is successfully selected as the next hop relay to forward the broadcast message in the desired propagation direction.

The figure 2. shows that the vehicles are randomly moving in a highway with 4 lanes, and half of the lanes are used for vehicles driving to one direction and other half are used for vehicles driving to the another direction. Each blocks are separated by safety distance in order to avoid vehicle collision. E1 is the source node that initiates an emergency message, and V4 is the current broadcast node. Node V1,V2 and V3 will not reply a BCTS frame to V4.Whereas V5 is eligible for relaying the message and starts a back-off timer upon receiving a BRTS frame. This guarantees that the emergency message will be efficiently forwarded along the desired propagation direction. Emergency messages are served with highest priority.

Multiple Sectoring

One of the important step here is to select next hop forwarder. This can be done by multi-sectoring mechanism as shown in Figure 3. Each vehicle in a particular RSU has its own communication range which always includes large number of vehicle. We can divide the communication area of a RSU into multiple sectors according to presence of vehicles. In this figure we partitioning the communication area of RSU into three equal sectors (number of sectors can be increased according to particular situation).The regions are R1, R2, R3.Out of these three regions vehicles present only in first two regions R1 and R2.In region R1 which includes vehicles V1,V2 and V5,the region R2 include V3,V4 and V6.There is no vehicle present in the third region. Vehicles in the region R1 (V1,V2 and V5) can communicate themselves and to RSU. Similar situation in case of region R2.Hence connection is established between every vehicles. Most advantage of this system is we can use sectored antenna in particular regions.

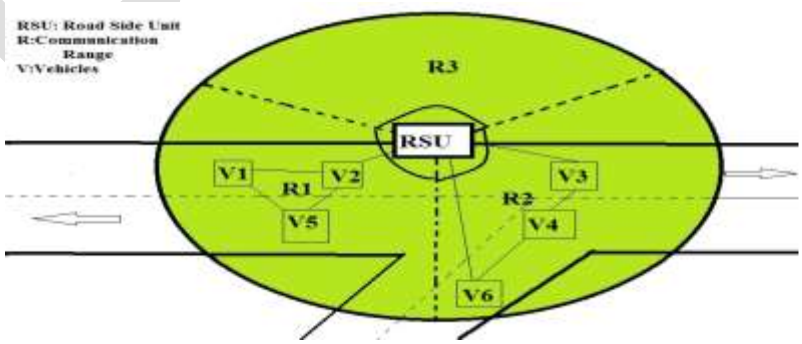

Fig 3.Sectoring in Communication region

We investigate the use of IEEE 802.11e to provide priority based service differentiation. The messages' importance leads to different message priorities which pose their own particular requirements on the communication system in terms of delay and reliability. For example, when an accident occurs, accident related messages will be transmitted. These messages must be sent immediately with high reliability and low delay. Therefore, these messages should have a higher priority compared with congestion related messages created during a traffic congestion period. This unavoidable contention can lead to significant message errors, causing low communication reliability. Higher priority messages will be transmitted more times than lower priority messages, resulting in higher reliability for higher priority messages.

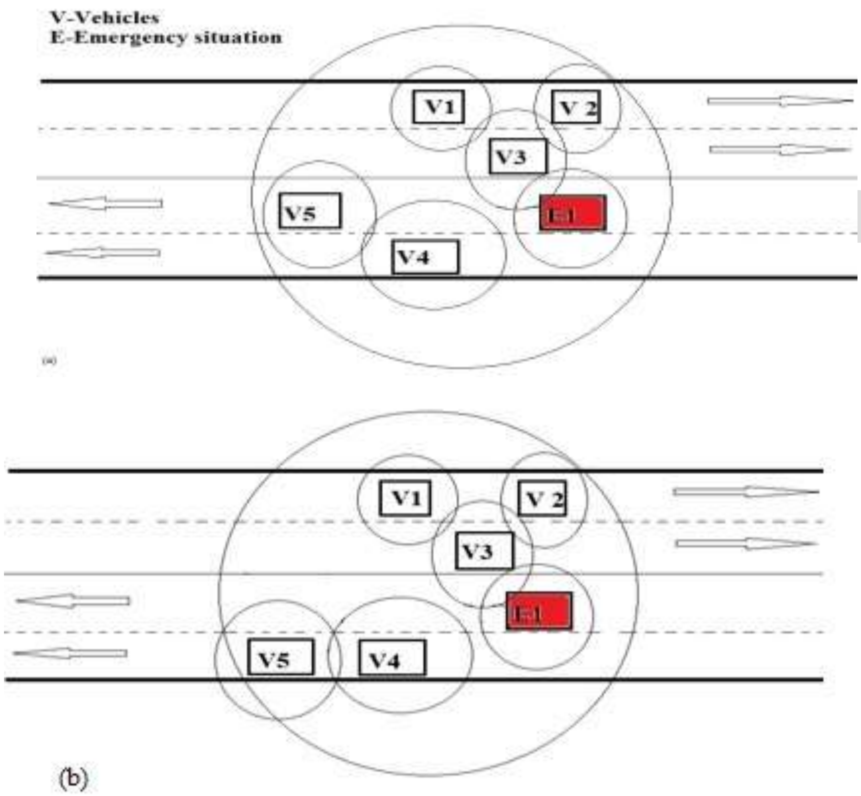

Fig 4. (a) E1 approaching other vehicles (b) Other vehicles changing their location

Figure 4(a) shows a four lane road, each pair in opposite directions. Also has vehicles and road side unit (RSU) with their communication range. Vehicles V1, V2 and V3 are move in one direction and remaining V4, V5 and E1 are in opposite direction. The red colour in the figure indicate emergency situation. The emergency signal is transmitted to each neighbouring vehicle and road side unit. Hence all the vehicles in the communication range of particular RSU get the emergency signal. The On Board Unit (OBU) in each vehicle can have the capability to the location and speed of emergency vehicle. Hence the drivers can change the location of others according to emergency vehicles path. Figure (b) shows position of vehicle V5 is changing according to location of E1. The present RSU transmit this emergency situation to near RSU and continuing till the emergency message reaches its destination.

Communication Standards for VANET

Dedicated Short Range Communication (DSRC)

It is developed by USA and is used in short to medium range communications service that is used for V2I and V2V communication. The United states Federal Communications Commission (FCC) had allocated 750 MHz of spectrum i.e from 8.5 GHz to 9.25 GHz to be used by Dedicated Short Range Communication (DSRC). DSRC spectrum has 7 channels with each channel 100 Mhz wide. Out of 7 channels, six channels are used for service purpose and remaining one for control purpose[5].

Wireless Access in Vehicular Environment (WAVE) (IEEE 1609.11p)

In 2003, American Society for Testing and Materials (ASTM) sets ASTM-DSRC which was totally based on 802.11 MAC layer and IEEE 802.11a physical layer. The main problem with IEEE 802.11a with Data Rate of 54 Mbps is it suffers from multiple overheads. Vehicular scenarios demands high speed data transfer and fast communication because of its high topological change and high mobility. For this the DSRC is renamed to IEEE 802.11p Wireless Access in vehicular Environments (WAVE) by the ASTM 2313 working group. This works on MAC layer and physical layers. WAVE consists of Road Side Unit (RSU) and On-Board Unit (OBU). WAVE uses OFDM technique to split the signals. The following figure 1.3shows the WAVE, IEEE 802.11p, IEEE 1609 and OSI model.

DATA DISSEMINATION

Here network simulator 2 is used , nodes are deployed in the environment. Here each vehicle have an individual id and location, when an vehicle enters into RSU range its id and location is registered in RSU.RSU acts as an server to transfer the requested information to the requested vehicle. When a vehicle (Source node) "V1" request a packet to RSU it verify its id and location then transfer the packet to requested vehicle ie (Destination Node).In this model , when a vehicle "V1" request a data to Road Side Unit the RSU will verify its Id and location if the ID and location is registered in RSU it transfer the packet to the requested vehicle. The vehicle must be in the optimal location and it is fixed by the service provider when we design the node creation model is mainly used to reduce packet drops as well as to reduce delay while packet transfers.

Simulation Results

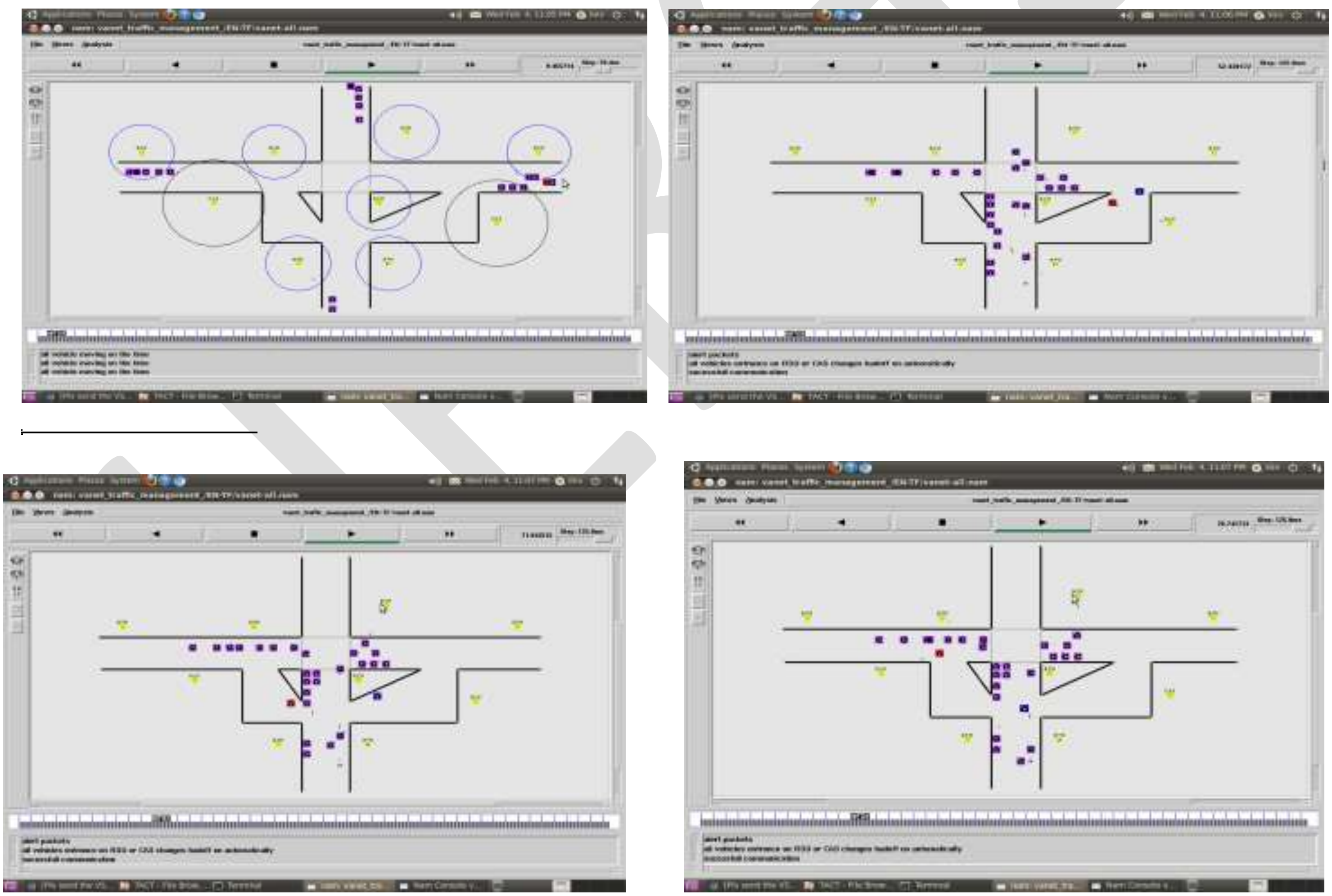

Fig.5 Different stages in message dissemination: messages are spread by road side units and also from one vehicle to another, easy path is calculated which have less in traffic, emergency vehicle follows the easy path and reaches the destination easily.

Performance of each parameter from simulation

Fig.6 Packet transmission comparison

Fig.7 Packet transmission delay graph

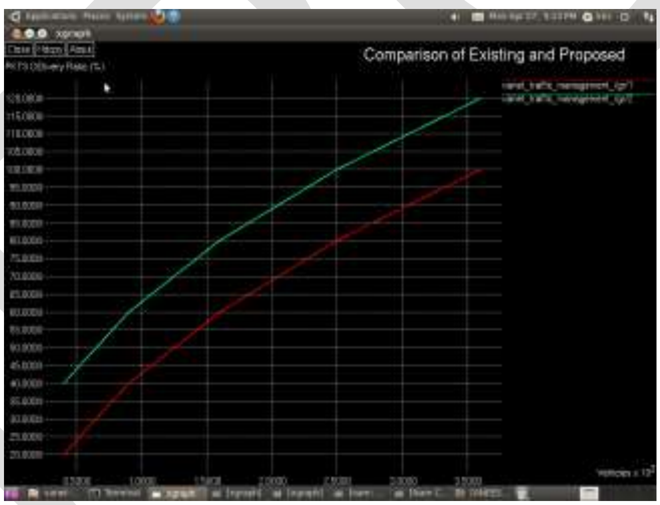

Fig.8 comparison of packet delivery ratio (PDR)

Conclusion

In this paper we have proposed a system for efficient time critical emergency message dissemination in VANETs. Here we use a cross layer broadcast protocol and multiple sectoring technology. In this system that is able to share Infrastructure to vehicle and Vehicle to Vehicle Communication with Messages very accurately. So towards this goal the system i.e. Design and Implementation of inter infrastructure and vehicle to vehicle communication for traffic information sharing mesages from a moving vehicle and vehicle to vehicle communication. It is demonstrated through simulation results that the proposed system outperforms the benchmark protocols in terms of the average delay, average message dissemination speed, and average packet delivery ratio (PDR).Hence our proposed system conclude that for every vehicle it becomes very easier to deal with the traffic issues and many more accidental scenarios that come across due to the lack of real time road side issues.

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