A Review on Multi-Hop Message Dissemination Strategies in VANET Environment

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Abstract— Vehicular Ad Hoc Network (VANET) is a fast emerging new technology with an integrating ad hoc network, wireless LAN (WLAN) and cellular technology to achieve intelligent inter-vehicle communications and to improve road traffic safety and efficiency. As VANET is distributed, dynamic and self-organizing in nature it can easily turn into infrastructure less information system, in which vehicles can participate themselves to transfer and share important traffic and situation information as dissemination of traffic information depends on rebroadcasting protocol used by relay nodes. In this paper explains review some of important emergency message rebroadcasting protocols and techniques that are existing. In particular paper mainly focus on exploring multi-hop rebroadcasting protocol with probability based assignment and delay based assignment to rebroadcasting node.

Key words: Multi-hop Broadcasting, Routing in VANET, Emergency Message Dissemination, Inter-Vehicle Communication in VANET, Broadcasting protocols

I. INTRODUCTION

Vehicular Ad Hoc Network is emerging new technology for safety during the driving to recover from unwanted situation on the road. It will likely to be in effect in real world that there will be a prototype change in traffic information systems. In particular it is desired that vehicle get real-time traffic data and distributed over mobile nodes instead fixed sensor used in current infrastructure based systems. VANET which is infrastructure independent can easily play role of self-organizing traffic and information system, in which each vehicle participate for collecting and disseminating useful traffic information such as a mobile node neighbour information, density, segment travel time, desired controls on-board units.

The notion behind VANET is to provide i.) Ubiquitous connectivity vehicles on the road who are connected to outside world through other networks ii.) Effective vehicle-to-vehicle communication that enable Intelligent Transportation System (ITS). So, VANETs are also known as Inter Vehicular Communications (IVC) or Vehicle-to-Vehicle (V2V) communications. ITS is major application of VANET. It includes numbers of traffic control applications like traffic monitoring, prevention of collision, traffic flow control, real time alternative routes computation. Another application of VANET is to providing internet connectivity to vehicular nodes while on the move, for the general purpose of communication like surfing and productivity [1].

IVC has strained an important and significant role in both academic as well as industry research area. To accommodate this research issue several workshops are established such as ACM international workshop on Vehicular Ad Hoc Network from 2004 and International Workshop on Intelligent Transportation from 2003. While passing these years, some automobile manufacturers have already begun to invest in inter-vehicle networks. Audi, BMW, DaimlerChrysler, Fiat, Volkswagen have united to create non-profit organization called Car2Car Communication Consortium (C2CCC) [2] which aims to increasing further road traffic safety and efficiency by means of IVC. In April 2009 IEEE formed new IEEE 802.11p task group which aims to focus on providing a wireless access to vehicular environment and then IEEE 802.11p standard for wireless access of vehicular network communication is published.

Traffic information dissemination in VANET is sole problem. VANET has generally broadcast-oriented nature so, traffic information is of public interest rather than individual or specific. Opposite to an unicast which has data to be typically transmitted over internet, in VANET broadcasting has a several significant advantages over unicast for disseminating information like vehicle doesn’t need to know destination address and route to specific destination. This cause elimination of complexity of route discovering, address resolution, and topology management which are difficult in VANET due to dynamic nature of network. This paper mainly focus our attention on information dissemination protocols for VANET environment. In particular we aimed to focus on Multi-hop broadcasting strategies with source broadcasting (i.e. broadcasting with one-to-all type scenarios) though there are other protocols available such as geocasting, multicasting, peer-to-peer content distribution, streaming is beyond to discussion of our topic in this paper.

VANET broadcasting protocols generally divided in two main category i.) Single-hop Broadcasting ii.) Multi-hop Broadcasting. The main difference between these two categories is the way they disseminate information in VANET environment.

Multi-hop broadcasting in VANET environment uses flooding technique in order to disseminate information. At the time when any vehicle receives emergency message signal to broadcast an information (i.e. source vehicle) it broadcast an information packet and some of vehicles within a relevance area of victim will become next relay vehicles (nodes) and perform relying task by rebroadcasting the packet, same way after rebroadcasting information of relay nodes some other vehicles become next relay node and forward information packet further. This way information propagates through network from source vehicle to destination vehicle.

Single-hop Broadcasting do not flood information packets. At the time when any vehicle receives information packet it keeps the information in its on-board database. Eventually during some period of time vehicle select some information from its database to broadcast. Than vehicle transfers information to other vehicle which are in its one-hop neighbour in the next broadcast so, basically in this category vehicle will carry information with itself while it travels.

The rest of paper is organized as follows. In Section II Multi-hop Broadcasting Strategies, in Section III Analysis of Existing Performance Metrics, IV Summery and Conclusion.

II. MULTI-HOP BROADCASTING STRATEGIES

As mentioned earlier Multi-hop Broadcasting uses flooding mechanism to propagate information packets over network. Pure flooding scheme in broadcasting has several drawbacks to use it in real world, these are scalability and packet collision. When network becomes denser the packet will be broadcasted more redundantly than in less denser network which cause waste of limited bandwidth of radio channel. While in denser environment there are also too many nodes available in neighbourhood to rebroadcast packets at the same time, these cause problem of packet collision. This problem is generally known to as a broadcast storm problem [3]. Good Multi-hop broadcasting with strategy must be able to address these issues. Common solution to this problem by most researchers is to optimizing and reducing number of redundant rebroadcasting packets. In next section we will see existing available approaches used in reducing numbers of packet rebroadcasting.

A. *Probability-Based Broadcasting:*

In probability-based broadcasting different probability is assigned to each vehicle. Vehicles than rebroadcast information packet according to its own probability [6], [8], [10], [11]. Since not all node will rebroadcast packets the number of packet collision and redundant node will be obviously reduced. Problem in this method is to finde and select the best probable node for rebroadcasting information packet using any probability declaration function. While basic function assign pre-define fixed probability other sophisticated strategy use different parameter like density, neighbour information and location which allow nodes to dynamically adjust their packet forwarding probability.

1) *Weighted p-Persistence:*

Upon receiving a packet first time vehicle checks its own probability based on distance between its own and the transmitter in weighted p-persistence scheme [4]. Generally distance between two can be acquired using comparison of current position with position of transmitter specified in the packet. Denoting relative distance between nodes i and j by D_{ij} and considering average transmission range R, the rebroadcasting probability, P_{ij} can calculated on the basis of following expression:

$$p_{ij} = \frac{D_{ij}}{R}$$

Based on this expression if node *j* receives duplicate packets from multiple sources within a waiting period WAIT_TIME before retransmission, it select smallest p_{ij} value as its reforwarding probability; it means that each node have to use relative distance to the nearest broadcaster in order to confirm that nodes which are farthest away has given higher probability for rebroadcasting [5].

2) *Auto-Cast:*

In Auto-Cast [6] method the rebroadcast probability is depended on the number of vehicles around the source vehicle (i.e. One-hop neighbours). In Auto-cast method author used following expression to get probability of each vehicle

$$p = \frac{2}{Nh \times 0.4}$$

Expression suggest N_h shows total number of one-hop neighbours. Using this probability expression, vehicle's probability of packet forwarding decreases as the number of one-hop neighbour increases. From the given express we can see that it only works when the number of one-hop neighbours of source vehicle is greater than or equal to 5 *($N_h >= 5$)*. It is not justified in [6] probability calculation function when one-hop neighbour are less than 5 ($N_h < 5$).

In addition to auto-cast method rebroadcast interval is also rebroadcasted periodically to increase coverage and reachability due to highly dynamic nature of VANET. Also rebroadcast interval is adjusted dynamically using following expression with α desired packet broadcast rate i.e. Packet to broadcast per second

$$t = \frac{Nh}{\alpha}$$

Performance of auto-cast is compared with MILE and MILE-on-demand [7] these are simple broadcasting protocols in which they rebroadcast packet periodically. It is noticed that auto-cast outperforms these protocols in terms of delivery ratio and latency of packet transmission, reason behind this is that auto-cast takes neighbour information in consideration when deciding forwarding probability.

3) *Link Based Distributed Broadcasting:*

All vehicles in VANET have a GPS (Global Positioning System) and GIS (Geographic Information Unit) unit on board. As VANET has a nature of frequent and rapid change of topology, fortunately it is predictable; fragmentation of network also occurs frequently. In most of case mobility of nodes is regular.

In the LDMB [8] method distance between sender and receiver, transmission power, transmission rate and vehicular density as an affecting parameters for detecting link status. As the any of the mentioned parameters changes the forwarding probability decision of vehicle changes accordingly. LDMB measures probability of packet reception. When source vehicle broadcast the emergency message vehicle in transmission will receive the message, in particular method purposed to transmit message in opposite direction of the running vehicle i.e. backward to the each vehicle and vehicle that receives message in forward direction will discard it. Backwards will calculate the possible reception probability of this message [9]. For ensuring the quality of link of transmission method sets probability threshold P_{th}. Then vehicles with high quality of link calculate waiting time before forwarding the message as

$$Tw = \lfloor (\alpha\, Psj - \alpha\, Pth - \varepsilon) * MaxSlot \rfloor * Ts$$

MaxSlot is the maximum number of slots vehicle waits before forwarding the message, T_s is length of slot, P_{th} is threshold value P_{sj} is packet reception probability of vehicle *j* which may receive packet from source vehicle *s*, α and ε are adjusting factor of waiting time. Vehicle waits for waiting time it had calculated and forward packet, other vehicles that are still in process of waiting receives the forwarding packet and stop the waiting process immediately. LDMB is completely distributed and there is no handshake exchanging before vehicle forwarding packet.

4) Irresponsible Forwarding:

Irresponsible Forwarding (IF) [10] method broadcast message considering parameters like its distance from the source and the density of its neighbours. Rebroadcast probability should be a function of distance between transmitting and receiving vehicle. In this method each vehicle computes the rebroadcasting probability based on the likelihood of having another vehicle downstream to rebroadcast the packet. In Irresponsible Forwarding method calculates its own forwarding probability according to the function

$$P = e^{-\frac{\rho_s(z-d)}{c}}$$

Where ρ_s is vehicle density, z is transmission range of vehicle, d is the distance between vehicle and transmitter, and $c \geq 1$ is a coefficient is used for shape a rebroadcasting probability. Probability is normally linear function of the distance. Based on this function, the rebroadcast probability is increased or decreased depending on the distance between the vehicle and transmitter. Rebroadcasting probability is decreased as the density of vehicle increased i.e. when network become a denser.

Number of the rebroadcasting packet s is controlled by adjusting parameter c [10]. Irresponsible Forwarding method is capable to keep desired number of rebroadcast packet at constant level even when network become more denser. Thus it scales with network density.

5) Reliable Broadcast Routing Scheme Based on Mobility Prediction (RB-MP):

In Reliable Broadcast Routing Scheme Based on Mobility Prediction (RB-MP) [11] method it select efficient and reliable rebroadcast nodes, according to prediction holding time provided by position and relative velocity. In RB-MP it selects stable routing in which relative speed of the neighbouring vehicle are calculated and inter-vehicle distance is also considered.

Each vehicle creates position table according to following data structure maintained in each node

$$\langle ID, M, Position, Speed, Dir, Distance, PHT, Selected \rangle$$

Where ID is node identity, M is the moment at which position gotten from GPS, Position parameter is position of node in *(x, y)* coordinate, Speed is average relative speed ΔV_{ij}, *Dir* is the direction of relative speed ΔD_{ij} defined by an angle with *X-axis*, Distance is inter-vehicle distance *D*. PHT is prediction holding time of the connection, Selected value 1 means being selected by RB-MP. RB-MP acquire movement information and position information through beacon interval and position updating period (PUP). Direction θ is calculated using

$$\theta i = \begin{cases} \left(360 + arctan\frac{y_i - y_{i0}}{x_i - x_{i0}}\right)\%360 & x > xi \\ 180 + arctan\frac{y_i - y_{i0}}{x_i - x_{i0}} & x > xi \end{cases}$$

Based on the previous position (x_{i0}, y_{i0}) and current (x_i, y_i). When the situation come and $x = x_i$ than,

$$\theta_i = 90 \times \max\{0, sign(y_i - y_{i0})\} - 270 \times min\{0, sign(y_i - y_{i0})\}$$

On the receiving a position message, the nodes calculate relative speed ΔV_{ij} and distance ΔD_{ij} by following equations respectively.

$$\Delta v_{ij} = v_i^2 + v_j^2 - 2 \times v_i \times v_j \cos(\theta_i - \theta_j)$$

Here *i* and *j* are the *ID* of the receiver and sender respectively.

$$D(i,j)\sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

$$\Delta D_{ij} = \sin(D - D_0)$$

(xi, yi) and *(xi, yi)* are previous position while *(xi, yi)* and *(xi, yi)* are the current. Prediction holding time can be calculated as

$$PHT(i,j) = \left|\frac{Max\{0, \Delta D_{ij}\} \times R - D(i,j)}{\Delta v_{ij}}\right|$$

When $\Delta v_{ij} = 0$, author defines the *PHT (i, j) = 2 × PUP*. In fact it just need to be more than PUP.

For selection of rebroadcast node RB-MP divides nodes into three stets: the SAME_ROAD_AHEAD, the SAME_ROAD_BEHIND set and DIFF_ROAD set. The nodes whose PHT is greater than another fixed value such as PUP are categorized into new set named SAME_PHT_BEHIND. If its cardinality is non-zero than the fastest node in SAME_PHT_BEHIND is selected and corresponding node selected is set to 1 and 0 to other nodes. In particular the cardinality of the SAME_PHT_BEHIND is zero than node which has maximum PHT is selected in SAME_ROAD_BEHIND and selected parameter is set to 1 and so it will be rely nodes.

6) Effective Safety Alert Broadcast Algorithm for VANET:

These methods of message broadcasting reduce broadcast storm and end-to-end delay of emergency message to all vehicles by choosing the last one in transmission range to rebroadcast emergency message. Information about vehicle is exchanged at close intervals between vehicles. When vehicles receive an alert message from victimized vehicles do not broadcast it immediately. They will follow the execution of The Last One (TLO) [12] algorithm to find furthest vehicle from the place of accident i.e. the last vehicle. And that only vehicle will rebroadcast the message while other will wait until the threshold waiting time interval ThB to take decision about rebroadcast.

At the moment when threshold interval time expires and other vehicles do not receives the same alert message from designated TLO i.e. node behind the self, the vehicle decide there is no relay node behind them. TLO will run again and find next last node and it will be repeated until successful broadcast is done. Authors concluded that TLO can work better than simple and weighted p-persistence. But the limitation is that it degrades its performance over inaccurate and GPS information.

B. Delay-Based Broadcasting:

In delay-based broadcasting generally some waiting delay time is given to each receiving vehicle before rebroadcasting the packet [13]. Vehicle with shortest waiting delay time gets highest priority. When other vehicles get know that packet has been already rebroadcasted they discard or drop the waiting process in order to reduce redundancy. Delay time is generally based on the distance between vehicle and transmitter. Next we review different existing delay-based multi-hop broadcasting strategies.

1) Urban Multi-hop Broadcast (UMB):

UMB [13] *is designed to address the problem of broadcast storm, hidden node and reliability problems in urban areas.*

UMB is basically composed of two subdivisions one is directional broadcast and another is intersection broadcast. UMB designed to operate without sharing local neighbour node information. To avoid problem of the hidden nodes UMB use handshake mechanism i.e. RTS and CTS handshake in point-to-point communication. For utilizing available channel bandwidth rebroadcasting duty is assigned to only vehicle that is farthest in transmission range without prior knowledge to topology information. UMB divides road inside the transmission range into the small segments and set a higher priority of rebroadcasting to the vehicle with farthest distance of segment. In the directional broadcast vehicle first send RTB packet that contains vehicle's own position and direction in which packet is supposed to propagate. Vehicles in transmission range will receive the packet and starts to transmit black-burst signal i.e. jamming signal for specified duration of time. Black-burst time duration is depends upon the receiver of RTB and transmitter. The function used for black-burst computation is

$$L = \left\lfloor \frac{\hat{d}}{Range} \times N_{max} \right\rfloor \times SlotTime$$

Where L is the back-burst duration, d is the distance between transmitter and receiver, Range is the transmission range, N_{max} is total road segments in transmission range, *SlotTime* is slot duration of black-burst. After block-burst duration vehicle listen to channel again. If channel found busy vehicle will relegates rebroadcast duty to other vehicles that are still transmitting black-burst. If vehicle finds channel idle than it transmit control packet called clear-to-broadcast (CTB) to vehicle that initiated RTB and vehicle that successfully transmit CTB packet will be next relay node for rebroadcasting packet.

After receiving CTB packet vehicle can start transmitting broadcast packet includes source node ID of the vehicle which has successfully sent CTB. Whin this relay node receives broadcast packet it acknowledges by transmitting an ACK packet back to the source vehicle. Other vehicles between broadcaster and ACK sender does not either acknowledge it or rebroadcast received packet. If any ACK not received by source node during the ACK timeout whole process start over again.

In intersection broadcasting function of UBM repeater are suggested to be installed at intersection in order to forward the packet successfully to other road direction [13]. Though UBM is not completely collision free, it is possible that when multiple vehicle in same road segment may be available and they may send CTB at the same time these cause in collision. Authors also suggested to resolve these problem by further splitting segment into N_{max} sub segment.

2) A Distance-Based Directional Broadcast Protocol:

In this broadcast method author purposed distance-based directional protocol called as Efficient Directional Broadcast (EDB) [14]. EDB will choose furthest receiver to assign message forwarding responsibility. EDB method does not use handshake mechanisms i.e. RTB and CTB are not used. EDB methods works with node having equipped with two fixed directional antenna one pointing front and second pointing back side with beamwidth of 30° degree.

When vehicles receives a broadcast packets to forward need to forward packet opposite to incoming direction of packet. Each vehicles assigns waiting time themselves. Vehicles that receives packet successfully have to wait for the designated waiting time before it decides whether or not to forward this packet. During the waiting time if vehicle listen to same packet again that it simply discards the waiting process. Waiting time which is function of distance between transmitter and receiver can be calculated as

$$WT = \left(1 - \frac{d}{R}\right) maxWT$$

In above waiting time function R is the transmission range, d is the distance between transmitter and receiver, and *maxWT* is maximum waiting time allowed i.e. time-out duration. After waiting time expires it send acknowledgement packet ACK immediately to its neighbour node. This is done to inform neighbour vehicle that they did not need to perform rebroadcast task. If vehicle does not receives same message from other relay node that it starts to broadcast message. In particular to this function, the farthest vehicle will have shortest waiting time and the vehicle with less waiting time given highest priority to forward the packet. EDB also attempts to increase reliability by periodically sending packet if node not found any packet within interval *maxWT*.

3) Slotted 1-Persistance Broadcasting:

In Slotted 1-persistance [4] broadcasting scheme when any node receives a packet it checks packet ID and forward that packet with an assigned time slot. If and only if received packet is not duplicate before its assigned time slot, else node will simply discard the packet. Calculation of time slot can be done using following function

$$T_{S_{ij}} = S_{ij} \times \tau$$

In the function τ is the one-hop delay with medium access and propagation delay. Assigned slot number represented as S_{ij} which can be calculated as

$$S_{ij} = N_s\left(1 - \left\lceil \frac{min(D_{ij}, R)}{R} \right\rceil\right)$$

In the function above D_{ij} is the distance between transmitter and receiver vehicles i and j. R is the vehicle's range of transmission, Ns is the pre-determined numbers of slots. It is suggested in [4] that N_s is the design parameter which should be chosen carefully. N_s value will be varied depending on the traffic density as value can be increased as network become more denser and decreased when network becomes less denser. While dealing with this method it is possible that their may be more than one vehicle broadcast in same time-slot, results in collision of packet. During the waiting time duration it broadcasts the packet if it hears the packet for the first time and no one has transmitted packet before.

Vehicle density based emergency broadcasting (VDEB) protocol is similar to slot based broadcasting, in which waiting is the function of distance between transmitter and receiver. [15] The density is calculated from the number of available nodes around the transmitter and vehicle density is explicitly considered in VDEB which is an improvement over slotted 1-persistance method.

4) Neighbour Information-based Broadcast:

In neighbour information-based broadcasting scheme (NIBS) [16] vehicles initiate communicate using exchange of hello message periodically. Hello message includes vehicle ID and geographical position. With exchange of this message each vehicle build and maintains neighbour table which contains vehicle IDs and position of vehicles based on received hello messages which will be later used for selecting best broadcasting vehicle for an emergency vehicle.

For selection process of broadcasting vehicles NIBS is based on slotted p-persistence scheme [4]. When vehicle receives message it checks the message ID and relative distance between sender and it self. When vehicle has turn to rebroadcast the message i.e. the slot from which it belongs to, it will rebroadcast the message unless the vehicle receives duplicate message during and before completion of its waiting time. In [16] it is mentioned that there are two major problems. There may be an empty slot without any vehicles when dealing with the sparse network and there may be too many vehicles converge on one slot while dealing with denser network, these cause collision and frequent collision leads to broadcast storm problem.

NIBS attempts to solve these problems by tracking the number of vehicles behind itself at time of emergency message to transmit. It keep tracks the number of vehicle behind itself by looking up the position of the vehicles in neighbour table. When source vehicle transmit the message it contains message ID and total number of vehicles behind itself. Receiving vehicle check message ID and total number of vehicles contained in the message, it discards the message if message ID is duplicated, else vehicle will count the total number of vehicles between itself and source vehicle using neighbour information table. It counts the difference between number of vehicles between itself and sender calculated and number of vehicles in message and determines the furthest order from source vehicle. Using these order it calculate its own waiting time to rebroadcast message. For *n-th* furthest vehicle waiting time function is

$$t = (n-1) * \tau$$

In the function τ is WAIT_TIME prior to rebroadcasting. Vehicle will rebroadcast the message on *t* if it not overhears the same message from other vehicle.

5) Density Aware Broadcasting:

Density aware broadcasting scheme (DABS) [17] is basically intended to use neighbour vehicle density to eliminate broadcast storm problem. DABS also attempts to resolve an issue of propagation delay. As mentioned in [18] that due to hidden node terminal problem vehicles does not able to receive message which are in one-hop range. Therefore message has to broadcast in multi hop fashion.

DABS assumes that vehicles with certain or higher power than threshold power RxTh have the same radio range of *R* meter and as vehicles within radio range *R* has the higher probability to receive broadcast packet successfully than the vehicle outside radio range *R*. For maximizing probability and reliability of packet reception DABS categories vehicles which are outside range *R* but not farther than *2R* from sender will be considered as hidden terminal. When any hidden terminal starts transmitting during the transmission of sender, it will cause reception in some node in range *R* to fail. This problem can be solved by maximizing the communication range *R* under predetermined degree of interference.

In DABS authors considers only those neighbour vehicles which are in need of broadcast message for calculating waiting time. Which will results in reduced waiting time and overall delay. Each vehicle exchange periodic beacon message to keep track of local topology. When an emergency situation arise vehicle initialize list with name N. List N includes neighbour vehicles which are considered in need of emergency message. Each vehicle has waiting time before broadcasting message. Function for calculating vehicle waiting time is

$$T_w = \frac{\left[\left\{1 - \frac{min(R_{rss}, R_{max})}{R_{max}}\right\}\left\{\frac{\lambda_s}{\lambda_{S_{max}}}\right\}\tau\right]}{N}$$

To reach message at range Rmax it takes time τ twice to the packet's transmission *2T* plus propagation delay time δ, can be mentioned as $\tau = 2T + \delta$. $\lambda_{S_{max}}$ is maximum vehicle density in jammed traffic scenario. Vehicles will have less waiting time in less dense network as author incorporated density for calculating waiting time.

6) Reliable method for Safety Information Dissemination:

As VANET is dynamic in nature, frequent disconnection over network topology is characteristics of VANET. This cause difficult to VANET technology to be reliable practically. Reliable method for safety information dissemination (RMSID) [19] attempts to increase the reliability of VANET network when frequent disconnection problem arise due to fragmentation in the network. In order to avoid collision and contention problem method assign a different delay and waiting to each vehicles before they rebroadcast emergency message by knowing vehicle's own position and distance between itself and sender. Waiting time calculation function is same as the EDB scheme.

$$WT = \left(1 - \frac{d}{R}\right) maxWT$$

After rebroadcasting of emergency message the vehicles between main sender and relay upon receiving of duplicates simply discards the duplicate message.

Broadcasting of emergency message in network fragmentation can be diminished by connectivity holes, results in unreliability and interrupt in forwarding process. To overcome with this problem first step is to detect the connection hole from network. Basically relay node keep stores the message which has been forwarded until waiting time expires or until it hears duplication of the same message by next relay node. If vehicle does not receive duplicate message rebroadcast by next rely node it is possible there is chance of network to be fragmented. If situation occurs than vehicle keep transmitting a small control packets includes its id and position till it finds next relay node. In the case when message life time reached but next relay node is not detected that this process will be stopped.

7) Simple and Robust Dissemination Protocol:

In simple and robust dissemination protocol (SRD) [20] it attempts to deal with the problem of broadcast storm problem and frequent disconnection in sparse as well as dense network. Unlike most of multi-hop broadcasting scheme SRD protocol assigns message forwarding responsibility to multiple vehicles rather than single one. SRD method improves store-carry-forward mechanism which provides high delivery ratio and low propagation delay even when network has fragmentation issue.

Message forwarding method in this protocol is switching depending upon the network whether it is denser or sparse. In dense network message forwarded by minimum number of vehicles using broadcast suppression technique [4], [21]. In sparse network it switch to store-carry-forward communication model technique. Which is employed to forward the message whenever multi-hop connectivity with vehicle is not available.

SRD use exchange of periodic message aimed at each road direction to determine whether vehicle is cluster tail or not. For suppression technique SRD use slotted 1-persistance protocol [4] with some alteration for guaranteed equal distribution of vehicle among assigned time slot with an additional delay in each time slot to reduce occurrence of collision. Time slot assignment function using altered slotted 1-persistance is as

$$T_{S_{ij}} = (S_{ij} \times st) + AD_{ij}$$
$$S_{ij} = \lfloor NS \times (1 - PD_{ij}) \rfloor$$

In the function $T_{S_{ij}}$ is time slot calculated for slot number S_{ij}, *st* is the value larger than one-hop, transmission and propagation delay and AD_{ij} is additional delay to differentiate the broadcasting, *NS* is number of time slots utilized respectively, PD_{ij} is percentage distance between vehicles with estimated radio range *R*, which can be calculated as

$$PD_{ij} = \left\lfloor \frac{min(D_{ij}, R)}{R} \right\rfloor$$

D_{ij} is the relative distance between sender vehicle *i* and receiver vehicle *j*, *R* is transmission range in the given function.

In the tail state of SRD protocol a vehicle stores the message and forwards it with modification flag *FromTail*. Thus it concludes store-carry-forward mechanism. If message is not in tail state than vehicle use modified slotted 1-persistance method to forward the message.

C. Virtual Backbone Based Clustering:

As VANET has no physical backbone for routing the emergency message, though a virtual backbone can be constructed in VANET and this backbone can act as a virtual network for routing of messages [22]. In this section we see a VANET message dissemination method that creates a virtual backbone and use set of nodes to propagate the emergency message over a network.

1) Applying Connected Dominating Set:

In [22] it is mentioned that to overcome the limitations of the VANET like flooding or broadcast storm and increase scalability particular nodes can be selected as relay nodes for forwarding responsibility of message. The selection of those particular nodes in VANET is difficult task. Cluster network infrastructure can created to choose that relay node

A connected dominating (CDS) set is graph G with set of nodes S if every node not in S is adjacent to some node in S and subgraph induces by S is connected [23]. CDS can be act and used as a backbone of network for broadcast the message. For creating a CDS node requires two-hop neighbour knowledge to decide whether or not it is in dominating set and the construction of set will be distributed since topologies changes frequently and dynamically also, there is no central management. Assuming VANET as a graph G with vehicles V and set of links between vehicles E.

$$G = (V, E)$$

A CDS can be defined in this graph G as $V' \subseteq V$ if for each node $u \in V$, u is either in V'or there exist some v so, $v \in V$ such that $u, v \in V$ and subgraph include by V', i.e. $G' = G(V')$ is connected.

Efficiency of CDS based broadcasting is depending upon method of finding the CDS. In this method only dominator will retransmit broadcast packets. In fact vehicle itself will decide whether to be dominator of CDS or not by exchanging periodic beacon message to acquire neighbour vehicle information.

CDS formation is done by marking process [24] which marks each vehicle in VANET graph G = (V, E). Vehicle v in G can decide them whether or not to mark themselves based upon neighbour information. Initially each v in V is unmarked. After exchanging neighbour information N(V) with vehicles in their transmission range r, they maintain neighbour set of vehicles

$$N(v) = \{u \mid \{v, u\} \in E\}$$

Each v is marked if there exist two unconnected neighbour and these marked v is included in different set called marked vertices V'. For rebroadcasting of message only those marked vertices will now forward the packets i.e. nodes in set V' will only allow to rebroadcast the packets. Other vehicles will only receive the packet. Thus creation of virtual backbone can help to reduce the problem of packet collision in VANET. Though it has disadvantage over some existing method that, number of vehicles in dense network will may cause problem in formation in backbone and more number of vehicle in CDS will be redundant in terms of message forwarding. This problem can be overcome by applying further optimization in selection of CDS node and reducing number of rely nodes.

III. ANALYSIS OF EXISTING PERFORMANCE METRICS

In the most of case of any protocol that existing they thoughtfully evaluated in favour of any one metric because its performance are presented their while other are ignored. Instead of discussing only those of metrics we will discuss that are commonly used and existed as an issue from the point of VANT research.

Most common interest of VANET research is one that, how fast information can be propagated, second is how frequent can packets duplicated and the last is how far packet can be spread. So from this we can identify most common metrics performance metrics are time, frequency and distance respectively. Formally performance metrics can be categorized in four domain frequency, space, time and mixed. We can evaluate our performance using these domain.

Frequency domain includes metrics redundancy rate which is a ratio of no. of duplicate packet by no. of source packet. Redundancy is key performance indication of any broadcasting protocol as is should be set least as possible for good protocol. Forward packet ratio which is ratio between no. of vehicles forwarding the packet and no. of vehicles in network, which measure portion of vehicle in network that rebroadcast the packet.

Broadcast overhead is ratio between no. of duplicates packet vehicle received by vehicle and no. of vehicles in defined zone, calculates the duplicated packets in network. Delivery ratio or success ratio metric of frequency domain is ratio between no. vehicles receiving broadcast packet and no. of vehicles reachable by pure flooding, which measures proportion of vehicles that successfully receives the broadcast packet. Collision ratio which measures the rate of collision occurrence defined as ratio between no. of collision packet and no. of transmitted packet.

The metrics in space domain measures basically how far packet can propagate in network. Metrics in space domain are propagation distance is difference between packet last position and initial position which is also distance between origin of packet and last point where it received. One-hop progress metric is difference between position of next broadcast vehicle and position of current transmitter. Number of hop propagated metric is calculation of hops that packet can traverse in network.

Time domain in VANET measures a time required to propagate packet. Different metrics of time domain are, end-to-end delay or propagation time and rebroadcast latency which is difference between packet received at specific point and instant at which packet is originated for end-to-end delay metric. Rebroadcast latency is difference between instant the packet received by next vehicle and instant the packet is received by current vehicle, which calculates the time until packet received successfully by next vehicle.

Propagation speed or dissemination speed is also an important metric that calculates the packet propagation rate by ratio between propagation distance and propagation delay.

IV. SUMMERY AND CONCLUSION

This paper explains different emergency message broadcasting protocols and techniques in VAENT. The main focus of designing these broadcasting protocols is in decreasing the excessive rebroadcast of packets. In particular with multi-hop broadcasting it can be overcome by either probabilistic assignment function or by delay assignment function. Many factors attempt to interfere in performance of these protocols as waiting delay time adjustment, rebroadcast probability based on vehicle location, vehicle density, propagation delay which should be adjusted to improve the performance of protocol.

It is quietly difficult to compare the existing performance metrics of protocols, reason behind these is that this metrics are not still unified metric that can measure overall performance of each existing protocol. In order to increase efficiency of the designed protocol one should consider that packet should broadcast farther with less redundancy and with higher rate of success.

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