A Review Analysis on Emergency Data Dissemination Techniques in Vehicular Adhoc Networks

C. Balakumar, Dr. E. Karthikeyan

Abstract— A Vehicular Ad-Hoc Network (VANET) is an amazing application of Mobile Ad-Hoc Network (MANET) that facilitate vehicles to vehicles and vehicles to road side units and its base stations communication with the main objective of providing secure and safe transportation in an efficient way. The emergency alert message information are transferred through V2V (vehicle to vehicle data communication), so the parameters like network strength, wait time, high mobility and repeated network disconnections plays vital role for the data communications. The different data dissemination advances in VANET can be followed to intimate the vehicles about the traffic congestion which leads a safe and efficient travel journey. In this paper, different data dissemination techniques are widely reviewed and identified the main challenges in it. There are many VANET data dissemination techniques were applied, but it really does not provide adequate transmission speed for emergency oriented data transmission services. In most of the situations it leads to unexpected traffic congestion and accidents. To minimize the same, VANET network need intelligent and effective routing protocols for intra vehicle communication. The various data dissemination techniques used to share the information in highway and urban environment with good quality of services, rebroadcast and the assurance of message when it reaches the destination are studied and reviewed with different research authors papers. It covers application areas, challenges, different dissemination techniques and security issues in the VANET.

Keywords: Data Dissemination, Vehicular Ad-Hoc Network, Dissemination Techniques and Challenges, Routing Algorithm, Road Side Unit, On Board unit, Authentication Unit, Quality of Service.

1 INTRODUCTION

The Traffic congestion and accidents are rapidly increasing with the increase in the usage of vehicles around the world. As per the UN study report, India loses 3% GDP in road accidents. Every year $58 billion loss due to road accidents and the traffic congestion cost in four cities (Delhi, Bangalore, Mumbai and Kolkata) as $22 billion per year. Vehicular Ad hoc Networks (VANETs) are the finest application to boost the transportation features such as road safety, traffic congestion information and sharing infotainment within the network infrastructure where a huge number of event-driven messages require to be disseminated in a programmed way. The Vehicular Ad Hoc Networks (VANETs) are created by using the basic ideas of Mobile Ad Hoc Networks (MANETs) to exchange the information with vehicles close by using data dissemination techniques. The Hybrid Intelligent Transportation Systems (ITS) is used to distribute the information between the vehicles which acts as a router and host for the data transmission. In recent years, VANET attracts attention from both research and industry communities. The main focus of VANETs is to make the road journey more safe and comfort[1]. Nowadays, the Vehicles are designed with embedded sensors, processing units and wireless communication capabilities which leads to arrive powerful and potential life changing applications on safety, efficiency, comfort, public collaboration and participation while they are on the road [2].

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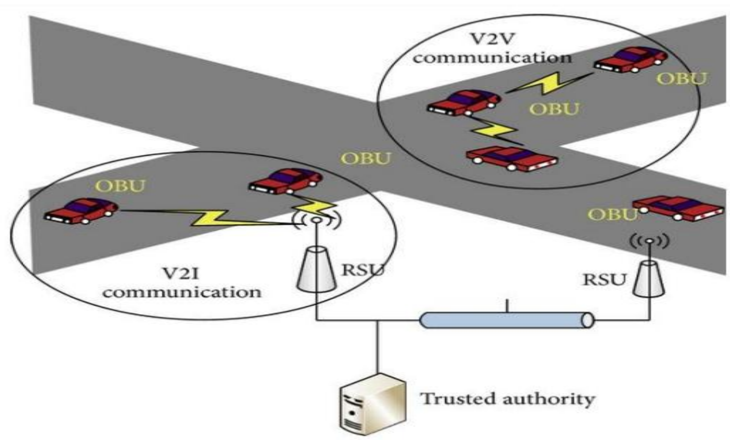
It allow to deploy different architecture for vehicular network in highways, urban and rural environments to support the applications with different Quality of Service. The VANET architecture with its components On Board Unit (OBU), Application Unit (AU) and Road Side Unit (RSU) are shown in Figure 1.



Most of the vehicle are equipped with the AU device, which contact the designed application for communication by OBU device. The AU can be fixed as a devoted device for safety applications or a common device like personal digital assistant [3]. It can be connected through a wired or wireless network connection and may be present within the OBU as single unit. The difference between the AU and the OBU is consistent and logical. The RSU is generally fixed with the road side unit or in dedicated locations like road main junctions or parking slots. The RSU is designed with network capacity to a short range based on IEEE 802.11p radio communication technology with other devices to share the information within the specified network area [3]. The main aim of VANET architecture is to enable and share the information of nearby vehicles with one another and vehicles with fixed road side units as discussed below,

Vehicle to Vehicle (V2V) network: The direct communication between vehicles without any infrastructure support and it can be primarily used for safety, security and dissemination applications.

Vehicle to Infrastructure (V2I) network: This network is for data communication or sharing information between the vehicles and the road side unit infrastructure and it mainly used for data or information collection.

Hybrid Infrastructure: It allows Vehicle to Vehicle (V2V) and Vehicle to road side Infrastructure (V2I) data communication. For Example, a vehicle can share the information to the roadside infrastructure either in a single hop or multi-hop fashion depending on the distance.

2. Applications

VANET applications monitors various information types such as the vehicle conditions, surrounding roads, approaching vehicles, surface of the road and weather conditions to make the infrastructure more secure and efficient.

Safety Related Applications

This applications mainly used to increase the safety related on the road and the traffic congestion, the various applications are discussed below,

a. **Collision Avoidance:** The major accidents can be avoided if the drivers are given the information in proper time like 0.30 seconds before the collision happens. The accident information like a indicator or a spot location is shared to other vehicles to avoid and prevent the other nearby vehicles to not to choose the same road.
b. **Cooperative Driving:** A continuous and safe travel can be accomplished by having traffic related information warning or alert signals like route change, the speed limit of the road, signboard for a bridge, school, bend or curve ahead etc. Drivers are most responsible persons involved in this application. Many road accidents are occurred because of the lack of drivers cooperation in driving.
c. **Traffic Optimization:** In VANET, the vehicles can send and receive the information. The various signals like TRAFFICJAM, ROADWORKS AND ACCIDENT etc., can be sent to the vehicles selected the same route or nearby when the route has a disruption, so the vehicles can choose an alternate route / road to save time [4] and optimize their trip.

User Based Applications

It sometimes called as user based permissions and used for securing applications at individual level. The VANET provide following services as follows,

a. **Peer to Peer application system:** This applications are used to offer services like video, songs, pictures and short messages between the vehicles in the network area.
b. **Internet Connectivity:** VANET provides the stable and steady connectivity of the internet to the users without any disconnection for long time through which people connect with each other for sharing of information.
c. **Other services:** VANET can be used in application like payment service to collect the taxes, to locate the fuel station and to pay restaurant bills, etc., [3] [4].

3. Challenges

There are huge challenges persist in wireless communication networks and design requirements due to the different form and application of VANET. It must be noted that the research challenges in VANET are wide and not limited to only these areas.

a. **Quality of Service (QoS):** To meet the emerging requirements of heterogeneous applications in the Internet which is able to provide only best effort service. QoS is a guarantee given by the network to provide performance and efficiency for a flow in terms of bandwidth, delay, jitter, packet loss probability, etc., [6]. Adhoc networks have more challenging problem in QoS than ever before, despite some of reactive routing protocols can be configured to return only paths that comply with QoS parameters.

   RF channel characteristics often change unpredictably along with the difficulty of sharing the channel medium with many neighbor nodes in the network, each of its having own QoS requirements. There are numerous multi layer attempts to improve the QoS problems from the service to the MAC layer. A promising method for satisfying QoS requirements is an integrated approach of cross layer or vertical layer integration [7]. QoS policies, algorithms and protocol priorities are to be researched in the future. Due to the nature of ad hoc networks, QoS cannot be guaranteed for a long time because of the link quality variation [6] [7]. The connection quality should be investigated the current issues by detecting and report changes in the network.
b. **Efficient Routing Algorithms Design:** Routing algorithm is used to send data packets from one node to another in time and proper manner. Efficient routing algorithm means a routing method with minimum delay, maximum system capacity and less computational complexity [7] in network in an efficient way. Currently, designing such algorithm which can be implemented in multiple topologies of the network and satisfies all of the above mentioned properties is an dynamic area of research in VANET [6] [7].
c. **Message Communication in Vehicular Networks:** The VANET applications require transmission, collecting, assembling and processing the large volume of data packets / Message. The message broadcasting is an alternate solution for its low cost and support for huge volume of data in automotive wireless communication networks. Hence, several broadcasting techniques and mechanisms have been taken into consideration by many researchers. These techniques include restricted and unrestricted bandwidth digital service solutions as well as satellite broadcasting solution which has already incorporated real time traffic data services [7]. Broadcasting techniques are associated with broadcast storm problem. This problem could be reduced or eliminated by reducing the message broadcast range within specific area thereby reducing the unnecessary

network overhead. This concept is called location-aware broadcasting [8]. Another approach that has emerged is clustering approach where neighboring mobile vehicles form clusters or manageable groups which limit the message broadcasting range [9].

d. **Highly Dynamic Spatio Temporal Traffic Conditions:** The density of vehicles in VANET varies from very tiny as in highway scenario to extreme large as in a traffic jam in city scenario [7]. The flow of vehicular traffic is also dynamic, primarily contingent upon the time of the day. To deal with varying spatio temporal traffic conditions is important and challenging. Specifically, in the beginning phase of VANET deployment, it is anticipated that only few vehicles are VANET enabled [9]. Participation by only few such vehicles possibly aggravates the problem of frequent network fragmentation, thereby the defective diameter of a VANET is restricted. The other criteria are wireless channel impairments such as slow fading and fast fading that causes dynamic traffic variations. Fast fading can occur when vehicle density is low and vehicles can travel at a high speed. On the other hand, Slow fading is experienced in city environment where vehicle density is high and vehicles move slowly in traffic jam [8]-[10]. The VANET domains and channel conditions are vary significantly with the environments. Therefore, the design of adaptive channel access protocols with resistance to channel impairments is main concern [9] [10].

e. **Scalability and Robustness:** Designing a scalable and robust network remains an open area of research in VANET because of its challenging characteristics [10]. Many design fails when VANETs transform from sparse to high density mode or from high mobility to slow traffic scenarios [11]. A complete VANET framework that is scalable to all different network and robust to the topological changes is required [12].

f. **Cooperative Communication:** A key challenge in VANET is enabling the communication between different nodes in the network. The different concepts of cooperative communication from wireless network may not be directly fit to VANET. To which extent nodes should exchange information between themselves in cooperative communication is one of the major research areas in the Vehicular network design [12].

g. **Security:** The Security issues are the main critical and large challenging area for research in ad hoc networks. Since nodes use the open and shared radio medium in a unsecured environment, they are particularly prone to malicious attacks. Lack of any centralized network management or certification authority makes the dynamically changing wireless structure more vulnerable to infiltration, eavesdropping and interference etc. Accordingly, the research efforts on security have mostly concentrated on secure data forwarding. However, many security risks are related to unique features of ad hoc networks. The most serious problem is the risk of a node being captured and compromised[13]. This node have access to structural information on the network and relayed data. But it can also send false routing information which would paralyze the entire network quickly.

One of the current approaches to the security problems is building a self organized public key infrastructure for VANETs cryptography. Other challenging issues on ad hoc networks are node cooperation, interoperation with the Internet, aggregation, multicast and as well as the theoretical limitation of VANETs [12].

4. Data Dissemination Methods in Vanet

The data dissemination methods can be categorized based on the mode of communication as broadcast, multicast, anycast and unicast. In the broadcast method, there is a source node as the sender and all other nodes are receivers, while a group of nodes will be the destination receivers in multicast. In anycast, the node attributes such as speed or position satisfy some conditions will be the receivers. In the unicast, there is only one node as the receiver pre-defined by its ID or position.

Many problems in VANET are resolved by the process of effective data dissemination. During data dissemination the parameters such as network size, vehicle's speed, patchy and intermittent connectivity between mobile nodes [13] are to be considered. In addition, there is one more problem which can severely affect the entire process is latency requirements. Consequently, content information has to be discovered quickly and distributed among all nodes. According to the literature, there are many schemes to deliver the information in VANET [13]. The following are the different approaches for data dissemination:

Opportunistic Data Dissemination: The information can be received from infrastructure or vehicles as the target vehicle pass nearby or cross them [12] [14].

Vehicle-Assisted Data Dissemination: All vehicles carry information along with them and deliver it either to the infrastructure (RSU) or to other vehicles when they come across. In order to disseminate the information, the mobility is also concerned apart from the wireless transmissions [13].

Cooperative Data Dissemination: Partial information can be downloaded by the vehicles that can be shared later to obtain the complete information. This method is mainly appropriate for content dissemination [13].

Truc D.T. Nguyen et al proposed a Store Carry Forward (SCF) scheme[16] which the vehicle will store and forward a message whenever it detects a new neighbor that has not previously received that message. To verify the neighbor has previously received a message or not, it compares the hash received from the beacon packet with the hash of the storing message. Each SCF vehicle typically stores the message in a predefined interval. After that, it discards the message. They proved that the vehicle speed follow a gaussian distribution with the probability density function.

$$f(v) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(v-\mu)^2}{2\sigma^2}} \quad (1)$$

where v is the vehicle's speed, μ and σ is the mean and standard deviation values of emergency message sending signal speed. This scheme adopts a novel SCF mechanism to solve both broadcast storm and network partition problems, while maintaining high neighbor Information accuracy.

L. Y. Wang, et. al, proposed coordinated control of vehicle platoon and forced consensus in Network Topologies[17]. The new method for improving the highway safety and effectiveness by coordinated control of vehicle platoons is introduced. The primary goal is to know the influence of network topologies and uncertainties on control performance. Vehicle placement is devised as a weighted and forced consensus control problem. Many algorithms are introduced with convergence properties. Due to vehicle conditions, a desired distance before an vehicle differs at different locations by using this following formula,

$$L = \sum_{i=1}^{r} \quad d_{(i)}t \tag{2}$$

Where, r as constant, d_i is the distance between vehicles i and i – 1. The main advantages of the method is verified using local control to attain a global deployment so the communication complexity is reduced and scalable to hold dynamic changes of the vehicles and networks, robustness beside road side conditions and communication network uncertainty problems.

P. Fernandes, proposed Platooning with IVC enabled autonomous vehicles strategies to mitigate communication delays improve safety and traffic flow[18]. It mainly deal with intra platoon information management strategies for dealing with safe and stable operation. IVC is emerging as a prominent technology for helping in reducing the traffic congestion. The recent technological advances on communication such as dedicated short range communication (DSRC). Considering the desired i^{th} vehicle position defined by the below formula,

$$x_{i\_des=}\, x_{i-1} - L_i \tag{3}$$

J. Ploeg et.al proposed cooperative Adaptive Cruise Control (ACC) [19]. Currently the highway facility has become a restrictive factor of traffic jams regularly. Apparently, the road capacities can be improved by reducing the distance between the vehicles by maintaining the certain same velocity. The ACC can adjust the velocity of the vehicles to recognize a preferred distance to the previous vehicle. The distance between the vehicles and relative velocity are measured by a radar or a laser scanner. However, ACC is mostly proposed as a comfort system. This method also incorporate a time delay D(s) representing the latency θ stimulated by the wireless network due to different factors like queuing, contention, broadcast and propagation. The delay in network can be compensated by an estimator using this block scheme, Γi(s) = Γ(s) (independent of i) can be shown as below,

$$\Gamma(s) = \frac{1(D\,(s) + G\,(s)\,K\,(s))}{H\,(s)(1 + G\,(s)\,K\,(s))} \tag{4}$$

Where the vehicle transfer function G(s), spacing policy transfer function H(s), feedback of law is K (s).

P. Kavathekar proposed a brief survey and categorization of vehicle platooning [20]. An important innovation in the automotive industry that aims at improving the safety, mileage, efficiency and the time needed to travel. Autonomous capable vehicles in tightly spaced, computer controlled platoons will lead to savings in fuel, increased highway capacity and increased passenger comfort. The introduction of automation into road traffic can provide essential solutions to the mainstream issues of accidents, traffic congestion, pollution and energy consumption.

T. Taleb, et.al, proposed an Effective Risk Conscious and Collaborative Vehicular Collision Avoidance System [21]. The Cooperative Collision Avoidance (CCA) for intelligent transport system and the risk aware medium access control (MAC) protocol are used to boost the responsiveness of the CCA scheme. With the use of CCA system, the number of accidents and the associated damage can be reduced significantly.

V. Sadatpour et al proposed a scheduling algorithm for beacon safety message dissemination in VANET[22]. It experience from poor reliability in road traffic congestion. The main cause of this problem is carrier sense multiple access (CSMA) environment of Dedicated Short Range Communications (DSRC) in MAC layer. They are discussed a scheduling algorithm in the application layer is proposed to alleviate the problem. First, split the roads into a number of geographical sections. In each section, a cluster is formed between the moving vehicles. Then apply a scheduling algorithm including two levels. In the first level, nonadjacent clusters can broadcast at the same time.

$$N = \frac{2R}{L_s} \tag{5}$$

where R is the transmission range of the Cluster head Vehicle (CV) and the Ls is the minimum distance allowed between two vehicles. The 2R is the length of each Cluster Space (CS). If the road has M lane, there are B road blocks in each CS.

$$B = M \times N \tag{6}$$

where only one vehicle can be located in each block. Each road block is identified with index (i, j) where 0≤ I ≤ N-1and 0 ≤ J≤ M-1each road block is assigned a time-slot label as shown below,

$$\delta = i + j \times N + 1 \tag{7}$$

The second level scheduling mainly deals with every cluster inside and implement a time division multiple access (TDMA) approach. The simulation results shows that the proposed algorithm enhance the reliability in beacon message dissemination. The information accuracy of each and every vehicle can be obtained from its nearby vehicles are increased. Thus the proposed second level scheduling leads to huge enhancement of the safety level provided by Beacon Safety Messages (BSMs).

R. Hall and C. Chin, proposed vehicle sorting for platoon formation[23] impacts on highway road entry and throughput. They develop strategies to categorize vehicles into platoons with the goal of increasing the distance that platoon stay as whole. The Automated Highway System (AHS) are projected to maximize the throughput and highway safety with computers, communication and sensing controls. In the platoon concept for AHS, vehicles travel on highways in a closely spaced groups. Within a platoon, vehicles are separated by very short distances of spacing from platoon to platoon can be considerably longer to minimize the likelihood that platoon crash with each other. To maximize the highway throughput, it is advisable to create platoons size larger and that remain unbroken over long distances.

Anees A et.al, proposed time critical emergency message dissemination in VANETs[24], which utilize multi-hop transmission protocol and a partitioning protocol. The partitioning protocol mechanisms are, emergency message selection using various mechanisms. Second is multiple sectoring and dividing the region into various sectors. Finally, transmit this emergency message into nearby sectors and Road Side Unit (RSU). It provides a faster and more reliable emergency message dissemination by cutting the channel access time and minimizing the contention period jitter. VANET is not limited up to Vehicle to Vehicle communication only, it also deals with road side units communication. They are,

a. Cross layer broadcast protocol
b. Number of sectors depending on the vehicle density in a specific region

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 this 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.

Ravindra J. et. al proposed a broadcasting scheme for message dissemination in VANET[25]. Broadcast scheme is used for disseminating safety related information between the vehicles. The broadcasting of messages over wireless networks face many challenges due to network link unreliability, broadcast storm, unknown terminal, duplicate message and redundancy which highly degrade the performance and efficiency of the network. Efficient Directional Broadcast (EDB) is a delay based multi hop broadcasting protocol that works similar to Urban Multi hop Broadcast (UMB) protocol. EDB make use of the directional antennas instead of the Request to Broadcast (RTB) and Clear to Broadcast (CTB) control packets. In specific, each vehicle can be equipped with two directional antennas with 30 degree beam width. There are two types of packet forwarding in EDB like UMB, that is directional broadcast on the road section and directional broadcast at the intersection of the roads. In directional broadcast on the road section, a source vehicle broadcast a packet and the vehicles follow the source in a stream will rebroadcast the same packet to other vehicles until no vehicle in the downstream. To minimize the number of duplicates in rebroadcast packets, EDB allocate a waiting time before packet rebroadcasting to each vehicle within the network range of the transmitter. The waiting time function can be arrived by using the distance between the vehicle and the transmitter and transmission range. In detail, when a vehicle receives a packet, it calculate its own waiting time by the following function as,

$$w = (1 - \frac{d}{R})maxWT \tag{8}$$

Where R is the range of the transmitter, d is the distance between the transmitter and the vehicle and maxWT is the maximum waiting time [25].

S. Lakshmi, et. al proposed prioritized directional broadcast technique[26]. The message priority assignment technique is used to prioritize the message as urgent, very urgent or general messages. Binary partition phase is executed to discover the candidate relay node inside the source coverage area. Prioritized directional broadcast technique with message priority assignment is proposed to avoid the vehicles from huge accidents. At first, the message priority assignment is used normally and then the message priorities can be assigned according to the message's nature and dissemination distance to keep QoS of the messages. when a very urgent message is received from the source. it signify the received message is in emergency message transmission. The Priority Metric (PM) value is used to assign the priority to a message as very urgent, urgent or general message. The PM can be calculated as shown below,

$$PM = K * \left(\frac{1}{e^{0.05*d}}\right) \tag{9}$$

where K is the priority coefficient that stand for how fast the message priority dropped, d is the dissemination distance that is the distance between the incident and receivers position.

Tonguz et al[27] proposed the Urban Vehicular BroadCAST (UV CAST) protocol in which the packet rebroadcast wait time is calculated by using the location and the distance between the vehicles. A shorter rebroadcast delay is assigned to the vehicles which is located at an intersection and plan to disseminate data messages in various directions.

M. O. Cherifet.al[28], used Under the Road Oriented Dissemination (ROD) protocol, data is disseminated separately in each direction, aiming to optimize data dissemination at an intersection. To fulfill these goals, these mechanisms make use of vehicular GPS positions, which are inserted in the header of broadcasted messages and used to locate the node in the road map. The ROD protocol includes data that encodes the coordinates of intersections, hence it requires a considerable amount of side information, that is location specific.

Jagruti Sahoo et al[29], proposed an IEEE-802.11 based multi hop broadcast protocol to handle the issue of emergency message dissemination in VANETs. The protocol implement a binary partition approach to partition the area inside the transmission range repeatedly to get the extreme probable segment. The forwarding work is assigned to a vehicle selected in that segment. To achieve the directional broadcast for highways environment, the protocol shows good adaptation to handle difficult road structures. The broadcast delay must be minimized for time critical safety applications. The contention delay remains stable even any changes in vehicle density.

Carolina Garcia-Costa et al[30] proposed a model for the number of accidents in a platoon of vehicles equipped with a notification system with warning messages regarding the collision. This is capable to notify any emergency events happened to the vehicles. This model facilitate the calculation of the average number of collisions takes place in the platoon, the possibility of the various ways in which the collisions may take place and other related information. Eventhough an exponential distribution has been used for the traffic density, it is also applicable for different possible distributions for the traffic densities as well as for other major model parameters. Besides the actual communication system engaged is independent of the model since it is distant by a message delay variable, which can be used to assess various communication technologies.

5. Conclusion

VANETs are innovative technology which can specifically applicable to disseminating emergency messages in roadways to improve highway safety and information services. We reviewed data dissemination techniques of VANETs and its challenges which affects the performance of network communication. However, the performance and efficiency of VANETs depends heavily on the mobility, routing protocol scheme, vehicular density, driving environment and many other factors.. Since emergency alert messages are communicated as a wireless transmission then, V2V delay, efficiency and mobility should be considered. Nowadays the vehicles are equipped with WLAN devices to enhance traffic safety and improve transport efficiency. The vehicles can directly communicate with each other and with roadside units. In such networks, vehicles can share information within a short range. In turn, VANETs are composed with high mobility nodes. Thus, they exhibit a topology that may change fast and in irregular ways to complicate the communication. Therefore, it is essential to provide the user with a well organized configuration of the communication protocols to facilitate the best quality of service (QoS) possible before to its deployment. VANET applications range from safety and crash avoidance to Internet access and multimedia. Nevertheless, VANET shows its unique characteristics which impose both applications and challenges to the research communities

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