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A Review of Various Broadcasting Protocols in VANET

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Abstract-Vehicular ad hoc network (VANET) is a new type of Mobile Ad hoc Network (MANET). VANET supports safety systems, designed to avoid road accidents. Broadcast transmission is used in VANET to alert all vehicles within a geographical area about an emergency situation. The successful dissemination of warning messages beyond the transmission range of vehicle faces various issues like broadcast storm, hidden nodes problem, feedback problem, channel load etc. In this paper, various broadcasting data dissemination protocols are surveyed separately and their fundamental characteristics are revealed. In the end a tabular comparison of all the protocols has been done.
Key-Words-VANETs; Data Dissemination; Protocols

1 INTRODUCTION

Vehicular Ad hoc Networks (VANETs) belongs to wireless communication network. VANET is the wireless network in which communication takes place through wireless links mounted on each node (vehicle).VANET turns every participating vehicle into a wireless router or node allowing vehicles approximately 100 to 300 meters of each other to connect and create a network with a wide range. Each node within VANET acts as both, the participant and router of the network. These nodes communicate through other intermediate nodes that lie within their own transmission range [1]. Although some fixed nodes acts as the roadside units to facilitate the vehicular networks for serving geographical data or a gateway to internet etc. Higher node mobility, speed and rapid pattern movement are the main characteristics of VANET. The basic target of VANET is to increase safety of road users and to provide comfort to the passengers.

VANET safety application depends on exchanging the safety information among vehicles to vehicles (V2V communication) or between Vehicle to infrastructure (V2I Communication) using the control channel.

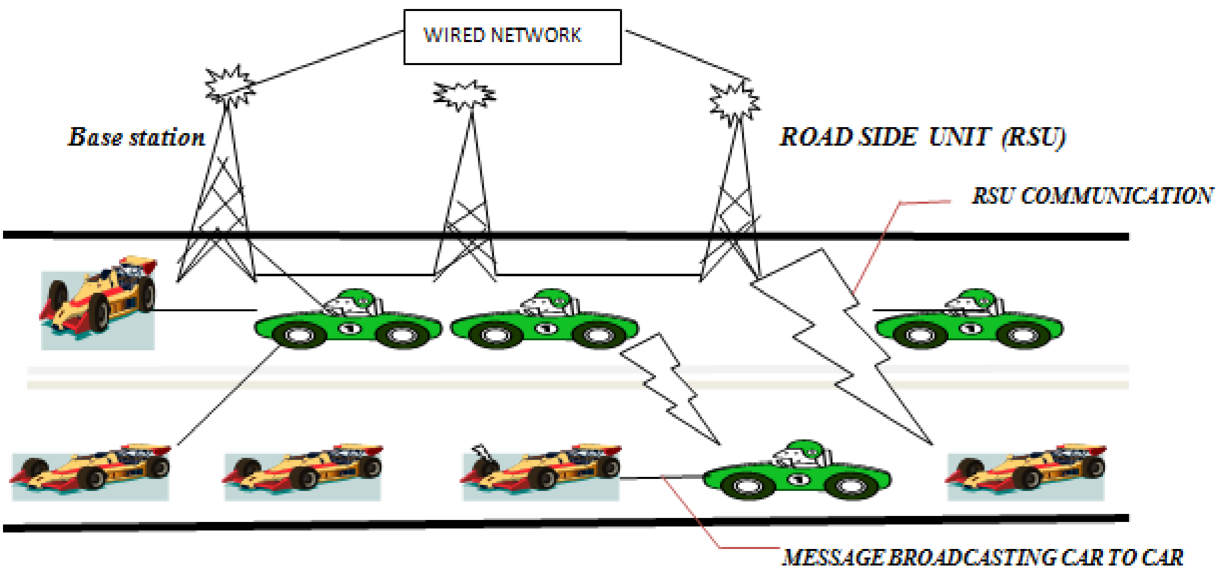

fig1: Vanet structure

VANET safety communication can be made by two means:

I. Periodic Safety Message (called Beacon): The Beacon messages are status messages containing status information about the sender vehicle like position, speed, heading etc. Beacons provide fresh information about the sender vehicle to the surrounding vehicles in the network helping them to know the status of the current network.

II. Event Driven Message (called Emergency Message): Emergency Messages are the messages sent by a vehicle to detect a potential dangerous situation on the road. This information should be disseminated to alarm other vehicles about a probable danger that could affect the incoming vehicles. Emergency messages in VANET are sent in broadcast fashion where all the vehicles inside the coverage area of the sender should receive the message.

The coverage area is not enough as it hardly covers a 1000m (which is the Dedicated Short Range Communication (DSRC) range [2]) due to attenuation and fading effects . Therefore, there is a need of technique that increases the emergency message reception with high reliability and availability.

During the last few years, various broadcasting techniques are designed for fast and effective dissemination of emergency messages within a geographical area to achieve the safety system. The next section talks about these techniques.

2 BROADCASTING PROTOCOLS IN VANET

Broadcasting protocols are classified into two main categories according to the spreading of information packets in the network. These categories are:

- **Single-hop Broadcasting:** In single-hop broadcasting when an information packet is received by a vehicle that information is kept in the vehicle's on-board database instead of flooding. Periodically, vehicles select some of the records stored in its database for broadcasting to all other vehicles in its one-hop neighborhood. Ultimately, vehicle's mobility is involved in spreading the information in single-hop broadcasting

Multi-hop Broadcasting: In multi-hop broadcasting, a packet is spread in a network by the way of flooding. When a sender vehicle broadcasts an information packet, a number of vehicles within the surrounding area of the sender will become the next relay vehicles by rebroadcasting the packet further in the network. Similarly, after a relay vehicle (node) rebroadcasts the packet, some of the vehicles in its surrounding area will become the next relay nodes and perform the task of forwarding the packet further. As a result, the information packet is able to propagate from the sender to the other distant vehicles.

2.1 Single Hop Broadcasting Protocols

In single hop broadcasting, vehicle periodically disseminates important and relevant information stored in its database to the other vehicles in the network. To keep the most up-to-date information without redundancy, the broadcast interval must be set appropriately. It should not be too long or too short. Single-hop broadcasting protocols can be further divided into following two categories: -

2.1.1 Fixed Interval Based Single Hop Broadcasting Protocols

Fixed interval based broadcast protocols focuses only on the selection and aggregation of information. Traffic Info [7] is an example of Single Hop broadcast protocol in which every vehicle is equipped with a global positioning system (GPS) and digital road map. Vehicles periodically broadcasts the traffic information (travel times on road segment) stored in its database to all the other vehicles in its surrounding area. Each vehicle stores its own travel time and time taken by other vehicles during travelling into the database. Although single-hop broadcasting scheme is inefficient in broadcasting all the records from database but, Traffic Info uses the bandwidth efficiently and broadcasts only the most relevant information from the database. The relevance of the information is determined by a ranking algorithm, which is based on the current location of the vehicle and the current time.

TrafficView [8] is another single-hop broadcasting technique that exchange information about speed and position of vehicles. In this technique, instead of broadcasting all stored record from the database, only a single record is broadcasted after aggregating the multiple records.

2.1.2 Adaptive Interval Based Single Hop Broadcasting Protocols

In adaptive broadcast interval protocols, an adjustment of broadcast intervals is also taken into consideration. Abiding Geocast protocol [9] is an example of adaptive broadcast interval protocol which was designed to disseminate safety messages within a useful area where these messages are still relevant. In this scheme, a vehicle which detects an emergency situation first starts broadcasting a warning packet. Packet specifies the area where the warning is still relevant. When another vehicle receives the warning message, it will act as a relay node and keep broadcasting the warning packet as long as it is still traveling in the concerned area. Each vehicle adjusts its rebroadcast interval dynamically in order to reduce the number of redundant warning packets. The rebroadcast interval is decided by the transmission range, speed, and the relative distance between the emergency site and the vehicle.

2.2 Multi Hop Broadcasting Protocols

As mentioned earlier, in multi-hop broadcasting, flooding is used for propagation of packet in the network. However, a pure flooding is inefficient because it lacks scalability; there is lot of packet collision, broadcast storm and reliability problem. Multi-hop broadcasting protocols are designed to overcome the problems with flooding. These Protocols can be further divided into following categories: -

2.2.1 Delay Based Multi Hop Broadcasting Protocols

In a delay-based multi-hop broadcasting scheme, to address the redundancy problem different waiting time is assigned to each receiving vehicle before rebroadcasting. The vehicle having a shortest waiting time gets the highest priority to rebroadcast the packet and other vehicles abort their waiting process as they know that packet has already been rebroadcasted.

In Contention-Based Forwarding (CBF) protocol [10], vehicle sends a packet as a broadcast message to all its neighbors. On receiving the packet, neighboring vehicle will contend for forwarding the packet. The node having the maximum progress to the destination will have the shortest contention time (waiting time) and will first rebroadcast the packet. If other nodes receive the rebroadcast message, they will stop their contention and delete the previously received message. This protocol mainly proposed for forwarding the periodic safety message (Beacons).

The problem with this protocol is a management technique to manage the contention for all the neighboring vehicles and there is a chance that the nearest vehicle to the sender may not hear the rebroadcast of another vehicle, thereby this vehicle will rebroadcast its own message and results in hidden node problem also it may lead to broadcast storm problem that makes the protocol useless.

Emergency Message Dissemination for Vehicular (EMDV) [11] is delay based protocol which selects farthest vehicle within the transmission range to make the rebroadcasting of the emergency message.

Link-based Distributed Multi-hop Broadcast (LDMB) [12] is also a class of delay based multi-hop broadcasting, in which all the receivers of the emergency message are potential forwarders. Each forwarder computes and waits for contention time, if the contention time ends the forwarder will start to rebroadcast the emergency message. The problem of this protocol is that all the message receivers will compute the waiting time and wait to make the rebroadcast, simultaneously the closest vehicles to the sender will do the same and this will make the entire network busy for any message received.

Fastest-Vehicle [13] is another multi-hop broadcasting protocol. It uses speed information of each vehicle and distance of the selected vehicle from the destination vehicle. On the basis of speed v of the vehicles and distance s of the vehicles from the destination, the time t for each vehicle within the transmission range is calculated. The vehicle with the least time is selected as the next hop for data dissemination.

2.2.2 Segment based multi hop broadcast protocol

In segment based multi-hop broadcasting scheme, to address the broadcast storm problem and hidden node problem transmission range of sender is divided into segments.bit divides a road into smaller segments and gives the rebroadcast priority to the vehicles that belong to the farthest non empty segment.

Urban Multi-hop Broadcast (UMB) [14] protocol is a segment based multi-hop broadcasting protocol designed to solve the broadcast storm, the hidden terminal and the reliability problems in multi-hop broadcasting. UMB divides a road into smaller segments and gives the rebroadcast priority to the vehicles that belong to the farthest non empty segment. To select the farthest node and address the hidden-node problem, the source node first sends a request to broadcast (RTB) message. All nodes receiving the RTB transmit a black burst message of duration proportional to the distance of their segment from the source. Only the node in the farthest segment transmits a clear to broadcast message (CTB) letting the source node know of its selection as a relay node. One disadvantage of this scheme is that the vehicle selected as the relay node has to wait for the longest time due to the longest black burst duration.

Smart Broadcast (SB) [15] was proposed to improve the shortcomings of UMB protocol. In SB source node first sends a RTB message containing information about the contention window, segment size, and the message direction. The relay node is selected as the one whose contention window expire first .Relay node sends a CTB message that informs other vehicles to cancel their rebroadcast. On hearing the CTB message, the source node then sends the warning message to be forwarded by the selected relay node.SB is inefficient because, there is a lot of packet collisions caused by the selection of same back-off value for multi-hop transmission.

Time slotted multi-hop broadcast protocol (TS) [16] was proposed to overcome the shortcomings of SB protocol. In TS to address the broadcast storm problem, transmission range of vehicle is divided into segments; segment leader is selected for each segment that are responsible for relaying the warning messages over multiple hops to further nodes. To address the hidden node and interference with ingle hop messages, Time is divided into multiple time slots, in first phase sender firstly sends a black burst signal to temporarily suspend the ongoing single-hop messages. The vehicle with the longest black burst signal will find the medium free after black burst period and then transmit a CLEAR packet (second phase) to inform all the vehicles in the transmission range of the upcoming multi-hop warning message . Upon receiving the CLEAR packet, vehicles suspend their queued multi-hop warning message until the start of the next multi-hop time slot. In the CONTENTION phase, each segment leader checks if it is a new warning message or a duplicate message is received from a vehicle located further in the message direction. In the ACK phase, the segment leader with the shortest contention time will transmit an ACK packet. After receiving the ACK of the warning message from the winning leader in the current time slot, all other segment leaders (i.e., potential forwarders) delete the corresponding warning messages in their queues.

2.2.3 Beacon message based multi hop broadcast protocol

Beacon messages are implemented in many approaches .Beacons provide fresh information about the sender vehicle to the surrounding vehicles in the network helping them to know the status of the current network. This neighbor information is very useful for retrieving many useful data such as vehicle density [17], link reliability [18], transmission radius etc. Suriyapaibonwattana & Pomavalai [19] suggested using of the neighbor location to see if the distance between itself and the previous broadcaster is the greatest. Each vehicle submitted its location information in its advertised beacon message. Therefore, each vehicle will have knowledge of its neighbors in term of both numbers of neighbors and their respective positions.

When the report is broadcasted, each vehicle will calculate its distance with respect to the broadcaster of the vehicle and all of its neighbors from the information it has. If it turns out the distance of the vehicle to the broadcaster is the longest, then the vehicle will rebroadcast the message. Otherwise, it simply remains silent.

Unlike using the distance, Reliable and Efficient Alarm Message broadcasting protocol (EAMB) [20] uses transmission reliable rate. Transmission reliable rate indicates that how many vehicles would successfully receive the message if one rebroadcasts. Therefore, the vehicle with the greatest number is the winner. The step taken is the same as ESAB protocol. Each vehicle calculates the number for itself and its entire neighbor. If it found out that, its number is the greatest, and then it will broadcast.

2.2.4 Probability Based Multi Hop Broadcasting Protocols

In probabilistic-based broadcasting approach, each vehicle rebroadcasts a packet according to the assigned probability. Since only few vehicles will rebroadcast the packet, redundancy and packet collisions are reduced.

Weighted p-Persistence protocol [21] is a probability based broadcasting scheme in which a vehicle that receives a packet for the first time computes its own rebroadcasting probability based on its distance from the transmitter. The distance can be computed by comparing its current position with the position of the transmitter specified in the packet. The rebroadcast probability is computed using equation: -

$$Pij=Dij/R$$

Where *Dij* represents the distance between sender *i* and vehicle *j*, and *R* is the transmission range of transmitter *i*. On the basis of above equation, vehicles that are farther away from the transmitter will get higher rebroadcast probabilities. However, vehicle density is not taken into consideration in this probability assignment function. Hence, in the dense network, the number of rebroadcast packets can still be large.

Distributed Probabilistic Broadcasting (DPB) [22] is another approach, in which local vehicle density (number of neighbors) is also taken into consideration while determining the forwarding probability. Each vehicle exchanges HELLO packets periodically with other vehicles, to know how many neighbors are there. The density along with the distance is the inputs to derive p for each vehicle.

Table1. Comparison of Various Broadcasting Data Dissemination Protocol in VANET

s.n-o	Name of protocol	Hopin-g level	Basis	Advantage	Disadvantage
1	Traffic Info	Single hop	Fixed Broadcast Interval	Broadcast travel time information periodically	Information about Speed, position and distance are not broadcasted
2	Traffic View	Single hop	Fixed Broadcast Interval	Broadcast speed and position information	Information about travel time and vehicle density are not broadcasted.
3	Abiding Geocast	Single hop	Adaptive Broadcast Interval	Reduce redundancy	Increase in delay time, only for single hop
4	Contention Based Forwarding(CBF)	Multi hop	Delay	Broadcast storm problem is removed, less redundancy	Hidden node problem, contention management required, feedback problem, only for periodic safety message

5	Emergency Message Dissemination Vehicular (EMDV)	Multi hop	Delay	Chances of emergency message reception are higher, less delay	Broadcast storm, hidden node and feedback problem
6	Link Based Distributed Multi-hop Broadcast(LDMB)	Multi hop	Delay	Reliable, remove hidden node and feedback problem	Broadcast storm problem, high packet collision,network remain busy
7	Fastest Vehicle	Multi hop	Delay	Less redundancy, fast and effective	Hidden node problem
8	Urban Multi-hop Broadcast (UMB)	Multi hop	Segment based	Broadcast storm and hidden node problem is solved, reliable	More delay time, interference with single hop mess-age, feedback problem
9	Smart Broadcast (SB)	Multi hop	Segment	Less redundancy, More reliable, removes hidden node and broadcast storm problem	Packet collision is high, interference problem
10	Time Slotted multi-hop Broadcast(TS)	Multi hop	Segment	Reliable, removes broadcast storm, Hidden node and feedback problem. no interference with Single hop messages	Packet collision is high, required high bandwidth
11	Efficient Security Alert Broadcast (ESAB)	Multi hop	Beacon message	Each vehicle has information of other vehicle,broadcast storm problem is solved, reliable	Delay is high
12	Reliable Alarm Message Broadcasting (RAMB)	Multi hop	Beacon message	Reliable, no feedback problem, broadcast storm and hidden node problem are solved	High Delay , chances of collision are high
13	Weighted-p Persistence	Multi hop	Probabilistic	Use distance for calculating the probability,reliable less delay	In less concentrated area reliability is less
14	Distributed probabilistic Broadcasting(DPB)	Multi hop	Probabilistic	Use vehicle density for calculating probability	Not much effective and fast, hidden node problem

3. CONCLUSION

In this paper, various broadcasting data dissemination protocols are surveyed separately and their fundamental characteristics are revealed. Every rebroadcasting technique has its own advantages and disadvantages. Almost all the broadcasting protocols are suitable for V2V communication and suitable for urban traffic conditions. Any broadcasting protocol should address the hidden node problem, reliability problem and the broadcast storm problem. This concise work will help in better understanding of broadcasting protocols in VANETs and pave their way to develop a new protocol which handles the hidden node problem, broadcast storm problem, other traffic considerations into a new broadcasting protocol that works for both rural and urban traffic conditions.

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