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A Broadcasting Scheme for Message Dissemination in VANET

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ABSTRACT
Vehicular Ad hoc Networks [VANET] is one of the fastest emerging technologies for research as there are many issues and challenges to be addressed by the researchers before the technology becomes commercialized. Vehicular communication systems developed largely by the growing interest in intelligent transportation systems [ITS]. Cooperative driving can improve safety and efficiency by enabling vehicles to exchange emergency messages to each other in the neighborhood and to assist driver in making proper decision to avoid vehicle collisions and congestion. Broadcast transmission is usually used for disseminating safety related information among vehicles. Message Broadcast over wireless networks poses many challenges due to link unreliability, hidden terminal, message redundancy, and broadcast storm, etc., which greatly degrade the network performance. In most of the emergency situations, there is less time to make a handshake with other nodes in the networks, as the emergency message is to be delivered fast and efficient. Broadcasting information is usually very costly and without limiting techniques this will result in serious data redundancy, contention and collisions. This work focuses on Broadcasting Scheme for Message Dissemination.
Keywords **-** *Broadcast Storm, intelligent transportation systems [ITS], Message Dissemination, Redundancy.*

I. INTRODUCTION

The term VANET as an acronym for vehicular ad-hoc networks was originally adopted to reflect the ad-hoc nature of the highly dynamic networks. First, consider the opportunities. If vehicles can directly communicate with each other and with infrastructure, an entirely new paradigm for vehicle safety applications can be created. Even other non-safety applications can greatly enhance road and vehicle efficiency. Second, new challenges are created by high vehicle speeds and highly dynamic operating environments. Third new requirements, necessitated by new safety-of-life applications, include new expectations for high packet delivery rates and low packet latency. Further, customer acceptance and governmental oversight bring very high expectations of privacy and security.

VANET communication is based on two types. (i)V2V (Vehicle-to-Vehicle) communication, (ii) V2I (Vehicle-to-Infrastructure) communication. In Vehicle-to-Vehicle communication, The VANET communication can be either done directly between vehicles as 'one-hop' communicate

on, such as car-to-car communication. In Vehicle-to-Infrastructure communication, VANET communication can be done between vehicles and road side infrastructure as 'multi-hop' communication.

II. MOTIVATION

Vehicular ad hoc networks (VANETs) are more and more popular today. Due to the advanced technologies, such as the Global Position System (GPS), power-saving embedded computer, and wireless communication system, people can enjoy many convenience services while they are driving in cars. Safety and comfort messages are main kinds of messages transmitted in VANETs. With the safety messages, the drivers can be aware the car accidents happened in front of the vehicle even if the line of sight is bad. Then, the drivers can change their road lanes or something else to avoid hitting the abnormal cars. Or they can change their route to destination in time and thus avoid getting into a traffic jam. The comfort messages are used for other applications, such as the shopping, parking lot or the weather information.

Every year, many people lose their lives or get injured on roads and huge amounts of time and fuel are exhausted because of road accidents or traffic jams. According to the report of the Ministry of Public Security of the People's Republic of China, 65225 people were killed and 254075injured in 2010 because of road accidents in China [1]. These losses would have been avoided or minimized, if drivers had been informed of the risk ahead in advance. For this reason, both of the research community and automotive industry have paid considerable attention to the vehicular ad hoc networks (VANETs) [2].

There are two main types of VANETs applications: safety and nonsafety applications. The purpose of safety applications is to increase the safety of both the passengers and the vehicles simultaneously. This purpose can be achieved by sending emergency messages to the vehicles located in the risk zone [3-5].

Yang *et al*. [6] mentioned that about 60% roadway accidents could be avoided if the drivers of the vehicles were provided warning at least one-half second prior to a collision.

This calls for an efficient message (safety message) dissemination mechanism for VANETs.

III. BROADCASTING SCHEME

Broadcasting is defined to be a one-to-all communication. I.e. a mobile node sends a message that should be received by all other nodes in the network (provided they are connected). A broadcasting mechanism is the core of every mobile ad hoc routing protocol for route discovery or announcement. Broadcasting Scheme generally divided in to two main categories:

A. Single-hop Broadcasting
B. Multi-hop Broadcasting

A. Single-hop Broadcasting

[1] Collision Ratio Control Protocol (CRCP)[7]

In CRCP, each vehicle disseminates the traffic information periodically. The traffic information in this case are the location, speed, and road ID. It is assumed that these data can be measured at every second. In this protocol, a mechanism for dynamically changing a broadcast interval based on the number of packet collisions is proposed.

The number of packet collisions increases as the network density increases. Thus, in order to keep the number of packet collisions at the desired level, vehicles need to adaptively adjust their broadcast intervals. In particular, in this protocol, the broadcast interval will be doubled if the estimated collision ratio observed by a vehicle and the estimated bandwidth efficiency are greater than the pre-defined thresholds. Otherwise, the broadcast interval is shorten by one second.

[2] Abiding Geocast[8]

The Abiding Geocast protocol is designed for disseminating safety warnings within an effective area where these warnings are still relevant and applicable. In this scheme, when an emergency situation occurs, the first vehicle that detects it starts broadcasting a warning packet. In the packet, an effective area where the warning is still relevant and should be kept alive is also specified. When another vehicle receives the warning packet, it will become an active relay node and keep broadcasting the warning packet as long as it is still traveling in the effective area. The vehicle stops broadcasting when it goes outside of the effective region.

[3] Traffic View[9]

Traffic View is a single-hop broadcasting scheme designed for enabling an exchange of traffic information among vehicles. The types of information exchanged among the vehicles are speed and position. In this scheme, when a vehicle receives a broadcast packet, it stores the information in its database. The information is then rebroadcasted in the next broadcast cycle. However, instead of broadcasting every record in its database, the vehicle aggregates the speed and positions of many vehicles into a single record and then broadcast this aggregated information.

B. Multi-hop Broadcasting

[1] Weighted p-Persistence[10]

In this case, distance between the sender and receivers along with transmission range of node are used as weighted factors to determine the forwarding rebroadcast probability which is calculated on per packet basis. The main issue of this technique is that there is high probability of collision as multiple vehicles simultaneously decided to rebroadcast though with different probabilities.

[2] Slotted 1-persistence[10]

This technique is based on the concept of division of transmission band into sub-bands and assigns different sub-bands for transmission to different distance ranges from the transmitting node. Each sub-range will be assigned its own WAITTIME to rebroadcast the message. Once a node receives an alert message from a neighboring node for the first time, it retransmits with probability 1 after expiration of WAITTIME, otherwise it discards the packets.

This approach falls behind in scenarios when there is more than one vehicle in the farthest slot ready to transmit messages simultaneously, this leads to collision of packets.

[3] Urban Multi-hop Broadcast (UMB)[11]

The UMB protocol is designed to solve the broadcast storm, the hidden node, and the reliability problems in multi-hop broadcasting. Basically, UMB divides a road inside the transmission range of a transmitter into small segments, and it gives the rebroadcast priority to the vehicles that belong in the farthest segment. In UMB, two types of packet forwarding are defined: (i) directional broadcast which use RTB-CTB-DATA-ACK scheme and (ii) intersection broadcast in which forwarding function is used and it is suggested that a repeater be installed at an intersection in order to forward a packet to other road directions.

[4] Efficient Directional Broadcast (EDB)[12]

EDB is a delay-based multi-hop broadcasting protocol that works quite similar to UMB protocols. However, the RTB and CTB control packets are not used in this protocol. In addition, EDB also exploits the use of directional antennas. In particular, it is proposed that each vehicle be equipped with two directional antennas, each with 30-degree beamwidth.

Similar to UMB, there are two types of packet forwarding in EDB, namely directional broadcast on the road segment and directional broadcast at the intersection. In directional broadcast on the road segment, a source vehicle broadcasts a packet and the downstream vehicles will rebroadcast it further.

To reduce the number of redundant rebroadcast packets, EDB assigns a different waiting time before rebroadcasting to each vehicle within the range of the transmitter. The waiting time is a function of the distance between the vehicle and the transmitter. In fact, when a vehicle receives a packet, it computes its own waiting time according to the following function.

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

Where R is the transmission range, d is the distance between the vehicle and the transmitter, and maxWT is the maximum waiting time.

[5] Reliable Method for Disseminating Safety Information[13]

The RMDSI protocol [21] aims at solving the reli-ability problem when the network becomes disconnected. This protocol also uses delay to differentiate the rebroadcast priority of each vehicle. Similar to EDB, when a vehicle receives a packet, it computes a waiting time before rebroadcasting the packet according to the waiting function of EDB.

An additional feature of this protocol is a mechanism for solving the network fragmentation problem. Basically, a relay vehicle will keep a copy of the packet that it has just rebroadcasted until it hears a duplicate transmission by the next relay node or until the packet lifetime expires.

[6] Water-Wave Broadcasting Scheme[14]

Water-Wave Broadcasting (WWB) scheme simulates the propagation of emergency waves using analogy of water waves. As referred from [14], the characteristics of WWB are that it is distance-based and it uses carry and forward method for broadcasting messages. As shown in Fig.1 below the water wave is triggered at the center, and the head wave leads the wave propagation to the outer area. The aftereffect waves make the inner area rippling. In an emergency warning service, a warning wave is generated as an emergency event is detected. The propagation medium is vehicles on the road. The head wave spreads the event to the whole warning area. Vehicles hold the head wave as they move and forward it to other encounter vehicles. The warning area keeps rippling until the end of the warning time. Any node entering into a ripple area will be notified of this event. The following types of nodes (or node roles) are defined and some of them are depicted in as follows :

- Source node: a node that triggers an emergency event.
- Head node: a node that promotes the head wave.
- Normal node: a general node in the network.
- Sender node: a node that is sending out a packet.
- Receiver node: a node that is receiving a packet

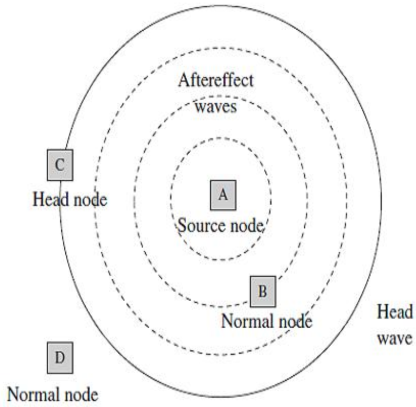

Fig 1. An Imaginary water-wave propagation [14]

IV. CONCLUSION

In this paper, we have analyzed various Broadcasting scheme or techniques for message dissemination in VANET. So, we can say that this paper can be used as reference by researchers which are trying to build a technique for efficient message dissemination in VANETs.

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