Cluster Based Message Dissemination for Broadcasting the Emergency/Warning Messages using a Novel Scheduling in VANETS

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Abstract- **Vehicular ad hoc networks are a special case of mobile ad hoc networks (MANETs). Unlike MANETs, VANET nodes are moving very fast. It becomes quite challenging to maintain a stable path for broadcasting Emergency and Warning (E/ W) messages from a risk zone. So routing takes an important role in VANETs. Reducing network overhead, avoiding network congestion, traffic congestion and increasing packet delivery ratio are the major issues of routing in VANETs. So it is essential to broadcast the risk notification (RN) messages such as accident and injury prevention messages, congestion control messages, road condition and other emergency/ warning messages in time to the rear vehicles. In this paper we propose a novel approach to categorize the messages and to give priority for the E/ W messages using a scheduling algorithm. The neighboring vehicles broadcast the RN messages from the risk zone using inter- zone clusters and intra- zone clusters communication to the rear vehicle by applying the proposed scheduling algorithm. Our simulation results show that this approach performs well and produce less network overhead, congestion control and high packet delivery ratio. We compared our approach with the existing protocol.**

Keywords- **VANETs, RN messages, Risk zone, Cluster, Scheduling**

I. INTRODUCTION

Vehicular ad hoc networks (VANETS) , also called Vehicle to Vehicle Communication (V2VC) or Inter Vehicle Communication(IVC). In VANETs, the mobile nodes are vehicles with high mobility. Due to the high dynamic topology of VANETs, the routing path frequently breaks. Intelligent Transport System (ITS) covers the new trend of computer and communication technologies and applications used for traffic management that aims to improve passenger safety and increase the efficiency of the transportation systems [16]. It includes a wide range of technology for vehicular information such as vehicle communication system, Global Positioning System (GPS),digital mapping, video cameras, sensor and technologies together with advanced information processing to provide relevant and timely information to users and traffic management systems to reduce traffic congestion, improve traffic efficiency, avoid accidents and improve road safety.

Vehicular Ad Hoc Network (VANET) is a special purpose Mobile Ad-Hoc Network (MANET) that is an important component of ITS. VANET is used for the exchange of messages between vehicle to vehicle (V2V) and also between vehicles and fixed roadside equipment (V2R) used for traffic management. Vehicles communicate using on-board sensors and communication equipment using Dedicated Short Range Communications (DSRC) that includes wireless technologies like WIFI, IEEE 802.11, WIMAX, IEEE 802.15 and Bluetooth [15].

There are a number of significant differences between VANET and MANET [14]. VANETs like MANETs allow vehicles to form a self-organized network without the requirement of permanent infrastructures. However, VANETs have a highly dynamic topology as compared to MANET, due to the high mobility of vehicles and the movement of the vehicles can be from both directions. On the other hand, unlike MANET, vehicular movements are restricted to a geographical pattern, such as a network of streets or highways. Unlike MANET, vehicles support substantial power resources for V2R and V2V communication. Another important aspect of VANET is that, a good portion of the messages exchanged are both delay-critical and safety-critical.

The main problems related to VANETs are the high speed of moving vehicles, causes frequent path breaks. So in our approach, we use clusters (self organizing vehicles into groups) for broadcasting warning messages. The government and many manufacturers are mostly trying to adapt many rules in transport management for the smooth and safety driving. Hence, the accident rate is reduced for some level. However, in our day to day life, some thousands or countless number of accidents are happened all over the world. Our country goods are transported by long trucks. It causes high traffic and congestion on high ways. It will affect all the rear vehicles.

Some system should be introduced for clearing traffic and for broadcasting safety related messages to the rear vehicles. So, we have developed an approach to broadcast emergency/ warning messages in time to the rear vehicles. Our proposed approach is compared with the existing protocol such as REACT [3]. The rest of the paper is organized as follows: Section II deals about related work; section III describes Last Received First Served (LRFS) scheduling, section IV deals about LRFS scheduling algorithm, and section V deals simulation and results using NS2.

II. Related Works

The protocol proposed in [2], describes a novel energy efficient risk notification message protocol to broadcast risk messages. It identifies the risk zone and broadcasts the risk message. It increases the network overhead by broadcasting the risk messages to each other. In [5], many scheduling algorithms are used to broadcast the risk notification messages. In this approach, the RN messages are sent to each neighboring nodes individually without grouping as cluster. So it increases the network overhead and network congestion. The protocol proposed in [8], determines the status of its neighbors by sending beacons periodically. It behaves based on the broadcast message it received. It mainly concentrates on reducing number of duplicate beacons using broadcast suppression approach.

In [9], a spatio- temporal emergency information dissemination protocol (STEID) is used to quickly disseminate traffic alerts such as accidents or congestion for the neighboring vehicles. It uses WiFi clusters connected through proxy servers and cellular network. In this approach, the emergency message is propagated within the cluster and unicasted to the server over cellular links. Each new emergency message is informed to the police by the servers. The protocol (REACT) proposed in [3] uses not only geographical information for both position and speed, but also road map information. A node that wants to send a packet can choose the best forwarder using the knowledge of both neighbors and road maps. It finds the distance between current node and the destination. This difference is considered as a threshold. Then the distance will be calculated between the neighbor's and the destination. The node with minimum distance is considered as next forwarder. Our proposed system is very simple technique for disseminating E/ W messages. In [10], a fast alarm message broadcasting in vehicular ad hoc network is used for broadcasting emergency alarm messages to the nearest vehicles. It uses sensors to identify the risk zone. It is not sure that sensors are deployed everywhere on the highways.

The technique used in [1, 11] describes a new Hybrid VANET Routing Protocol (HVRP) for forming clusters to broadcast emergency messages. It uses inter and intra cluster routing protocol. The multi path routing protocols are implemented in [4, 6, 12, 13]. These protocols perform two phases: route discovery and route maintenance. During route discovery phase, multiple paths are selected for the same source and destination. Initially it uses a primary path for forwarding messages. If any of the links on primary path fails, then it goes for route maintenance phase. Now any other path from the already discovered multipath will be selected to take over the data dissemination.

III. LRFS Scheduling

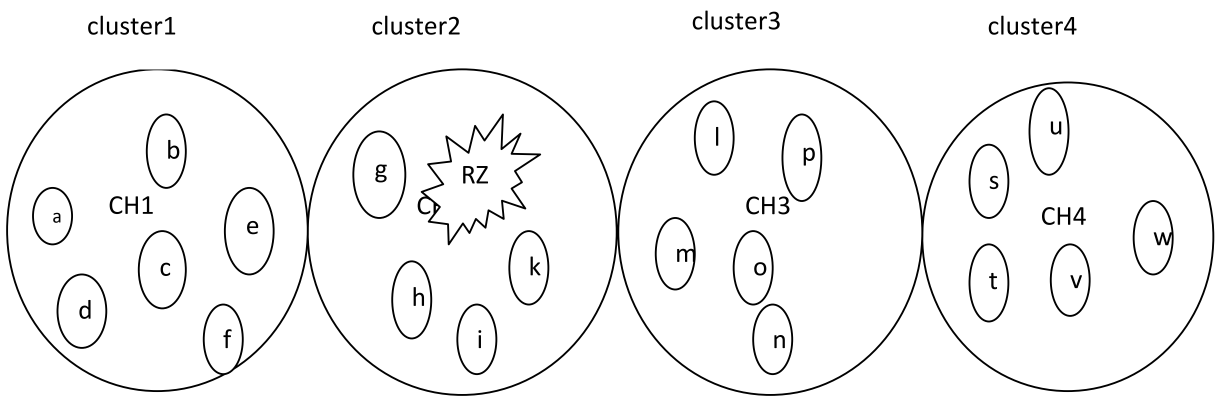
The Last Receive First Send scheduling consists of the following modules

- Cluster formation
- Multipath Routing
- Identification of risk locations
- Scheduling E/ W messages

A. *Cluster Formation*

The VANET nodes are organized into groups called clusters. How cluster is formed? Each vehicle broadcasts HELLO beacons to its neighbors for finding nearest cluster. Then it waits for t seconds. If that vehicle receives any HELLO packet from any nearest cluster with cluster ID within t seconds, then it joins as a member of that cluster. Otherwise, it will consider itself as a Cluster Head (CH). Each cluster has a cluster head. The other nodes are known as members of that cluster. Normally, the cluster head broadcasts the emergency messages to its members. The cluster head and its members maintain a routing table. Each members and its CH maintains routing information in proactive approach. Each members of that cluster find a path with other cluster members in reactive approach. This scenario in VANETs is shown in fig 1. It consists of four clusters. In that, the nodes c, j, o and v are cluster heads. The risk zone is shown at cluster 2.

Proactive algorithms employ classical routing strategies such as distance vector routing (DSDV) or Link State Routing. Generally the proactive algorithms maintain routing information in its routing table about the available paths even if the paths are not used so long. So it needs high storage space in the table. In our approach, we use proactive algorithm only within the cluster by identifying the entire unused link within the cluster based on the beacon rate



Where a, b, c, etc are cluster members

RZ- Risk Zone

Fig 1: Cluster scenario

received. The link with less beacon rate is known as $Link_{weak.}$ The details of the node with less beacon count will not be maintained in the table. This provides high packet delivery ratio and low network overhead.

B. Multipath Routing

Within the cluster, each CH and its members use multipath routing to broadcast the emergency/ warning messages. Before sending the E/W messages, the source node S, selects two or three multiple paths from its routing table for the same destination D. Among this three routes, initially, only one primary path will be used for broadcasting. If any path breaks, then another alternate path will be selected by the source node.

C. Identification of risk locations

In the proposed approach, we assume that the risk zone will be identified by the affected cluster (the cluster which has risk zone). In Fig 1, the affected cluster in cluster 2. So this cluster tries to make alert to all the rear clusters and forward clusters by broadcasting the emergency/ warning messages such as accident prevention, congestion control. In the above figure, the rear clusters are cluster 3 and cluster 4. The forward cluster is cluster 1. So that the rear clusters can select the alternate route without reaching risk zone. The E/ W packet transmission and scheduling are explained in the following sections. The structure of emergency risk message is given in Fig. 2:

CID	SID	MType	SeqNo	Time	Payload	RPosition

CID- Cluster ID

SID- Source ID

MType- Message Type (Congestion, Accident, others)

SeqNo- Sequence number

Payload- Message

RPosition- Risk Location

Fig: 2 structure of emergency risk message

The E/ W messages are generated by the affected cluster. It is known as Cluster$_{ERZ}$. It attaches its CID, SID, MType, SeqNo, Payload (message) and risk location (latitude and longitude). The risk location is determined by each vehicle from its GPS receiver.

D. *Scheduling E/W messages*

Each cluster calculates the distance between neighboring clusters. The Cluster$_{ERZ}$ periodically receives the Hello packet from the rear and forward clusters. These clusters are not aware of the emergency risk zone. The members of Cluster$_{ERZ}$ will calculate the distance between the risk zone and the other clusters. Now the members of Cluster$_{ERZ}$ maintain a table with the following details.

SID	CID	Lat	Lng	T	Message Received	Distance

NID	CID	Message Type	Seq No	T1	Lat1	Lng1

Where SID- Source ID

CID- Cluster ID

Lat- Latitude of source

Lng- Longitude of source

T- Message generated time

NID- Node ID

Lat1- Latitude of node

Lng1- Longitude of node

Fig 3: The Cluster$_{ERZ}$ table contents

In Fig. 3, SID is the ID of the vehicle which generates E/ W messages from risk zone. CID is the ID of the cluster which is the CH of that source node. The E/ W generated time are T. The message received time from rear node is T1. Each member of Cluster$_{ERZ}$ will save the distance detail of the entire rear cluster. The distance is calculated from lat and lng of source node and lat1 and lng1 of rear vehicle using Haversine Formula [7].

Each member nodes of Cluster$_{ERZ}$ uses LRFS (Last Received First Served) scheduling to forward the E/W messages. Those nodes will not broadcast E/ W messages to the rear and forward clusters immediately. Because, in highways, the moving speed of vehicle nodes are too high. So before sending E/ W message by the affected cluster, all nearest rear and forward clusters creates traffic congestion. Therefore, it is not essential to send emergency messages to the nearest clusters of risk zone. So our main objective is to send E/ W messages to the clusters which is somewhat far away from the risk zone. Then only the network and traffic congestion will be avoided. For doing this, our proposed system uses a $ threshold waiting time. We know that, in VANETs, each vehicle broadcasts HELLO packets periodically. The Cluster$_{ERZ}$ receives HELLO packets from rear and forward clusters. Each member of Cluster$_{ERZ}$ waits for $ time. It calculates distance between Cluster$_{ERZ}$ and rear clusters. This parameter value is stored in the Cluster$_{ERZ}$ table. It starts to forward message if calculated time exceeds $ time. The Cluster$_{ERZ}$ will broadcast the E/ W message through the neighboring cluster. The message will be forwarded to the cluster (Cluster$_{safe}$) if its distance is higher than any other cluster. The reactive routing protocol is used to broadcast HELLO messages between inter clusters. The members or the cluster head of Cluster$_{safe}$ which received the E/ W message will send a Hello reply packet to the source of Cluster$_{ERZ}$. Simultaneously, it passes the E/ W message to the other members of its own cluster and its CH. Thus, congestion will be highly avoided in the critical zone.

IV. ALGORITHM FOR LRFS

In fig 1, the $Cluster_{ERZ}$ is cluster 2. The members of that cluster are g, h, i and k. The cluster head is j. The cluster head j met an accident with the other cluster. So it creates traffic and network congestion. Now the nodes g, h, i and k will wait for $ time to receive HELLO packet from its rear and forward clusters, cluster 1, cluster 3 and cluster 4 without sending E/ W messages. The algorithm to perform this operation is given below:

```
begin
(i)     calculated time=0
(ii)    identify the risk location
(iii)   for each packet received from other cluster
        begin
(iv)            maintain its latitude and longitude in        its table
(v)             calculate distance and enter into the   table
(vi)            wait for $ seconds
(vii)           calculated time= calculated time + 1
        end
(viii)  if (calculated time > $)
        begin
(ix)            Send E/W message to the Cluster_safe
        end
end
```

Based on fig 1, the distance value is calculated between cluster 1- cluster2, cluster 2- cluster 3 and cluster 2- cluster 4. The calculated distance value is stored in $Cluster_{ERZ}$ table. Based on the calculated distance value, the $Cluster_{ERZ}$ will decide that the cluster 4 is very far away from the risk zone. Therefore, the cluster 4 is $Cluster_{safe}$. The $Cluster_{ERZ}$ will send E/ W message to $Cluster_{safe}$

Action of CH of $Cluster_{safe}$

We assume that the nodes s and t (members of cluster 4) will receive the E/ W messages first from the risk zone. Now these nodes give priority to the E/ W messages. Suddenly, the nodes s and t are for sending an ACK packet to the source of the risk zone. Simultaneously, it passes the same E/ W message using proactive routing protocol within the intra- cluster to u, w and cluster head v. Then the CH v will give the emergency diversion message to all its members. This scenario is shown in the following algorithm.

```
begin
(i)     for each E/W message to member of  Cluster_safe
        begin
(ii)            immediate ACK to the source of E/ W
(iii)           simultaneously sending E/ W to its CH
        end
(iv)        for each E/ W message to CH
        begin
(v)         send immediate message within its cluster member to divert its path
        end
(vi)        for each E/ W to member node
```

```
        begin
(vii)       send ACK to its CH
        end
end
```

After receiving the emergency warning message from its cluster head, the member of that cluster will send an ACK message to its CH. Then all the nodes try to divert its current path.

V. Simulation And Results

The simulation of the proposed algorithm was based on NS2. The transmission range was set to 500m. The simulation has been done with multiple nodes. Fig 3. shows the simulation carried out in NS2 for 75 nodes.

TABLE I. PARAMETERS USED IN NS2

Channel Type	Channel/ Wireless Channel
Propagation model	Propagation/ Two ray Ground
MAC	Mac/ 802.11
Antenna	Bidirectional
No. of nodes	75
Transmission Range	500m

The performance graph is shown below. The figure 4 shows that the proposed system uses n clusters. So it needs n number of E/ W messages to disseminate all clusters exactly once.

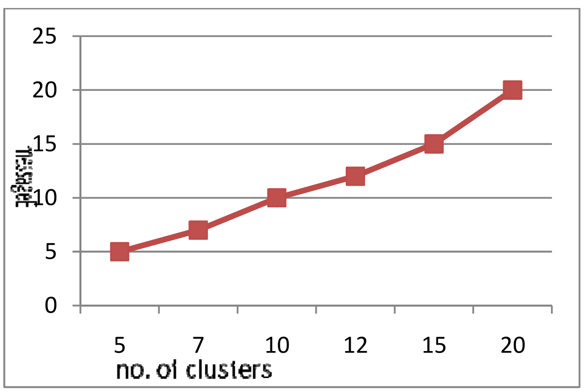


Fig 4: Clusters with E/ W message in proposed system

The following Fig. 5 shows the performance of the existing systems. Some of the existing system are not using clusters and scheduling algorithms to disseminate E/ W messages. It simply broadcasts the emergency message to all the neighboring nodes individually. It increases the traffic and network overhead.

Based on the solution given in fig 5, if there are 25 nodes (vehicles), then 25 E/ W messages will be flooded. So, if number vehicle increases, number of packets to be broadcast also increased. But in fig 4, the packet to be broadcast count increases based on the number of clusters. Using our proposed approach, it is enough sending one E/ W message to one cluster.

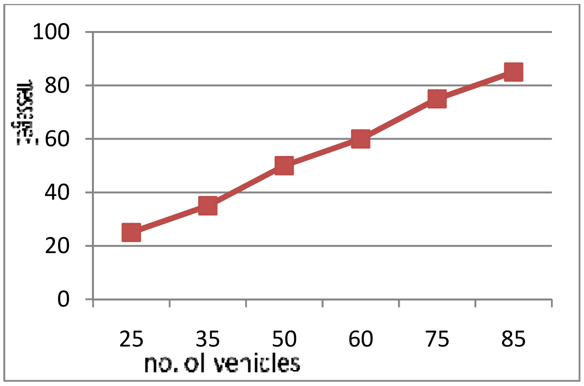


Fig 5: E/ W message dissemination without using clusters

In Fig. 6, the performance of proposed system is compared with the existing protocol REACT. The REACT protocol calculates the distance between current nodes with its destination. It also calculates the distance between neighboring nodes with the destination. All the nodes are with short distance from the risk zone .So it causes congestion. The proposed system calculates the distance between risk zone and the clusters based on its latitude and longitude. Thus, it reduces congestion.

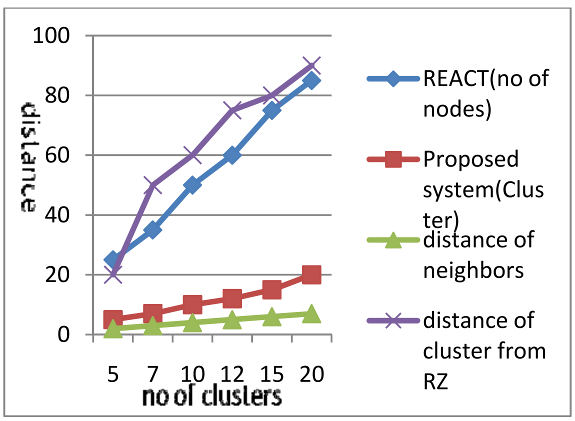


Fig 6. Comparison of proposed system with REACT protocol

Conclusion And Future Work

In this paper, we introduced a novel scheduling approach for reducing traffic and network congestion using clusters. Here we used clusters for reducing E/ W message count. It is enough to send only one E/ W message to the far away cluster. The node which receives the emergency message will intimate to all the other members of its cluster. By doing this the rear cluster can change its current path before reaching the risk zone. Due to this, the network congestion and traffic congestion will be highly reduced. Our proposed system is compared with REACT protocols. We argue that our proposed system provides better result than the other existing protocols.

In the proposed approach, the road conditions and speed of the vehicles are not considered. So In our future work, we consider all the other parameters to produce best solution.

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