# AN ADAPTIVE BROADCAST MECHANISM TO IMPROVE ALERT MESSAGE DISSEMINATION IN VANETS

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## Abstract

*VANET is a rapidly emerging research field and is essential for cooperative driving on the road. VANET technology uses moving car as nodes in a network to create a mobile network. The number of vehicles has been increased on road in the past few years. Due to high density of vehicles, road accident and the potential threats on the road is increasing. VANET is aiming to equip technology in vehicles to reduce these factors by disseminating messages to each other. Warning messages have to be quickly disseminated in order to reach maximum number of vehicles on road. Adapting to the environment where the vehicle is moving is essential to improve the warning message dissemination when an abnormal situation occurs on the road. The notification to the nearby vehicle is done by simply broadcasting the messages which is retransmitted over and again by the vehicles simultaneously to other nearby vehicles. Due to this retransmission of warning message it leads to problem namely broadcast storm problem. This work proposed an adaptive broadcast message forwarding process to improve the warning message dissemination in real urban scenarios and predict the reduction in severity of broadcast storm problem. The efficiency of the alert dissemination can be increased if the vehicles determine the city profile of their current area.*

***Keywords—*** *Adaptive mechanism, alert dissemination, broadcast storm problem, roadmap scenarios, Mobility Models, VANET.*

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## 1. INTRODUCTION

Vehicular Ad hoc Networks (VANETs) are a special case of Mobile Ad Hoc Networks (MANETs) wherein the nodes are modeled as vehicles. These nodes are capable of communicating with each other on an adhoc basis, without a fixed Infrastructure. VANET considers each participating node as a router thus enabling the nodes to connect to each other and transfer the data, thus creating a network. VANET is a subclass of Intelligent Transportation System (ITS) in order to provide safety and comfort to the road users. The major applications of VANET includes safe driving, co-operative driving, traffic optimization. Since vehicle is moving on the road, vehicles make connection with another vehicle that may never met before. This connection lasts for only few seconds since the vehicle is moving in its own direction, and never meets again in the network. These connections will be lost as each car has a high mobility and may be travel in opposite direction. Mobility pattern of vehicles depends on traffic environment, road structure, speed of vehicles, driver's behavior and so on. Currently vehicles have become the main transportation tools, and VANETs has become a hot research topic for more and more researchers begin to realize the potential perspective of the vehicle network. This work mainly focusing about the data dissemination in VANETs and try to propose a message dissemination algorithm for the applications which are emerging for VANETs

Adapting to the environment where the vehicle is moving is essential to improve the warning message dissemination and to reduce the broadcast storm problem. This work mainly focus on traffic safety and efficient warning message dissemination, where main goal is to increase the accuracy of the information received by the nearby vehicles when a abnormal situation occurs. Existing techniques for VANET usually considers vehicles in the road such as their density, speed and position. Most of the works related to VANET in the literature mainly focus on end-to-end routing in highway scenarios. These techniques are not suitable to warn highest number of vehicles when an abnormal situation occurs in realistic vehicular traffic environment. In the past, a lot of techniques have been proposed to enhance the warning message dissemination but none of them is tested in real urban scenarios. New proposal for warning message dissemination in real urban scenario is needed which should consider both the number of vehicles in the environment and the road topology information.

This work proposed traffic safety and efficient message dissemination for reducing the latency and to increase the accuracy of the warning message dissemination received by nearby vehicles when a dangerous situation occurs Manuel [3]. An algorithm called PAWDS, Profile-driven adaptive Warning message Dissemination System is proposed which dynamically modifies some of the key parameters of the alert dissemination process to enhance the efficiency of the warning message dissemination and reducing the broadcast storm problem by considering city profile. In VANET, any vehicle detecting an abnormal situation should notify the anomaly to nearby vehicles that could face this problem in a short period of time. Hence a simple broadcasting increases the number of messages in the network over time. Simultaneous forwarding of messages without any condition will cause message redundancy, contention and massive packet collisions [8]. Such a situation must be avoided or reduced.

The rest of the paper is organized as follows. Section II presents several broadcast storm reduction techniques and adaptive forwarding mechanisms related to the work. Section III justifies the necessity of city profile information and their classification. Section IV describes the implementation of algorithm and checks the effects of broadcast storm problem. In Section V presents and analyze the obtained results. Finally, Section VII concludes the paper.

## 2. BACKGROUND AND RELATED WORK

In the networking literature, there are several works that proposed either broadcast storm reduction techniques or adaptive mechanisms to enhance message dissemination. The following section deals with most representative work related to proposed work.

### 2.1 Broadcast Storm Mitigation Techniques

There are various techniques by which a message could be disseminated over the network. In the networking literature, there are several works that proposed to reduce the broadcast storm problem and adaptive mechanism to enhance the efficiency of the alert dissemination. The following literature review deals with the literature works related to this project.

The Counter-based scheme [8] uses a threshold C and a counter c to keep track of the number of times the broadcast message is received. Whenever $c \geq C$, message rebroadcast is inhibited. The Distance-based scheme [8] use the relative distance d between vehicles to decide whether to rebroadcast or not. When the distance d between two vehicles is short and the additional coverage (AC) of the node is lower, rebroadcasting the warning message is inhibited. If d is larger, the additional coverage will also be larger. The Location-based scheme [8] requiring more accurate locations for the broadcasting vehicles need an accurate geometrical estimation (with convex polygons) of the AC of a warning message. Since vehicles usually have GPS systems on-board, it is possible to estimate the additional coverage more accurately.

The other rebroadcast schemes for VANET is slotted 1-persistence, slotted p-persistence and weighted p-persistence [9]. These three probabilistic and timer-based broadcast suppression techniques are not designed to solve the broadcast storm problem, but they can reduce the severity of the broadcast storm by allowing only nodes with higher priority to access the channel as fast as possible. These schemes are specifically designed for use in highway scenarios.

The Last One (TLO) scheme [6] technique reduce the broadcast storm problem by finding the most distant vehicle from the warning message sender node, this vehicle will be the only allowed node to retransmit the message in network. This method uses GPS information from the sender vehicle and the possible receivers to calculate the distance. GPS information must be accurate to achieve good results, and it is not correctly specified how a node knows the position of its nearby vehicles at any given time.

Enhanced Street Broadcast Reduction (eSBR) scheme [6] uses two types of message for communication between the vehicles namely, warning message, informing about an emergency situation and beacon message, informing about the position, speed etc. of the vehicle. The message is rebroadcasted after a fixed time interval if the distance between the sender and receiver is greater than the initialized rebroadcast distance. The message ID is stored in the vehicle database, if the same message is received again, by comparing it with already existent ID the message is discarded and is not forwarded again by the vehicle.

The Cross Layer Broadcast Protocol (CLBP) [1] uses geographical locations and velocities of vehicles to select the forwarding vehicles efficiently. This scheme uses Broadcast Request To Send (BRTS) and Broadcast Clear To Send (BCTS) frames exchanging for reliable transmissions. This scheme focus on single-direction environment like highway scenarios and its performance has not been tested in urban scenarios.

### 2.2 Adaptive Scheme for Message Dissemination

In VANET research works are less for message dissemination. Backfire Algorithm [4] proposed for improving the message dissemination. Vehicles calculates the density of neighbor vehicles to decide whether to forward or not. An opportunistic auto adaptive dissemination scheme proposed [2] - Adaptive Copy and Spread (ACS) Algorithm - for VANETs, this technique dynamically adjusts the dissemination strategies based on the moving patterns of vehicles such as direction and velocity,. This proposed scheme automatically increases or decreases the number of message replicas inside the broadcast area, and vehicles can decide when to start or stop broadcast a message. Adaptive spread and copy is designed to keep the message at the effective area's boundary for informing this situation when the vehicle entering as soon as possible.

In summary, VANET have many protocols but most of them are available for one direction scenarios or end-to-end routing. Some protocols are designed for the highway scenarios such as only one direction of prorogation is considered. Achieving efficient warning message broadcast is of utmost importance in vehicular networks to warn other vehicle of real time traffic information. To overcome these drawbacks, this work mainly focus on improving the efficiency of the warning message broadcast while reducing the number of messages in the vehicular communication network and improve the accuracy of information received by nearby vehicles.

## 3. IMPACT OF ROADMAP TOPOLOGY

One of the most important issues in the protocol design of VANET is absence of existing mobility model for imitating the realistic behavior of vehicular traffic [5]. Roadmap has an important influence in the message dissemination since topology constrains car movement. In order to reduce the broadcast storm problem messages are transmitted based on the road topology. Road topology is classified into three according to the number of streets and junctions in the city. They are Simple layout (low density of streets and junctions), Regular layout (medium density of streets and junctions) and Complex layout (high density of streets and junctions). There are three message dissemination schemes are used based on the city profile information. They are Full dissemination, Standard dissemination and Reduced dissemination.

**Full dissemination:** When the vehicles move in a low density area then vehicles can send as many message as possible since the vehicles in the city are less.

**Standard dissemination:** Density of vehicles in the city is medium vehicle should maintain balance between number of messages send and number of messages received.

**Reduced dissemination:** Vehicles send as few messages as possible because the vehicles move in a high density area.

## 4. IMPLEMENTATION OF ALGORITHM

Each vehicle is equipped with GPS and city profile is identified by using onboard GPS system. There are two types of messages namely, warning messages and beacon messages. Warning messages are used to inform other vehicles about the abnormal conditions on the road and beacon messages are exchanged among the vehicle to inform about their speed, position etc of the vehicles. Vehicle density is calculated by exchanging the beacon signal among the nearby vehicles. City profile identification and the density of vehicles on the road is the basis for the algorithm implementation. The algorithm efficiently selects the most suitable message dissemination depending on the profile of the street map and the estimated vehicle density.

The following Table 1 shows the parameters used in each working modes in the algorithm and T is the time taken to reconfigure the system. The effectiveness of the alert dissemination can be increased if the vehicles determine their city profile of their current area and adapting to the environment by selecting the appropriate dissemination scheme accordingly. Table specifies different broadcast schemes used in different working modes and interval between the message broadcast in each dissemination scheme .Most of the previous algorithm for VANET using a predefined set of values. In this work the existing algorithm automatically tune the parameters to enhance the warning message and select the efficient mode of operation for sending the message based on the city profile information and the estimated density of vehicle on the road. Adapting to the environment where the vehicle located is taken into account for the message dissemination.

**Table 1** Working Modes and Key Parameters

| Working mode | Interval between consecutive messages | Broadcast scheme | Min. rebroadcast distance |
|---|---|---|---|
| Full dissemination | 2 seconds | Counter based | -- |
| Standard dissemination | 4 seconds | eSBR | 200m |
| Reduced dissemination | 5 seconds | Distance based | 250m |

The working and pseudo-code for the algorithm as shown below

**Algorithm 1**: pseudo-code

```
Use standard dissemination scheme
While (1) do
obtain street map using GPS
Estimate the vehicle density using beacon message

if (city-profile is simple) then
        if(vehicle density>25/km^2) then
        use reduced dissemination scheme
        else
        use standard dissemination mode

else-if (city-profile is regular) then
        if(vehicle density>50/km^2) then
        use standard dissemination scheme
        else
        use full dissemination scheme

else-if (city-profile is complex) then
        if(vehicle density>75/km^2) then
        use standard dissemination scheme
        else
        use full dissemination scheme
sleep(T);
```

## 5. SIMULATION AND PERFORMANCE EVALUATION

Simulation result presented in this paper is done using Matlab 2010a. Since deploying and testing of VANET protocol is costly in the real world without prior testing of protocol. Simulation plays a vital role in imitating the realistic behavior of vehicular traffic. Matlab is good for implementing the algorithm accurately and provides mathematical proof for the algorithm implementation. Matlab offers many predefined mathematical functions for technical computing which contains a large set of mathematical functions. This work simulated with 200 vehicles in the roadmap scenario and result shown in the figure 1.

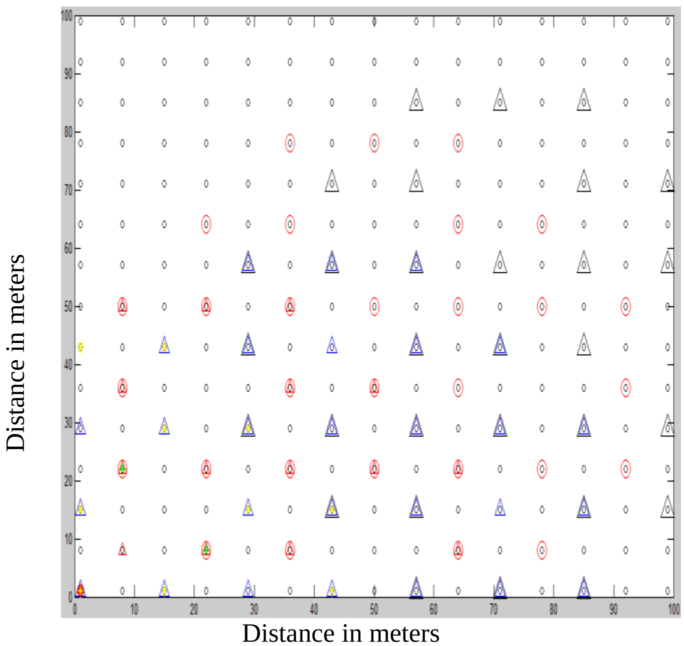


**Fig.1** Implementation of Algorithm

In figure 1, the entire colored circle and the blank circle represent the vehicle at an instant of time. Nodes are represented with different color for better understanding of results. Vehicle detecting abnormal condition is indicated in the figure 1 as red thick node at the bottom left corner of the scenario. When a vehicle detecting an abnormal condition it has to inform other vehicle by using simple broadcasting. Since each vehicle is equipped with GPS, selection of broadcasting node is based on the position of node. Selection of rebroadcasting node is based on the certain distance. The red thick node selects the green node as the next forwarding node. The green node again selects the yellow node as the next forwarding node. Yellow node then selects red triangle node as the next forwarding node but this node again selects the green node as forwarding node. This selected green node was previously the broadcasting node of red node. The red triangle node then selects the blue triangle node for message rebroadcast but some node selected was previously the broadcasting node of another node. This blue triangle node again selects read circle node as the next forwarding node. The red circled node selected for rebroadcast was previously the rebroadcasting node of some another node in the scenario. This red circled node again selects the black triangle node for message rebroadcast. But some of the node selected is previously the rebroadcasting node of other vehicles. This work shown that instead of selecting all the nodes in the sender's communication range for rebroadcast some of the nodes are selected in the communication range. The broadcast storm problem reduced efficiently but some of the nodes in the sender's communication range repeatedly act as the rebroadcasting node.

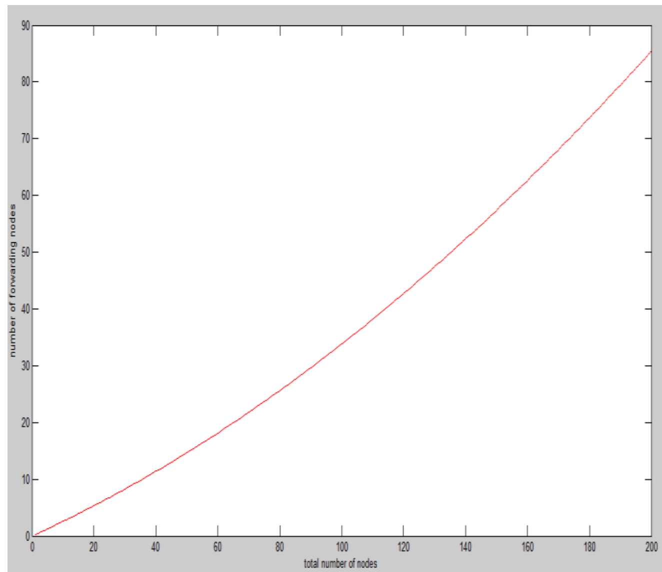


**Fig 2** Number of rebroadcasting nodes

Simulation results show that efficiency of alert dissemination is increased and reduced the broadcast storm problem. But some node again and again act as the rebroadcasting node of some others as shown in figure.1.Selection of a set of forwarding node for rebroadcasting is a challenge. About 42.50% of node has been selected for rebroadcast when simulated with 200 vehicles in the scenario as sown in figure.2. About 85 nodes act as the rebroadcasting node in the scenario.

## 6. CONCLUSIONS AND FUTURE WORKS

This work outcome mobility model for VANET and improves the warning message dissemination by considering dynamic roadmap profiling. Based on the city profile information and estimated vehicle density alert dissemination efficiency can be improved. When the vehicle determine the city profile of their current area where the vehicle is moving is necessary for improving the alert dissemination process. Algorithm selects adequate dissemination scheme based on the environment dynamically. Simulation result shows that around 50% of vehicle act as the rebroadcasting node when simulated with 200 vehicles. This work reduces the broadcast storm problem but not completely reduced the problem because some nodes again act as the rebroadcasting node and rebroadcast the same messages in the network. This work proposes a non-geometric broadcast approach for completely remove the broadcast storm problem. In order to minimize communication area overlap and maximize the broadcast coverage a virtual hexagonal network is considered. GPS accuracy affects the communication performance since GPS has about 50m to 100m of error bounds. Nodes that are closely located at the boundary of sender's communication range are selected for rebroadcasting the message and to maximize the broadcast coverage without using GPS.

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