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A Survey on Broadcast Routing Protocols in VANET

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Abstract

The next generation VANET systems are more dense and it supposed to handle high traffic rate as well as frequent interrupt in connection. It should consume less power and utilize bandwidth efficiently. At the same time, the VANET nodes must be simple, cheap, smaller in size and efficient enough to handle traffic. In wireless environment, the quality of received signal level degraded due to path-loss and shadowing from various obstacles in propagation path. In addition to this, nodes use flooding mechanism in which it unconditionally floods data packets in all the directions. Which is going to harm network in terms of bandwidth wastage, collision, energy consumption. 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. The most important goal in transportation systems is to reduce the dramatically high number of accidents and fatal consequences. One of the most important factors that would make it possible to reach this goal is the design of effective broadcast protocols. The survey of routing protocols in VANET is important and necessary for smart ITS. This paper discusses the various broadcasting routing protocols for vehicular ad hoc networks.

Keywords: *VANET, Flooding, Broadcasting, BROADCOMM, UMB.*

I. Introduction

Vehicular Ad-hoc Networks (VANETs) are a special form of Mobile Ad-hoc Networks (MANETs). VANETs are different from MANETs in several ways. First, vehicles are in a large volume, and network topology changes rapidly. Second, the mobility of vehicles is constrained by roads with limitations on driving speed. Although vehicles can move in high speeds, their directions and speeds are predictable. Third, vehicles usually do not have tight energy budget. Instead, bandwidth issues are more critical than energy ones in VANETs [1].

a. Architecture of Vehicular Networking

A Vehicular Ad hoc Network (VANET) is a kind of wireless ad hoc network to provide communications among vehicles and nearby roadside equipments. VANET consists of vehicles with on-board sensors and roadside units (RSUs) deployed along highways/sidewalks, which provides communications between vehicle-to-vehicle (V2V) and communications between vehicles-to-infrastructure (V2I) [2]. Creating a safety system on the road is a very important and critical concern for human today, each year nearly 1.3 million people die as a result of road traffic accidents – more than 3000 deaths each day - and more than half of these people are not travelling in a car, the injuries are about fifty times of this number [3]. The number of cars in 2004 is approximately estimated as 750 million cars around the world [4], with an annually constant increase by 50 million car around the world, with this constant raise, the estimated number of cars nowadays exceeding one billion, this raise the possibility to increase the number of crashes and deaths on the roads, road traffic accidents are predicted to become the fifth leading cause of death in the world, resulting in an estimated 2.4 million death each year as stated by the World Health Organization (WHO), besides traffic congestion makes a huge waste of time and fuel, this makes developing an efficient safety system an urgent need on the road. The new techniques in this system should aim to make the intelligent vehicle to think, communicate with other vehicles and act to prevent hazards. VANET safety applications depend on exchanging the safety information among vehicles (C2C communication) or between Vehicle to

infrastructure (C2I Communication) using the control channel, show in figure 1 [3].

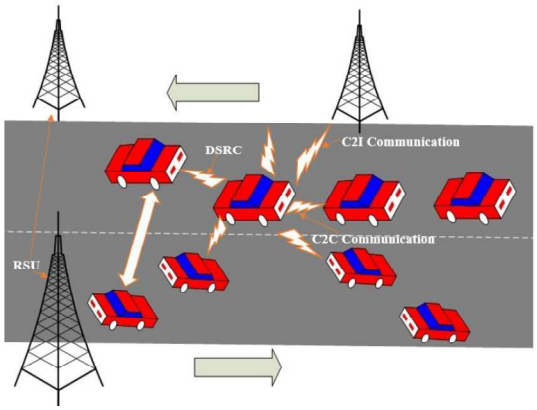

Figure 1: VANET Structure [3]

Vehicles can communicate information on traffic and road conditions with each other, as well as with fixed network nodes. The dissemination of emergency messages to all vehicles is a crucial problem in traffic scenarios such as for instance in case of accident the dissemination of safety messages may prevent secondary accidents and play a crucial role in the rescue of people It is therefore important to ensure a reliable broadcasting of warning and alarm messages, with low delivery delay [5].

II. Flooding

Most of the concerns of interest to Manets are of interest in Vanets, but the details differ. And finally, most vehicles are restricted in their range of motion, for example by being constrained to follow a paved highway. In addition, the term Manet mostly describes an academic area of research, and the term Vanet perhaps its most promising area of application. In Vanet it is easy to do communication between vehciles which is not possible in Manets. Flooding ensures the full coverage of all the network, that is, the broadcast packet is guaranteed to be sent to every node in the network providing the network is static. This flooding generates many redundant transmissions. Every neighbor pair will send copies of the same flooded message. The simple flooding algorithm with respect to MAC load, have power consumption and collision. The steps are as follows [5]:

Simple Flooding Algorithm

- The algorithm for simple flooding starts with a source node broadcasting a packet to all neighbors.
- Each of those neighbours in turn rebroadcast the packet exactly one time.
- This continues until all reachable network nodes have received the packet.

III. Broadcasting

The main purposes of ITS include providing real-time and comprehensive traffic information, and to give driving directions. In general, the traffic information can be classified into three categories: beforehand information, real-time information and afterward information. One of the most important services among them is emergency message dissemination. Emergency messages are useful for drivers in hazardous situations, e.g., dangerous road surface conditions, accidents and unexpected fog banks. Such messages are usually time sensitive and localized [6]. These messages can be disseminated to intended locations through multi-hop broadcast. Broadcast is a frequently used method for applications running on wireless environments. However, uncontrolled broadcasts will lead to broadcast storm problems [7], which cause severe packet collisions and redundancy and hidden terminal problems. Due to the high density and mobility of vehicles, designing an efficient broadcast protocol for VANETs in urban areas is a big challenge. Recently, there are many researches working on multi-hop broadcast problems in the VANETs. Khakbaz and Fathy proposed a relay-point selection mechanism to reduce broadcast redundancy and collision. The relay-point selection is an important issue for VANET broadcast. The two major challenges of broadcast are to ensure the reliability of messages while disseminating messages over the intended regions and keeping the delay time within the requirements of the applications. The design of broadcast protocols should exploit the peculiar features that differentiate VANETs from MANETs [6]. A geographic broadcast distributes data packets by flooding, where vehicles re-broadcast the packets if they are located in the geographic area determined

by the packet [8]. The application of broadcasting algorithms help to minimize overhead by reducing the occurrence of broadcast storms. Data and control packet forwarding must be loop-free and in the direction of the destination or target area location. Having packets forwarded across the shortest path towards the destination—typically found in conventional routing networks—is not a requirement due to the high network volatility. Several past routing efforts have investigated the design of ad hoc routing algorithms suitable for operation in a VANET environment to deal with: a node's mobility, by discovering new routes (reactive routing algorithms), updating existing routing tables (proactive routing algorithms), using geographical location information (position-based routing algorithms), detecting stable vehicle configurations (clusters), using a vehicle's movements to support message transportation and using broadcasting to support message forwarding. Vehicles periodically broadcast short packets with their identifiers and current geographic position. Upon receipt of such beacons, a vehicle stores the information in its location table. It is therefore possible to design a Cooperative Collision Avoidance (CCA) system that can assist in collision avoidance by delivering warning messages. When an emergency situation arises, a vehicle needs to broadcast a message to all of the vehicles behind it. The vehicles that receive this message selectively forward it based upon the direction from which it came which ensures that all members of the platoon eventually receive this warning [8].

a. Broadcasting Requirement Analysis

Any broadcasting techniques for VANET should satisfy the following requirements [9]:

- **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.

IV. Broadcasting Protocols in Vanet

During the last few years, a lot of broadcasting protocols for VANETs have been reported in the literature. They can be generally classified into two main categories according to the spreading of information packets in the network. These categories are [10]:

- **Single-hop Broadcasting:** In single-hop broadcasting, information packets are not flooded by vehicles. Instead, when a packet is received by a vehicle, information is kept in the vehicle's on-board database. Periodically, every vehicle selects some of the records stored in its database to broadcast. Hence, in single-hop broadcasting, each vehicle carries the traffic information with itself as it travels, and this information is transferred to all other vehicles in its one-hop neighborhood in the next broadcast cycles. Ultimately, vehicle's mobility is involved in spreading the information in single-hop broadcasting protocol [10].

- **Multi-hop Broadcasting:** On the other hand, in multi-hop broadcasting strategy, a packet is spread in a network by the way of flooding. In general, when a sender vehicle broadcasts an information packet, a number of vehicles within the vicinity 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 vicinity 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 [10].

V. Broadcast Routing Protocols

Broadcast routing is frequently used in VANET for sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. Broadcasting is used when message needs to b disseminated to the vehicle beyond the transmission range i.e. multi hops are used. Broadcast sends a packet to all nodes in the network, typically using flooding. This ensures the delivery of the packet but bandwidth is wasted and nodes receive duplicates. In VANET, it performs better for a small number of nodes. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, and DV-CAST [11].

a. BROADCOMM [12,13]

BROADCOMM is based on hierarchal structure for highway network. In BRAODCOMM the highway is divided into virtual cells which move like vehicles. The nodes in the highway are organized into two level of hierarchy: the first Level includes all the nodes in a cell, the second level is represented by cell reflectors, which are few nodes located closed to geographical centre of cell. Cell reflected behaves for certain interval of time as cluster head and handles the emergency messages coming from same members of the cell or nearby neighbor. This protocol performs similar to flooding base routing protocols for message broadcasting and routing overhead.

b. UMB : Urban Multihop Broadcast Protocol [12,14]

UMB is designed to overcome the interference, packet collision and hidden node problems during message distribution in multi hop broadcast. In UMB the sender node tries to select the furthest node in the broadcast direction for forwarding and acknowledging the packet without any prior topology information. UMB protocol performs with much success at higher packet loads and vehicle traffic densities.

c. SB: Smart Broadcast [10]

It. was proposed to improve the shortcomings of UMB protocol. In SB when a source vehicle has a packet to send, it transmits a request to broadcast (RTB) packet containing its location and other information such as packet propagation direction and contention window size. Also, all vehicles in the range of the source that receive the RTB packet determine the “sector” in which they belong by comparing their locations with that of the source vehicle. Next, all vehicles that receive the RTB packet choose a contention delay based on the sector that it resides.

d. V-TRADE : Vector Based Tracing Detection [12,15]

It is a GPS based message broadcasting protocols. The basic idea is similar to unicast routing protocols Zone Routing Protocol (ZRP). V-TRADE classifies the neighbors into different forwarding groups depending upon position and movement information. For each group only a small subset of vehicles is selected to rebroadcast the message. V-TRADE improves the bandwidth utilization but some routing overheads are associated with selecting the next forwarding node in every hop.

e. DV-CAST: Distributed vehicular broadcast protocol [12]

It uses local topology information by using the periodic hello messages for broadcasting the information. Each vehicle uses a flag variable to

check whether the packet is redundant or not. This protocol divides the vehicles into three types depending on the local connectivity as well connected, sparsely connected, totally disconnected neighborhood. In well connected neighborhood it uses persistence scheme (weighted p persistence, slotted 1and p persistence). In sparsely connected neighborhood after receiving the broadcast message, vehicles can immediately rebroadcast with vehicles moving in the same direction. In totally disconnected neighborhood vehicles are used to store the broadcast message until another vehicle enters into transmission range, otherwise if the time expires it will discard the packet. This protocol causes high control overhead and delay in end to end data transfer.

VI. Conclusion

Vehicular Ad-hoc Networks (VANETs) adopting Dedicated Short-Range Communications (DSRCs) have emerged as a preferred choice of network design for the Intelligent Transportation System (ITS). A possible application of the ITS is to disseminate emergency messages by multihop broadcast. Due to the high density and high mobility of vehicles, it is difficult to design an efficient broadcast protocol for VANETs in urban areas**.** This study provides the different routing protocols on VANET which provides reliable and efficient way for vehicle to vehicle communication. These protocols improve the overall performance of the network in terms of deduction of bandwidth wastage, collision, energy consumption.

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