An Overview of Broadcasting Protocols for Relay Selection in VANETs

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Abstract: ***The Vehicular Adhoc Network (VANET) proves its efficiency in reliability and transmission of life safety messages to its neighbours during emergency situations. There are many protocols are available in broadcasting of alert messages. These protocols are categorized based on the techniques used for the communication namely beacon, handshake or instant broadcasting. Then these protocols are again subdivided into different criteria in making selection of next relay node in alerting appropriate neighbours. The relay node takes the responsibility to disseminate the safety message to the upper level within the transmission range. In this paper, we provide researchers with a clear suggestion of the benefits and drawbacks relate with each scheme.***

Keywords: Protocols, Multi - hop, Relay, Regime, Rebroadcast

1. Introduction

Vehicular Adhoc Network (VANET) is one of the branches of Adhoc Network which is a blooming research area in Networking that provide communication between vehicles on roads. It can either be supporting or safety information to the vehicle drivers. Based on the purpose of information it has been divided into two types of application namely *Comfort* and *Safety* Applications. Again Comfort application is classified into *Traffic* and *Infotainment* Application. The Traffic applications includes speed breakers, traffic signals, different condition of network either dense or sparse, number of lanes, bridges, different entry type like one way or two way or no way, check post etc. The Infotainment application contains petrol bunks, coffee shop, bakery, hospitals, hotels, restaurants, play station, browsing center, land marks, toilets, police station etc. whereas Safety applications represents road accidents, agitation, road block, road repair, signal repair, traffic jam, natural disasters like volcano eruption, flood, landslide, fire accident etc. This information are intimated by the road side unit or communicated between awareness vehicles to unaware vehicles. The cooperative collision warning system (CCWS) provide safety applications to issue awareness or warning messages to the respective vehicle drivers under particular environment. This helps them to avoid danger or take appropriate actions in case if it is cannot be avoided to save from risk or their lives.

In Safety application the dissemination of message is done through broadcasting. This method is otherwise called as flooding where all the nodes retransmit the message to all its neighbor nodes except the sender node. This achieves high reachability but consumes channel bandwidth utilization. On the other hand in Comfort applications perform two types of message routing one is *unicasting* and another *geocasting*. Unicasting stands for message transfer takes place between two far away vehicles and in geocasting, message dissemination are targeted to certain geographical area. But the goal of all broadcasting algorithms is to maximize the utilization of bandwidth by decreasing the number of rebroadcasts with high reachability and low end - to - end delay. The general structure of all broadcasting algorithms explains that the sender will broadcast the message to its nearest neighbours. In turn all the neighbours would accept and route the message to their surface - level. This methodology minimizes the selection of forwarders to deliver the message in the network. One assumption made in these protocols is the availability of GPS service.

There are five types of criteria in selection of next relay to forward the broadcasted messages further in the network. The list are specified below;

1) The furthest node
2) The best link quality node
3) Most demanding node
4) Probability based forwarding
5) Backbone node

In furthest node, the node which is far away from the sender but within the transmission range is elected as the relay node. This criterion will maximize the progress of the node and minimize the number of rebroadcast. Examples of such protocols are TRADE & DDT [3], UMB [9], SB [10], MHVB [13], MAC [4] and LW - RBMD [12].

The node having the best channel condition will be considered as the next relay broadcaster. The selection is based on the received power of the node and the distance between the sender and the receiver. This criterion node is reliable but tolerate from latency and overall end - to - end delay. Some protocols under this category are RBLSM [11] and REAR [5].

In this criteria, the endanger node is given as high priority is elected according to the latest time for the message received by certain node. For calculation purpose the nodes position and graph type problems are included. This will ensure the delivery of message on time but performing calculation is cumbersome. An example of such protocol is Multicast [6].
Protocols in this criterion will contain a fixed value called probability according to vehicle location and based on that forwarding of message will be done. This will reduce the

number of broadcasted message since only few nodes will participate in it. Examples of such protocols are OAPB [8], DV - CAST [7].

Some protocols assume the extant of environment or form a new type of network like cluster network. In this criterion the message is delivered to certain node either fixed node or cluster head node. Examples of such protocols are UMB [9], cluster based broadcasting schemes.

2. Survey on Different Vanet Broadcasting Protocols for Retransmission

1) Min - Te sun et al [3] suggests *TRAcking DEtection* (TRADE) protocol and *Distance Defer Transfer* Protocol (DDT) for next relay selection. These protocols use the furthest node as the next node selection. The main objective is to obtain 100% bandwidth utilization of channel. The TRADE protocol classifies the neighbours into different groups and picks few vehicles for retransmission. Whereas the DDT protocol insert defer time slots for each message to determine rebroadcast. The comparison is made with the traditional broadcast protocol. The difference between two protocols is exchange of GPS information in TRADE consumes bandwidth where no exchange is done in DDT which saves bandwidth. TRADE is suitable for straight road and DDT for curly roads. Finally TRADE obtains higher bandwidth utilization and DDT acquires higher reachability.
2) Yavuz Peksen et al [4] recommended *Media Access Control* (MAC) protocol for next node selection in Vanet. This approach uses furthest candidate for next rebroadcasting. The transmission range is divided into several small segments and then rules are applied to each other. One node has free medium and other nodes act as back - up nodes. The node not in bounded area is not responsible to relay packets. Whereas any node who has no neighbor node will take the next relay responsibility. The back - off time mechanism is used based on the information such as distance and speed.
3) Hao Jiang et al [5] developed *Reception Estimation Alarm Routing* (REAR) for selecting next forwarder in Vanet Broadcasting. This uses best link quality node as the next broadcaster. Estimate the receipt probability to obtain a reliable and efficient alarm message routing. A receipt probability is an estimation of *large scale loss* based on the distance between sender and receiver. The large scale loss is a combined form of *path loss* and *diffraction loss*. Disk graph is used for representing communication range. A node having a high receipt probability is selected for next relay. This protocol involves three approaches and three functions. The first approach is taking a complete set for reliability and the second approach is for propagation progress. Three functions are involved in calculating contention delay namely Inverse, Power and Exp function.
4) Alvin Sebastian et al [6] proposed Multicast Routing Scheme (MRS) for selection of next relay candidate in transmission of life safety message. This approach uses the most demanding node for rebroadcasting the message. One of the multicast routing problems is delay - constrained minimum Steiner tree problem (D - CMST). The main objective of MRS is to deliver emergency message as fast and far as possible by minimizing the channel utilization. The D - CMST problem is represented in graph theory which shows the interaction between multiple vehicles in specific region at specific time. D - CMST problem is an extension of STP which finds the minimum cost tree that connects source and destination node. An optimal solution for this problem is obtained using metaheuristic algorithms. But this D - CMST algorithm is not designed for multicast routing due to cost and delay.
5) Ozan Tonguz et al [7] recommended Distributed Vehicular BroadCAST (DV - CAST) for selecting the next forward node in Vanet Broadcasting. This approach uses Probability based Forwarding for relay selection. Three light - weighted broadcast techniques are discussed namely weighted p - persistence, slotted 1 - persistence and slotted p - persistence. The main objective of these techniques is to obtain 100% reliability and 70% redundancy and packet loss ratio. There are three different network regimes namely dense, sparse and regular traffic. The dense traffic regimes are suited for well connected network and uses broadcast suppression mechanism. The sparse traffic regimes are suited for sparsely or totally disconnected network and uses store - carry - forward mechanism. Whereas the normal traffic regime uses any of the three networks.
6) Hamada Alshaer et al [8] proposed Optimistic Adaptive Probabilistic Broadcast (OAPB) for next broadcast candidate selection in Vanet. This protocol uses Probabilistic based forwarding for retransmission of emergency message. Two types of approaches are discussed namely *passive* and *active*. In passive, the receiver vehicle must have the responsibility to determine potential danger for itself. Whereas active provide warning message in time at low cost of wireless channel bandwidth. The solution specified in this approach is taken as the final stage of Fuzzy Vehicular Broadcast Controller (FVBC). For that purpose it needs linguistic variables and fuzzy logic rules have to be determined.
7) Gokhan Korkmaz et al [9] developed Urban Multi - hop Broadcast (UMB) for the selection of next relay candidate in Vanet Broadcasting. This protocol selects the Furthest and Backbone node for retransmission of safety alarm packets to other nodes. UMB protocol is divided into two phases namely *Directional* and *Intersection Broadcast*. In first phase, the sender will select the furthest node. In the second phase, repeaters will forward packet to all road segment. In light vehicle traffic, sub - segment is sufficient whereas in high vehicle traffic, sub - segment is reduced. Block - burst is used to select the furthest node with information such as position and distance. In future enhancement it is better to avoid the usage of repeaters.
8) Elena Fasolo et al [10] proposed Smart Broadcast (SB) for the selection of relay candidate in Vanet. This approach uses Furthest node as the next forwarder. It is designed to suit in highway scenarios. The main aim of this approach is to minimize the latency. Compared to other protocols, this protocol does not use any collision resolution scheme. It balances both message progress and latency. All information regarding any node in the

scenario is obtained using control packets such as Request to Broadcast (RTB) or Clear to Broadcast (CTB). It is good to resolve collisions due to intersections.

9) Mostafa Taha et al [11] designed a Reliable Broadcasting of Life Safety Messages (RBLSM) for the selection of next relay node. This approach suggest both Best link quality node and Nearest node for rebroadcasting the emergency message. Basically a vehicle is divided into two types namely *abnormal* and *other vehicles*. A vehicle is in abnormal situation when there is a drastic change of speed or moving direction according to that message is sent to other vehicles. Whereas other vehicle will receive the warning alarm message and react to it. Highest priority is given to vehicles residing in most dangerous situation. To achieve 100% reliability is by transmitting ACK signal or overhearing the forwarded packets. The choice of selecting node is based on vehicle location, direction and speed. Finally it ensures reliability with minimum redundancy. But it is necessary to have a clear prediction of driver behavior.
10) Yoonyoung Sung et al [12] recommended Light - Weight Reliable Broadcast Message Delivery (LW - RBMD) for the relay selection of node in Vanet Broadcasting. This approach makes the selection based on Furthest node for retransmission of safety message. It is an extension of Contention Based Forward (CBF) which is a receiver oriented forwarding mechanism. It ensures a successful delivery of message at intersection in an efficient and fast way. Here all the vehicles maintain its own information from GPS. This approach focuses on two things, one is message forwarding detection and another is rebroadcast scheme to recover failure. Finally this protocol achieves better reliability and less overhead.
11) Mariayasagayam et al [13] suggested Multi - hop Vector Broadcasting (MHVB) for the selection of next forwarder in Vanet Broadcasting. The selection of next relay is based on the Furthest node. This is an enhancement of existing MHVB protocol. This approach changes the existing Backfire algorithm into Sectoral Backfire algorithm and includes Traffic Congestion Detection Algorithm. It proves its efficiency of flooding based on distance and shows the improvement in terms of performance and saving network resources. But it is not well suited for dense network regimes.

3. Comparative Study on Vanet Broadcasting Protocols

Table 1: Comparative Analysis

Protocols	Type of criteria	Information Gather	Achievements	Limitations
TRADE & DDT	Furthest Node	GPS & Beacon	1. Maximize bandwidth utilization 2. Reduce number of broadcast message 3. Highest reachability	Overhead in exchange of GPS position information
MAC	Furthest Node	Beacon	1. Good in overall transmission range 2. Guaranteed medium allocation 3. Avoid long delay and Broadcast storm problem	Beacon message will drop packets due to background noise
REAR	Best link quality node	Beacon	1. Maximize receipt probability 2. Large coverage distance 3. Quick propagation 4. Higher reliability 5. Less broadcast packets	Difficult in identifying neighbours under contention delay and calculating its functions.
Multicast	Most Demanding node	Beacon	1. Reduces number of sent Messages. 2. Minimum radio transmission 3. In - time delivery of warning message	Delay - constrained minimum steiner tree (D - CMST) problem not designed for multicast routing due to cost and delay
DV - CAST	Probability based forwarding	GPS	1. Reliable 2. Robust 3. Bandwidth efficient	GPS trails is needed in irregular topologies, need to maintain accuracy of local topology information and necessary to keep neighbor list instead of flags
OAPB	Probability based forwarding	GPS	1. Very high delivery ratio 2. Better performance in broadcast overhead 3. Good performance in end - to - end delay	Computation of a rebroadcast probability is not clear
UMB	Backbone node and Furthest node	GPS	1. Very high success rate 2. Utilize channel efficiently 3. Avoid collision 4. Reliable broadcast communication 5. Disseminating message in all direction	Handling intersections without any repeaters
SB	Furthest node	Control messages	1. High reliability 2. Low propagation latency 3. Reduced redundancy	Should resolve collisions
RBLS M	Best link quality node and Nearest node	GPS	1. Very low latency 2. Minimize channel busy time (CBT) 3. Ensure reliability 4. Minimum redundancy	Hard to predict the behavior of vehicle drivers
LW - RBMD	Furthest node	GPS	1. Better reliability 2. Less overhead 3. Successful delivery of message	Flooding of broadcast message is very small

Enhanced MHVB	Furthest node	GPS	1. Efficient way of flooding based on distance 2. Improvement in performance and saving Network resources	Not applicable for dense network regime

4. Conclusion

This paper presents an overall comparison of several Vanet broadcasting protocols. The main aim of these broadcasting protocols is to maximize the bandwidth of channel utilization and minimizes the number of rebroadcasting of life safety messages by keep up the high reachability and low end - to - end delay. Table 1 displays to which criteria each protocols belongs, how the information is collected with its merits and demerits of each protocols. This provides an eye opener for the novice researcher to know a deep knowledge about each algorithm and collation with other protocols to narrow down their research work.

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