EFFICIENT BROADCASTING MECHANISMS FOR DATA DISSEMINATION IN VEHICULAR AD HOC NETWORKS

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ABSTRACT

Broadcasting is the process of sending a message from one node to all other nodes in an ad hoc network. It is a fundamental operation for communication in ad hoc networks as it allows for the update of network information, route discovery and other operations as well. In this paper, we review the pros and cons of different broadcasting methods in VANET. Also, the broadcast storm problem and broadcast suppression techniques for broadcasting in Vehicular Ad hoc Networks (VANET) are discussed, because blindly broadcasting the packets cause several problems that affect the quality of service in VANET. In order to avoid broadcast storm problem this paper provides a survey of some of the existing broadcast suppression techniques in vehicular environment.

KEYWORDS

Broadcasting, VANET, Broadcast Storm Problem, Broadcast Suppression Techniques.

1. INTRODUCTION

Broadcasting in Vehicular Ad Hoc Networks (VANET) is a technique especially to aid safety applications in VANET. The safety applications require an efficient data dissemination technique to broadcast the data to the vehicles on the road side environment. VANET safety applications include cooperative collision warning, intersection collision warning, cooperative driver assistance system, approaching emergency to vehicles etc., Also non-safety applications involve data transfer, traffic management applications, parking lot payment, and traffic information. The comfort applications include optimum route calculation with real time traffic data and applications for administration e.g. Vehicle identification also requires broadcasting.

Vehicular Ad Hoc Networks (VANETs) have been considered as an important communication infrastructure for the Intelligent Transportation Systems (ITS).In IEEE 802.11p, the Dedicated Short Range Communication (DSRC) is a core function and it is a US government project for vehicular network communication for the enhancement of driving safety and comfort of automotive drivers. DSRC-based communication devices are expected to be installed in future vehicles and to work with sensors in the vehicles to enhance road safety. The U.S. Federal Communication Commission (FCC) has allocated 75 MHz of spectrum at 5.9GHz to be used exclusively for vehicle communications. The overall bandwidth is divided into seven frequency channels. The channel CH178 is defined as the public Control Channel (CCH) for delivering the safety information and exchanging control packets among vehicles. The other six channels are Service Channels (SCHs) which support the transmission of non-safety applications.

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2. BROADCASTING IN VANET

Broadcasting in Vehicular Ad Hoc Networks (VANETs) has become an active area of research. VANET applications are inherently broadcast-oriented and require the underlying communication protocols to be reliable and scalable. On the other hand, the conventional broadcast mechanism may lead to broadcast storm problem which will heavily affect both the reliability and scalability of the protocols. In MANET [5] broadcasting occurs during route discovery or route maintenance, such as AODV route request hello messages but in VANET broadcast routing is commonly used in many safety critical ITS applications. The network disconnection problem for VANET is more severe than MANET due to high mobility caused by fast moving vehicles, sparse traffic densities during off-peak hours, and the limited market penetration rates of vehicles with equipped communication devices, especially in the initial stage. This disconnection time (on the order of a few seconds to several minutes) makes MANET protocols such as AODV unsuitable for VANETs. Hence, new network protocols are necessary to improve broadcasting in dense networks and routing decisions in sparse networks.

In dense networks, a pure flooding scheme results in excessive redundancy, contention, and collision rates causing problems in transmissions, referred to as the broadcast storm problem. Such problem is tackled with broadcast suppression techniques. When the traffic density is above a certain value, one of the most serious problems is the choking of the shared medium by an excessive number of the same safety broadcast message by several consecutive cars. In sparse network vehicles may face network disconnections when the transmission range employed cannot reach other vehicles farther in the direction of interest [9]. In such scenarios, protocols should also incorporate a store-carry-forward mechanism to take advantage of the mobility of vehicles to store and relay messages until a new opportunity for dissemination emerges. In such cases routing and broadcasting becomes challenging task.

In [1] the broadcast storm problem in VANET is discussed using a case study for a four-lane highway scenario which can provide 100% reach ability in a well-connected network and up to approximately 70% reduction in the broadcast redundancy and packet loss ratio. The proposed schemes are distributed and rely on GPS information (or Received Signal Strength when the vehicle cannot receive GPS signal), but do not require any other prior knowledge about network topology.

In [2], a performance evaluation of broadcast routing protocol and the deployment of RSUs inside the vehicular networks are discussed. Increasing the density of vehicles inside the network causes an increase in throughput. Moreover, including RSUs, the end-to-end delay is decreased and at the same time, the network throughput shows a better result. However, an extended number of RSUs has a negative impact on energy consumption in the VANET.

Optimized broadcast mechanisms reduce the level of redundancy during a broadcast, thereby reducing the broadcast storm problem. A broadcast transmission may be lost due to packet corruption, packet collision, or hidden node transmissions. Therefore, it is possible that even intended nodes may not receive a broadcast transmission. This is especially true in the case of optimized broadcast mechanisms, where a packet may be lost and a broadcast may not propagate due to reduced redundancy [4].

2.1 Broadcasting Requirement Analysis

Any broadcasting techniques for VANET should satisfy the following requirements:

- **Scalability**
  The broadcast protocol has to cope with any increase in the traffic density like traffic jams also ensuring correct operation of safety applications in such scenarios**.**
- **Effectiveness**
  The broadcast protocol has to assure that all nodes (or a percentage of nodes, defined by the application) in the destination region receive the disseminated information.
- **Efficiency**
  The broadcast protocol needs to eliminate message redundancy due to limited bandwidth. This is achieved by minimizing the forwarding rate, but still assures the reception of a message by all nodes in a specific geographic region.
- **Dissemination delay**
  Safety applications require the immediate relaying of information, without the introduction of any delay.
- **Delay-tolerant dissemination**
  It is desirable to cache information in frequent partitioning scenarios and propagate them later when new vehicles are available in the vicinity. Otherwise important information can be lost when the network in the destination region is not fully connected.
- **Robustness**
  The broadcast has to cope with packet losses in order to assure the correct function for vital safety applications.

3. BROADCASTING METHODS

Broadcasting refers to the operation of disseminating a piece of information from one node to other nodes in the network. The challenging issues in broadcasting are suppression of multiple warnings for the same event and determination of appropriate boundaries for message propagation. In vehicular networks [8], reducing message flooding in broadcasting is important to increase the reliability of disseminating safety messages to other vehicles. The following section shows the different broadcasting methods including probabilistic-based, counter-based, distance-based, location-based, cluster-based, traffic-based and neighbor knowledge based flooding schemes.

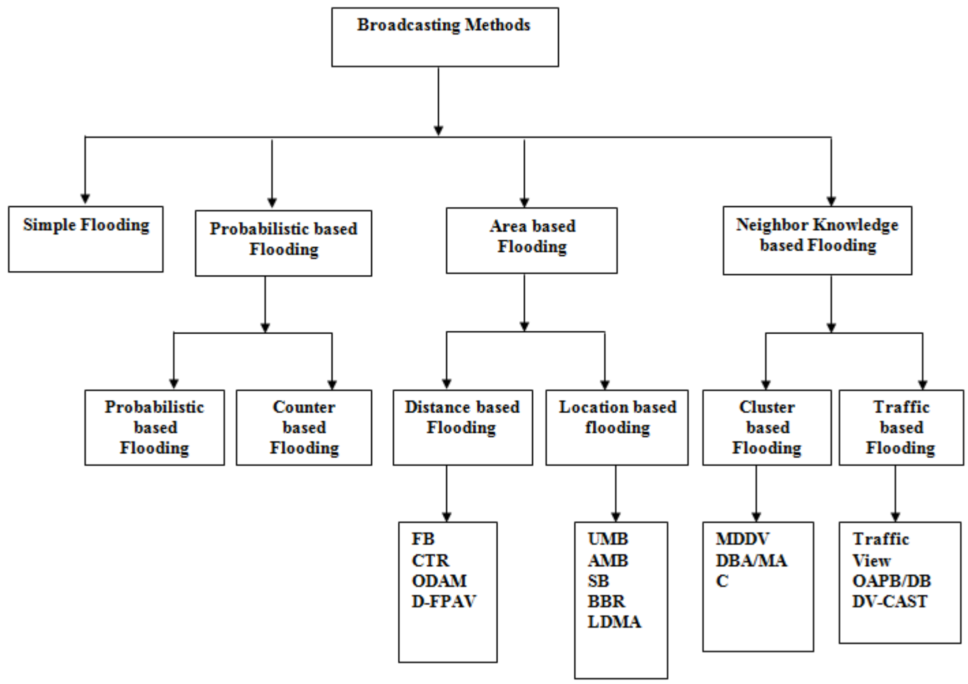

Figure 1: Taxonomy of Broadcasting Methods in VANET

3.1 Simple Flooding

Broadcast forms the basis of all communications in Vehicular ad hoc networks. The simplest form of broadcast is referred to as blind flooding. In blind flooding, a node transmits a packet, which is received by all neighboring nodes that are within the transmission range. Upon receiving a broadcast packet, each node determines if it has transmitted the packet before. If not, then the packet is retransmitted. This process allows for a broadcast packet to be disseminated throughout the ad hoc network. Blind flooding terminates when all nodes have received and transmitted the packet being broadcast at least once. As all nodes participate in the broadcast, blind flooding suffers from the Broadcast Storm Problem [4]. Blind flooding is extremely costly and may result in the following:

- **Redundant rebroadcasts:** It occurs when a node decides to rebroadcast a message to its neighbors; however, all neighbors have already received the message. Thus the transmission is redundant and useless.
- **Medium contention**: It occurs when neighboring nodes receive a broadcast message and decide to rebroadcast the message. These nodes must contend with each other for the broadcast medium.
- **Packet collision:** Because of the lack of the back-off mechanism, RTS/CTS dialog, and the absence of CD, collisions are more likely to occur and result in lost or corrupted messages.

3.2 Probabilistic-based Flooding

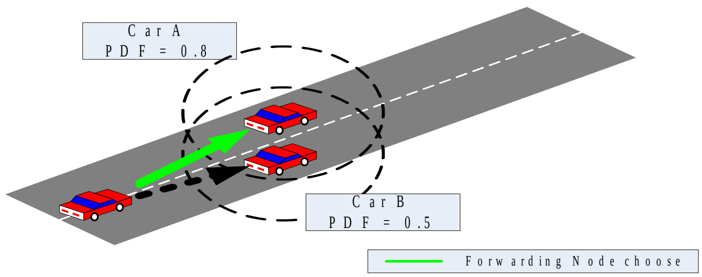

Figure 2: Probabilistic Flooding

In probabilistic-based scheme, messages are broadcast with a given probability ‘p’ and in many cases this probability is based on the protocol’s back-off timer. In this method the redundant retransmission is reduced but it will reach a lower number of destinations, depending on which nodes randomly decide to forward the packet. In [14], the probabilistic scheme predetermines a probability for every node and nodes will rebroadcast the received packet with the predetermined probabilities. When the probability is 100%, the scheme is equivalent to simple flooding. In the Receipt Estimation Alarm Routing (REAR) protocol [8], nodes that relay broadcast messages are selected by estimating the number of messages received. This is computed based on the received signal strength and packet loss rates for packets that nodes receive and this information is exchanged with neighboring nodes using heartbeat messages. Hence, nodes with higher delivery ratios are likely candidates to flood messages in the network. This reduces redundant broadcasting to nodes that have a higher probability of contention conflict with other nodes. REAR is based on the Manhattan mobility model for urban areas and a highway scenario with bi-directional single lane traffic.

It is further divided into two types:

- Simple Probabilistic Flooding
- Counter based Flooding scheme.

3.2.1 Simple Probabilistic based Flooding

In this method, the decision of rebroadcast is based upon a random probability. This probability may be as simple as flipping a coin or it may be more complex involving probabilities that include parameters such as node density, duplicate packets received, battery power, or a node’s participation in the network. Probabilistic schemes are simple methods for dense environments to mitigate broadcast storm problem in broadcasting. A basic probabilistic scheme is p-persistence scheme, where each node retransmits the packet with a predetermined probability p and this approach is referred to as probabilistic flooding. The selection of p is the main problem in this scheme but in [6] assistant location information is proposed with weighted p-persistence broadcasting (WPB). It is a classic probabilistic scheme and the assistance of location information makes WPB rational. They calculate the probability by using distance between receiving node and transmitting node to divide the average transmission range.

3.2.2 Counter based Flooding

When a broadcast begins, several nodes will rebroadcast the same packet, so one node will receive the same packet several times. Each node will count the number of times that a packet is received during a random period. Then nodes will compare the number with predetermined thresholds to decide whether to rebroadcast the packet or just drop it. The advantage of this scheme is that, the nodes need not know the structure of the network as well as no need to exchange neighbor's knowledge (suits VANET temporary environment). But it will increase the delay because every node should wait for a period of time [14]. An expected additional coverage function may be defined, which shows that the more number of times a host has heard the same broadcast packet, the less additional coverage the host contributes if it rebroadcasts the packet. This scheme eliminates many redundant rebroadcast when the host distribution is dense.

3.3 Area-Based Flooding

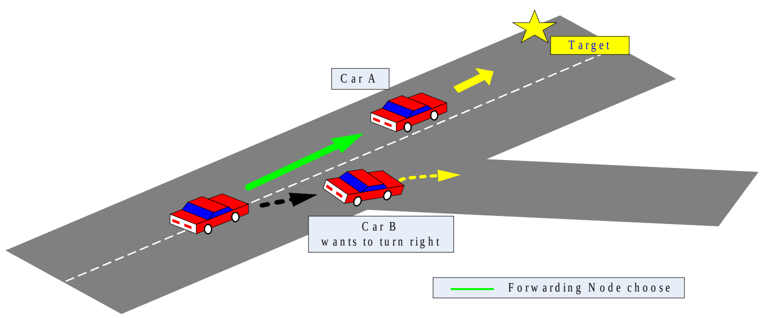

Figure 3: Area-Based Flooding

In area-based methods, messages are broadcasted based on the geographic area of the transmitting and receiving vehicle locations.

It is further divided into two types:

- Location-based flooding
- Distance-based flooding schemes.

The area based methods are feasible for VANETs because vehicles are the nodes in the network and equipped with GPS to receive the information, it is easy to get vehicles' geographic information through GPS. However, the determination of threshold is too difficult when the value is too small and the reliability can't be guaranteed when value is too big [14].

3.3.1 Location based Flooding

Location based flooding scheme aims to spread a message only to a specific geographic region and can be added to any other policies to meet that requirement. The nodes evaluate the additional coverage area based on their location, if the additional coverage area is less than a threshold, the node will not rebroadcast the packet. Some of the location based flooding schemes as discussed in [14] are listed below:

The Urban Multi-Hop Broadcast (UMB) is a location based protocol, which uses a combined approach to broadcast messages in an urban road network. For two-directional roads, it selects the node that is farthest away (MFR) as relay node using the black-burst method. When a vehicle enters the intersection, UMB uses fixed repeaters to disseminate messages to all directions except that of the originating source.

Ad-Hoc Multi-Hop Broadcast (AMB) protocol is an enhancement to UMB that does not require repeaters (infrastructure-less). Here, the node closest to the intersection position is nominated as the relay node for broadcasting. Both UMB and AMB use a custom built Wireless Simulator modeling the Medium Access Control (MAC) and Physical Layer of 802.11b.

Smart Broadcast (SB) is similar to UMB but uses a different back-off timer scheme based on the sender and receiver node distance. Border node Based Routing (BBR) elects only the edge nodes to rebroadcast messages. The edge node provides better coverage in sparse networks and is determined based on minimum common one-hop neighbors between the broadcasted nodes.

Finally, *Location Division Multiple Access (LDMA)* is a MAC scheme that ensures bounded delay for multi-hop vehicular networks. This scheme is the best choice because it can eliminate most redundant rebroadcasts under all kinds of host distributions without compromising reachability.

3.3.2 Distance based Flooding

In this scheme, nodes use the relative distance to make the decision. The longer the distance between the receiving and sending node the larger is the additional coverage. So the nodes whose distances to the senders are bigger than the threshold will rebroadcast the received packets [14].Each node is equipped with a GPS device or is able to determine signal strength of a neighboring node. Given the distance or location of broadcasting nodes, it is possible to calculate the expected additional coverage (in terms of area) a node may contribute by rebroadcast.

In [8] Rex Chen et al. explains the following four distance based protocols:

Fast Broadcast (FB) is a distance-based protocol that minimizes forwarding hops when transmitting messages. It contains two components, the estimation and broadcast phase. In the estimation phase, the protocol adjusts the transmission range using heartbeat messages to detect backward nodes. In the broadcast phase, it gives higher priority to vehicles that are farther away from the source node to forward the broadcast message.

The Cut-Through Re-broadcasting (CTR) also gives higher priority to rebroadcast alarm messages to farther vehicles within transmission range but operate in a multi-channel environment.

Optimized Dissemination of Alarm Message (ODAM) has a “defer time” to broadcast messages. This is computed based on the inverse proportional distance between receiver and source node. For ODAM, broadcast messages can only occur within risk zone area, determined with a dynamic multicast group based on vehicles’ proximity with the accident site. The advantage of this protocol is minimizing hop counts and its drawback is lower reception rates (delivery ratio) due to loss in radio power from longer propagation distances.
Distributed Fair Transmit Power Assignment for Vehicular Ad Hoc Network (D-FPAV) describes a scheme that provides fairness in broadcasting heartbeat messages by dynamically adjusting

every node's transmission power based on distance to other neighboring nodes. The method enables all nodes to share the channel capacity fairly when power control mechanism is well explored. This scheme has higher reachability than the counter-based scheme, but the amount of saving (in terms of the number of saved re-broadcasts) is not satisfactory.

3.4 Neighbor-Knowledge-based Flooding

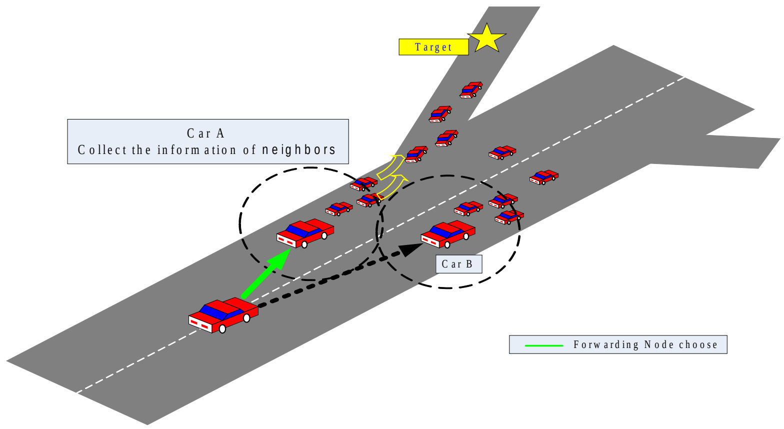

Figure 4: Neighbor-knowledge-based Flooding

In this method, most protocols require nodes to share 1-hop or 2-hop neighborhood information with other nodes [8]. This is particularly not suitable in vehicular environments, since such information can quickly become outdated due to the high speed of vehicles. In addition, adding neighborhood information to periodic messages results in high network overhead.
It is further divided into the following:

- Cluster based
- Traffic based flooding

3.4.1 Cluster based Flooding

Clustering [4] is the process of grouping nodes together into clusters (groups). A representative of each cluster is called the cluster head. Nodes that belong to a cluster, but are not the cluster head, are called ordinary nodes. Often nodes may belong to more than one cluster. These nodes are called gateway nodes. Only cluster head nodes and gateway nodes are responsible for propagating messages. Clustering is used as an optimized flooding mechanism, whereby only cluster heads and gateways rebroadcast messages. The cluster heads ensure reliable delivery of the message to those nodes belonging to their cluster. The process of forming clusters may be either active or passive.

In Active Clustering, nodes must cooperate in order to elect cluster heads. This is achieved through periodic exchange of control information. The formation of clusters in active clustering is independent of the background data traffic.

In Passive Clustering, cluster formation is dependent on background data traffic. Therefore, passive clustering will not form clusters until there is background traffic. Because in passive clustering, the flow of data traffic is used to propagate cluster control information and collect neighbor information through promiscuous packet reception. Passive clustering is beneficial in that it utilizes the existing data traffic to form clusters.

The two cluster based backbone mechanism for the dissemination are: *static and dynamic* backbone. The static backbone is created using a source-independent connected dominating set. The dynamic backbone is created using a source-dependent connected dominating set. Two important protocols discussed in [8] that comes under the clustering scheme are given below:

Mobility-Centric Data Dissemination Algorithm for Vehicular Networks (MDDV): It reliably forwards messages in complex traffic networks, that include high vehicle mobility in high and low density areas. It partitions vehicles into groups based on common travel routes (geographic and trajectory-based) and runs a localized broadcast routing algorithm to continuously forward messages to the head node in the cluster pack and moves closer to the intended destination. The performance of this routing protocol depends on the market penetration rate of vehicle-to-vehicle communication and road traffic density, which is affected by the time of day with its realistic movement traces.

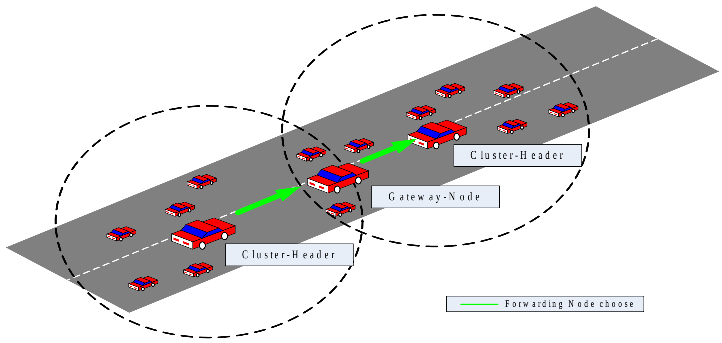

Figure 5: Cluster based Flooding

Dynamic Backbone-Assisted MAC (DBA-MAC) is a cluster-based broadcast mechanism for message propagation based on cross-layer intersection in the MAC. For a group of interconnected vehicles, higher priority nodes within the cluster are considered backbone members and are able to broadcast messages. The process of choosing backbone nodes within the cluster occurs periodically by selecting nodes that are farther apart to minimize hop count [8].

3.4.2 Traffic based Flooding

The Traffic View [8] protocol is a part of the broader e-Road project with the goal of building a scalable and reliable infrastructure for IVC systems.

In *Traffic View*, the message contains information on a list of vehicle IDs and its own vehicle position, vehicle speed, and broadcast duration time. Traffic View conserves bandwidth and deals with flow control of broadcast messages by aggregating multiple data packets based on relative vehicle distances and message timestamps. For example, two vehicles on the same highway lane traveling with similar speeds will have similar vehicle positions and vehicle trajectories. Hence, when updated information on vehicle positions are available, vehicle speeds may not be necessary. Two protocols under this category are listed below:

The Optimized Adaptive Probabilistic Broadcast and Deterministic Broadcast (OAPB/DB) protocol uses an adaptive approach to rebroadcast emergency warning messages by considering the incident zone area and local vehicle density with periodic heartbeat messages of vehicles that are within two-hops of distance. The mobility scenarios includes uniform traffic with two road lanes.

Distributed Vehicular Broadcast (DV-CAST) uses local one-hop neighbor topology to make routing decisions. The protocol adjusts the back-off timer based on the local traffic density, and compute forward and opposing direction connectivity with periodic heartbeat messages. Moreover DV-CAST is adaptive to the totally disconnected network and can temporarily wait-and-hold a packet until the vehicle hears heartbeat messages from other vehicles.

4. BROADCAST SUPPRESSION TECHNIQUES

The broadcast suppression technique reduces bandwidth utilization and broadcast storm problem. The basic broadcast techniques follow either a 1-persistence or a p-persistence rule. Due to the excessive overhead, most routing protocols designed for multi-hop ad hoc wireless networks follow the following rules:

- *The brute-force 1-persistence flooding rule:* It requires that all nodes rebroadcast the packet with probability 1 because of the low complexity and high packet penetration rate.
- *Gossip-based approach follows the p-persistence rule*: It requires that each node re-forwards with a pre-determined probability p. This approach is sometimes referred to as probabilistic flooding [5].

In both schemes, repeated reception of the same message or any expired messages should be ignored by broadcasting nodes in order to avoid inevitable service disruptions due to network saturation. In [13] to effectively reduce the broadcasts, the node should be able to identify the message that needs to be relayed or rebroadcasted opposed to the messages that appear to be legitimate initial broadcast. The identification can be done before the rebroadcasting is done. This can be done by keeping the nodes information on what message/broadcast is prevalent and relevant for that sector. Message identification is done by tags. Since tags are exchanged periodically at a predetermined frequency every node can be made aware of the latest broadcast message.

Broadcast suppression techniques have the following benefits:

- Needs no neighbor information
- Needs no control messages
- Maximizes distance per hop
- Minimizes packet loss

It calculates the value of probability by using the distance between receiving node and transmitting node to divide the average transmission range [14].

The following approaches are used to suppress the broadcast storm problem:

- Node receives message, estimates distance to sender
- Selectively suppresses re-broadcast of message
- Use p-persistence and 1-persistence rules

The following equations shows the calculation of probability for GPS based and RSS based system [16]:

- Estimate distance to sender as $0 \le \rho ij \le 1$
- Global Positioning System (GPS) based system

$$P_{ij} = \begin{cases} \dfrac{D_{ij}}{R} & \text{if } D_{ij} < 0 \\ & \text{if } 0 \le D_{ij} < R \text{ (approx. transmission radius)} \end{cases}$$

where $0 \le p_{ij} \le 1$

- Received Signal Strength (RSS) based system

$$P_{ij} = \begin{cases} \dfrac{RSS_{\max} - RSS_x}{RSS_{\max} - RSS_{\min}} & \text{if } RSS_x < RSS_{min} \\ & \text{if } RSS_{min} \le RSS_x < RSS_{max} \end{cases}$$

where $0 \le p_{ij} \le 1$

Yun-Weilin et al. in [3] demonstrates that the broadcast storm problem causes serious packet collisions and packet losses when too many vehicles simultaneously broadcast messages in a VANET. They propose, three distributed broadcast suppression techniques:

- Weighted p-persistence scheme
- Slotted 1-persistence scheme
- Slotted p-persistence scheme

These schemes are discussed below and shown in fig.6

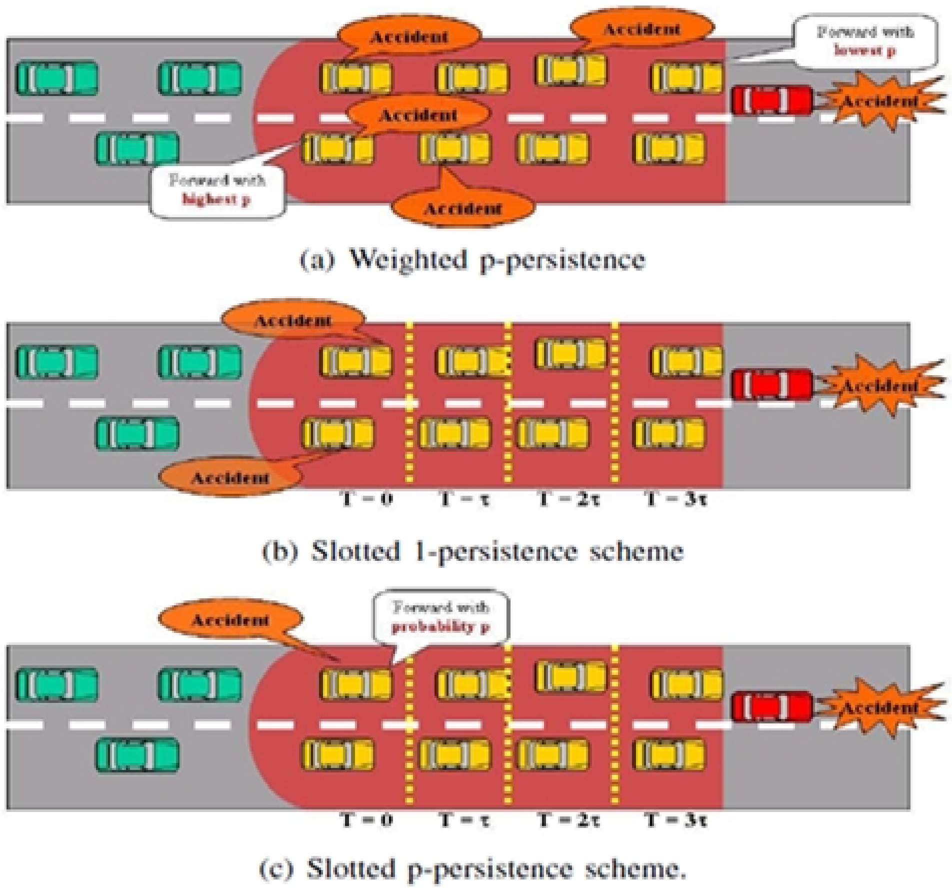

Figure 6: Broadcast Suppression Techniques [14]

4.1 Weighted p-persistence scheme

Rule: Upon receiving a packet from node i, node j checks the packet ID and rebroadcasts with probability p_{ij} if it receives the packet for the first time; otherwise, it discards the packet.

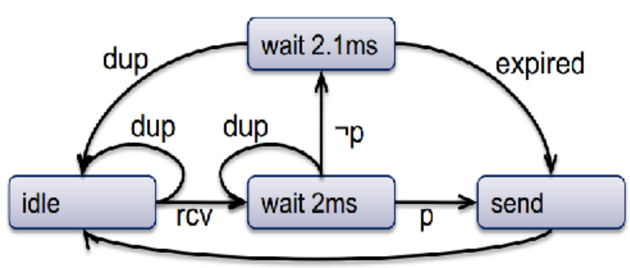

Figure 7: Weighted p-persistence with waiting time 2ms

- Probabilistic flooding with variable p_{ij} for re-broadcast
- Higher probability for larger distance per hop
- Wait WAIT_TIME (e.g., 2 ms)
- choose $p=\min(p_{ij})=\min(\rho_{ij})$ of all received packets (Probability for re-broadcast of packet)
- Ensure that at least one neighbor has re-broadcast packet

4.2 Slotted 1-persistence Scheme

Rule: Upon receiving a packet, a node checks the packet ID and rebroadcasts with probability I at the assigned time slot $T_{s,j}$ (after packet reception) if it receives the packet for the first time and has not received any duplicates before its assigned time slot; otherwise, it discards the packet.

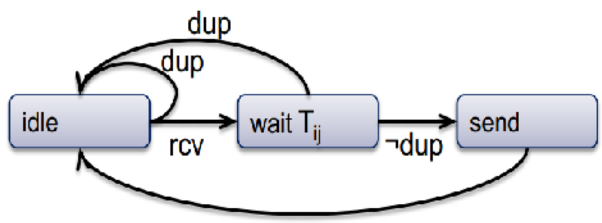

Figure 8: Slotted 1-persistence

- Suppression based on waiting and overhearing
- Divide length of road into slots
- More distant slots send sooner
- Closer slots send later (or if more distant slots did not re-broadcast)
- Higher probability to transmit over longer distance
- Divide "communication range" into N_s slots of length τ
- Nodes wait before re-broadcast, waiting time $T_{ij}=\tau\times[N_s(1-\rho_{ij})]$
- Duplicate elimination takes care of suppression of broadcasts

4.3 Slotted p-persistence Scheme

Rule: Upon receiving a packet, a node checks the packet ID and rebroadcasts with the pre-determined probability p at the assigned time slot $T_{s,j}$, if it receives the packet for the first time and has not received any duplicates before its assigned time slot; otherwise, it discards the packet.

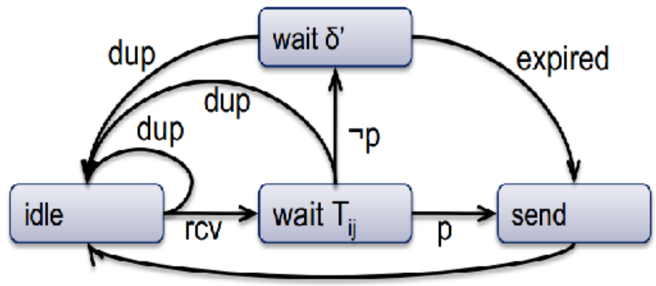

Figure 9: Slotted p-persistence

- Fixed forwarding probability p (instead of 1)
- Wait for T_{ij} (instead of fixed WAIT_TIME)
- Use probability p (instead of 1)
- Ensure that at least one neighbor re-broadcast the packet by waiting for $\delta' > \max(T_{ij})$

Unlike the p-persistence or the gossip based scheme, the weighted p-persistence assigns higher probability to nodes that are located farther away from the broadcaster given that the GPS information is available and accessible from the packet header. This is illustrated in Figure 6(a). From [5], in p-persistence case, the achievable performance depends on the pre-assigned probability p and the smaller the probability, the lower the link load. But small probability may also result in poor packet penetration rate in a sparse network. There is no benefit for using the re-forwarding probability in a very light traffic condition.

The time slot approach follows the same logic as the weighted p-persistence scheme but instead of calculating their-forwarding probability, each node uses the GPS information to calculate the waiting time to retransmit. For example, in Figure 6(b), the broadcast coverage is spatially divided into 4regions and a shorter waiting time will be assigned to the nodes located in the farthest region, i.e., farthest nodes broadcast immediately after reception, nodes in the next to last region broadcast T seconds after reception, etc. Hence, in the case where a node receives duplicate packets from more than one sender, it takes the smallest distance from node i and node j (D_{ij}). Similar to the p-persistence scheme, this approach requires the transmission range information in order to agree on a certain value of slot size.

At higher traffic density the re-forwarding probability should be set to at least 0.5 in the p-persistence case and 0.8 in the slotted p-persistence case in order to achieve at least 80% of the maximum performance. In two-dimensional network the routing overhead is reduced by a factor of 1-p in the p-persistence case and close to 70% in the slotted 1- persistence case. Although decreasing the re-forwarding probability p implies lower link load it leads to poor performance in both slotted and non-slotted p-persistence schemes.

5. EXISTING ALGORITHMS FOR OVERCOMING BROADCAST STORM IN VANET

While multiple solutions exist to alleviate the broadcast storm problem in a usual MANET environment [6], only few solutions exists to address the problem in VANET. In [11], three variables are utilized to mitigate the broadcast storm problem in VANET.

- Maximum Transmission Power P_t: Each vehicle can use this parameter to reduce the impact of the hidden terminal problem and achieve certain coverage percentage.
- Received Signal Strength (RSS): This can be used instead of the inter distance between the transmitter and the receiver in calculating the probability of retransmission.
- Vehicles Density λ_s: This is agreed upon from exchanged beacons.

Currently four popular algorithms for broadcast storm suppression have been proposed by different authors. They are:

1. The Last One (TLO
2. Adaptive Probability Alert Protocol (APAL)
3. Distributed Optimized Time (DOT)
4. Adaptive Broadcast Protocol (ABSM)

5.1. The Last One (TLO):

Kanitsom Suriyapaibonwattanaet al. in [3] proposes *The Last One (TLO)* broadcast method to reduce end-to-end delay and broadcast storm problem. They try to reduce broadcast storm problem by using probability to decide the vehicle that will rebroadcast alert message. When a vehicle receives a broadcast message for the first time, the vehicle will rebroadcast the alert message with a random probability. This method will help to reduce number of rebroadcasting vehicles and thereby the broadcast storm problem. This method could not fully ensure to avoid broadcast storm. It just reduces the chances of its occurrence. But this algorithm suffers when GPS provide incorrect information between 1-20 meters.

5.2 Adaptive Probability Alert Protocol (APAL)

In [10] Kanitsom Suriyapaibonwattanaet al. proposed *Adaptive Probability Alert Protocol (APAL)* rebroadcast protocol that use adaptive probability and interval to actuate rebroadcast. It could achieve best quality of performance compared to all other existing VANET protocols for safety alert message dissemination. The success rate of APAL protocol is high compared to different protocols. Loss of alert message problem cause low success rate. APAL changes interval and transmission probability adaptively to prevent alert message loss and could achieve highest success rate. Moreover it shows robustness of success in spite of increase in number of vehicles, and it remains near to 100%. For all other protocols, the success rate decreases rapidly with the increase in number of vehicles.

5.3 Distributed Optimized Time (DOT)

In [9] Ramon S. Schwartzthe et al. proposed *Distributed Optimized Time (DOT)* slot as a suppression scheme for dense networks. It solves scalability issues at each time slot by the presence of beacons, which are messages periodically sent by each vehicle containing information such as the vehicle's position and speed. The use of periodic beacons or hello messages has been sometimes avoided due to an increased network load.

The common approach to reduce broadcast redundancy and end-to-end delay in VANETs is to give highest priority to the mnost distant vehicles towards the message direction.

5.4 Adaptive Broadcast Protocol (ABSM)

In [7] Francisco et al. proposed an adaptive broadcast protocol called *ABSM* which is suitable for a wide range of mobility conditions. The main problem that a broadcast protocol must face is its adaptability to the very different vehicular arrangements in real scenarios. It should achieve high coverage of the network at the expense of as few retransmissions as possible, regardless on whether the network is extremely dense (e.g., big cities at rush hours) or highly disconnected (e.g., highways at night).

ABSM has turned out to be a very robust and reliable protocol. It extremely reduces the number of transmissions needed to complete a broadcasting task.

5.5 A Comparative Analysis of the above mentioned Storm Suppression Protocols are presented in the form of a Table below:

Broadcast Suppression Methods	Redundancy	End-to-End delay	Reliability	Robustness	Message Overhead	Scalability
Distributed Optimized Time(DOT) , 2012	√	√		√		√
Acknowledgement Based broadcast protocol ABSM ,2012			√		√	√
Adaptive Probability Alert protocol (APAL), 2009		√	√	√		
The Last One (TLO), 2008		√				
Weighted p-persistence	√					
Slotted 1-persistence						
Slotted p-persistence	√					

Table 1: Characteristics of Broadcast Storm Suppression Algorithms

(Note: √, denotes the characteristics of the protocol)

6. CONCLUSIONS

Most VANET applications favor broadcast transmission that addresses the broadcast storm problem to avoid unnecessary loss of information during dissemination. Emergency warning for public safety is one of the many applications that are highly time-critical and require more intelligent broadcast mechanism than just blind flooding. In this paper, the different types of broadcasting techniques in vehicular networks that addresses the broadcast storm problems in different traffic scenarios have been presented. The broadcast storm problem is the major challenging issue in VANET broadcasting because most VANET communications favor the broadcasting technique to disseminate data efficiently. In order to avoid broadcast storm problem, broadcasting suppression techniques are used in dense network and store-carry-forward technique used in sparse network. The broadcast protocol discussed work on different traffic regimes. In the absence of the GPS signal the existing algorithms can be modified to use RSS (Received Signal Strength) of the packet received to determine whether or not the packet should be retransmitted, but this approach is not efficient as GPS approach.

REFERENCES

1. Ozan Tonguz, Nawaporn Wisitpongphan, Fan Bai, Priyantha Mudalige and Varsha Sadekar, “Broadcasting in VANET,” in Proc. IEEE INFOCOM. 2008, pp. 1-6.
2. Francesco Lupi, Veronica Palma, and Anna Maria Vegni, “Performance Evaluation of Broadcast Data Dissemination over VANETs “ A Case Study in the City of Rome”, pp.1-4.
3. Kanitsom Suriyapaibonwattana and Chotipat Pomavalai,”An Effective Safety Alert Broadcast Algorithm for VANET,” IEEE 2008, pp.247-250.
4. Justin Lipman, Hai Liu, and Ivan Stojmenovic,”Broadcast in Ad Hoc Networks,” Springer-Verlag London Limited 2009, pp.121-150.
5. Ozan K. Tonguz, Nawaporn Wisitpongphan, “On the Broadcast Storm Problem in Ad hoc Wireless Networks,” IEEE 2006, pp. 1-11.
6. N. WISITPONGPHAN and O.K. TONGUZ,”Broadcast Storm Mitigation Techniques in Vehicular Ad Hoc Networks,” IEEE Wireless Communications, December 2007, pp.84-94.
7. Francisco Javier Ros, Pedro Miguel Ruiz and Ivan Stojmenovic, ”Acknowledgement-Based Broadcast Protocol for Reliable and Efficient Data Dissemination in Vehicular Ad Hoc Networks,” IEEE Transactions on Mobile Computing, Vol. 11, No. 1, January 2012, pp.33-46.
8. Rex Chen, Wenlong Jin and Amelia Regan, ”Broadcasting in Vehicular Networks: Issues and Approaches,” pp.1-7.
9. Ramon S. Schwartz et al. “Exploiting Beacons for Scalable Broadcast Data Dissemination in VANETs,” VANET’12, June 25, 2012 ACM, pp.1-10.
10. Kanitsorn Suriyapaiboonwattana, ChotipatPornavalai and Goutam Chakraborty, “An Adaptive Alert Message Dissemination Protocol for VANET to Improve Road Safety,” FUZZ-IEEE 2009, pp.1639-1644.
11. Khalid Abdel Hafeez, Lian Zhao, Zaiyi Liao, Bobby Ngok-Wah Ma, “A New Broadcast Protocol for Vehicular Ad Hoc Networks Safety Applications,” IEEE Globecom 2010 proceedings, pp.1-5.
12. Alexander Hamann, “The Broadcast Storm Problem,” Seminar: Ad Hoc Networks-2004, pp.1-39.
13. Aravind Srikumar, ”IBroadcast: Broadcasting scheme for vehicular ad hoc network,”,2010, pp.1-66.
14. L.Zhou, G.Cui, H.Liu, Z. Wu and D.Luo, “NPPB: A Broadcast Scheme in Dense VANETs,” Information Technology Journal 2010, ”pp.247-256.
15. Ai Hua Ho, Yao H. Ho, Kien A. Hua, “An Efficient Broadcast Technique for Vehicular Networks,” Journal of Information Processing Systems, Vol.7, No.2, 2011, pp.221-240.
16. “Vehicular Networks [C2X],” Computer and Communication Systems, [C2X] summer 2012, pp.1-37.