IJCSE International Journal of Computer Sciences and Engineering Open Access
Review Paper Vol.-6, Issue-7, July 2018 E-ISSN: 2347-2693

Systematic Review of Broadcast Routing Protocols for VANETs

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Available online at: www.ijcseonline.org
Accepted: 19/July/2018, Published: 31/Jul/2018

Abstract: Vehicular Ad-hoc Networks routing protocols play an important role for communication between vehicles and road side units. We can't use protocols of MANETs for VANETs because of different characteristics of VANETs like speed of movement of nodes, direction of movement and dynamic topology etc. Similarly VANETs routing protocols for highway network may not work well for urban areas because of different characteristics of highway network and urban area network. An efficient VANETs routing protocol should be able to send message to accurate destination with minimum delay and minimum overhead. Some routing protocols for VANET uses multicast approach and some uses broadcast approach. In this paper we will study various VANET broadcast routing protocols and will study their performance by comparing various parameters network reachability, received distance, transmission overhead and reception overhead.

Keywords: routing protocols, wireless networks, connectivity**.**

I. INTRODUCTION

In vehicular ad-hoc network vehicles or moving cars find each other and make an ad-hoc network. Vehicles should be equipped with some radio interface or on board units (OBU) [2] for transmission of message between vehicles or road side units. Such a transportation system is known as intelligent transportation system in which vehicles can make a network and each vehicle has capacity to send and receive messages. Vehicles may also be equipped with some hardware like global positioning system (GPS) [4] for delivery of message to accurate destination. Vehicles in a network either can communicate directly or with the help of road side units. The former case is known as vehicle to vehicle communication and latter case is known as vehicle to infrastructure communication. Road side units act as intelligent router that controls the activities of vehicles on road and forwards messages to vehicles or other near road side unit. Efficient routing protocol should be able to work with or without infrastructure support. Some nodes also act as router or forwarding nodes in vehicular ad-hoc network which can store and forward messages to other nodes. However selection of forwarding nodes [2] is a difficult task because it effects overall communication in the network. The main applications of vehicular ad-hoc network are to prevent accidents, to smooth traffic on road, to give warning message to drivers about road jam due to accident or any other reason so that they can choose alternate route to reach destination, to give traffic density information to drivers so that can choose a different path to avoid jam condition.

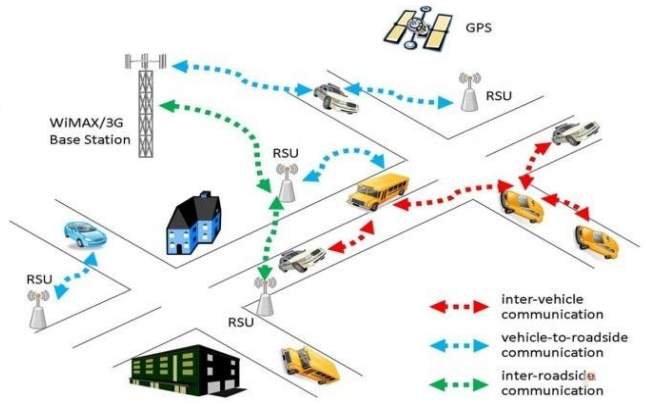

Figure1: Architecture of vehicular ad-hoc network

It is very challenging task to develop efficient protocol for message dissemination in vehicular ad-hoc networks. Such protocols can categorized based upon i) type of scenario considered for example one way highway or two dimensional highway or multidimensional urban environment ii) type of VANET application for which developed like safety, traffic control or for some commercial application iii) whether infrastructure support like road side units is required or not. An ideal VANET routing protocol should work for any scenario highway or urban, with or without infrastructure support, for any type of application. But developing an ideal protocol for VANET is very difficult task due to variable characteristics of VANET network like high mobility of

nodes, variable density of nodes and high velocity of vehicles.

Vehicles use WAVE [1] (wireless access in vehicular environment) protocol for communication between vehicles at MAC layer and physical layer. WAVE is IEEE 802.11p standard that is approved variation of IEEE 802.11 for communication between nodes in vehicular environment.

In this paper we will study and compare different VANET broadcast protocols with respect to various parameters such as network reachability, received distance, transmission overhead and reception overhead. In order to build efficient protocol for VANET first of all we have study characteristics of vehicular ad-hoc network. -The paper is organized as follows in section II we will discuss characteristics of vehicular ad-hoc network. In section III we will discuss various VANET broadcast protocols. In section IV we will compare performance of various VANET broadcast protocols with respect to various parameters. In section V we will conclude efficiency of various VANET protocols.

II. VANET CHARACTERSTICS

Vehicular ad-hoc network is part of Mobile ad-hoc network (MANET) that means nodes in VANET also can move freely in a certain region and stay connected. However we MANET protocols do not work well in vehicular ad-hoc network due different characteristics [10] of vehicular ad-hoc network. Here we will discuss characteristics of VANET that will differentiate it from MANET.

High Mobility: In VANET speed of movement of nodes (vehicles) is very much greater than speed of movement of nodes in MANET.

Dynamic Topology: Speed of vehicles in VANET is fast and also speed of all vehicles is random. So location of vehicle changes very rapidly that's why VANET has very dynamic topology.

Direction of movement: In case of MANET node can move in any direction but in case of VANET nodes can move only in well defined direction either in case of highway or in case of urban area network.

Energy : In case of MANET energy of nodes is a major problem because nodes has fixed small battery backup but in case of VANET cars or nodes has more energy due bigger battery size and battery is automatically charged by nodes as there is no charging option in case of MANET.

III. VANET BROADCAST ROUTING PROTOCOLS

In VANET transmission can be multicast, geo-cast or broadcast. Broadcast approach is good for delivery of massage in emergency situation like accident. But broadcast leads to redundant reception of message at destination.

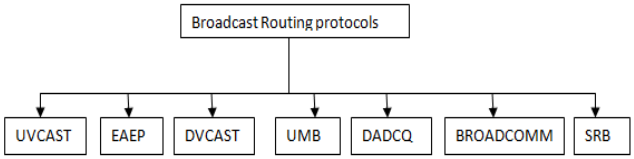

Figure 2: Broadcast routing protocols

3.1. Urban Vehicular Broadcast Protocol (UVCAST)

A number of protocols have been developed for urban scenario. Most of them are designed for well connected regime or requires infrastructure support in disconnected regime. Urban vehicular broadcast protocol [2] for VANET is completely distributed and works well in connected or disconnected regime without infrastructure support. Based on key challenges in urban scenario UVCAST should have following features.

a) Store carry forward work should be performed by more than one vehicle

To cover complete ROI(region of interest) more than one vehicle should play the role of SCF node because of requirement of transfer of message in multiple directions in urban scenario. If only one vehicle will work as SCF node than only sub region of ROI will be covered.

b) SCF vehicle should forward messages more than once

As we know in urban scenario vehicle changes direction very rapidly and moreover there a number of entry and exit points in ROI in urban scenario. SCF nodes will meet uninformed neighbors again and again. So SCF agents should carry on relaying the messages even they have sent message recently. However this may lead to redundant message to vehicles. Some mechanism can be applied like acknowledgments to control redundant broadcast of messages

c) Vehicles at intersection point should play role of SCF agent

Vehicle at intersection point has more neighbours as compared to other vehicles. Vehicle at intersection can send message to more vehicles. So it is better to choose vehicle at intersection point as SCF agent.

3.2 Edge Aware Epidemic Routing Protocol (EAEP)

This protocol [5] uses bandwidth of network efficiently and also improves reliability of delivery of message to accurate destination. EAEP reduces overhead of hello messages that are exchanged after fixed interval of time and also simplifies network maintenance. In this protocol each node sends its location information to neighbouring nodes in order to avoid beacon messages. Depending upon location of vehicles each node calculates probability whether or not to retransmit the message. EAEP protocol solves problem of broadcast storm

but disadvantage is that it does not solve the problem of link failure and increase packet delivery ratio.

3.3 Distributed Vehicular Broadcast Routing protocol (DV-CAST)

DVCAST [6] gathers information about its neighbours in order to start communication. Protocol use multi hope scheme to transmit messages. DVCAST gathers information about the network from beacon messages. DVCAST stores information about various network parameters like vehicle density state, traffic lights, neighbour nodes etc. When source node has less number of neighbouring vehicles or connected nodes it will not broadcast message. The packet is stored till more no of vehicles come into broadcast area. The packet is discarded if there is not a single vehicle in broadcast area. DVCAST uses a flag parameter to avoid duplicate messages. DVCAST performs well in both high and low traffic density because it reduces broadcasting overhead. Main disadvantages of DVCAST protocol is transmission delay and control overhead.

3.4 Urban Multi-hop Broadcasting Routing Protocol (UMB)

UMB [8] protocol uses multi hop broadcast scheme to transmit messages. UMB protocol was developed to eliminate hidden node problem and packet collision. In UMB protocol vehicles or nodes do not use previous network knowledge to forward packets. In this protocol previous network knowledge is not used instead sender find nodes in broadcast area by forwarding and acknowledging packets. UMB protocol work well to broadcast message to all vehicles in region of interest. UMB protocol works efficiently in high traffic density and high packet load. Disadvantage of UMB protocol is it does not use channel bandwidth efficiently.

3.5 BROADCOMM

This protocol [11] is used for highway network and is based on hierarchal structure. In this protocol highway is divided into virtual cells which move along with the vehicles. In this protocol there is two level of hierarchy for all vehicles on highway. All vehicles in a cell are included in first level hierarchy. Cell reflectors represent second level hierarchy which are responsible for communication of message with in cell. Cell reflectors are also responsible for forwarding and receiving message from nearby cell reflectors. This protocol works better for simple highway structure having few numbers of nodes. Disadvantage of this protocol is position of a vehicle completely depends on formation of cells

3.6 Distribution-Adaptive Distance with Channel Quality Routing Protocol (DADCQ)

This protocol [7] was designed for large networks with large node distribution. In this protocol vehicles or nodes are selected depending upon their geographic location before broadcasting a message. Performance of protocol heavily depends upon right selection of nodes. The destination node will not broadcast a recently received message if destination is in nearby area. This will minimize network delay and improves network efficiency. Disadvantage of this protocol is it creates message overhead.

3.7 Secure Ring Broadcast Routing Protocol (SRB)

This protocol [9] divides nodes or vehicles into three categories depending upon receiving power inner nodes, outer nodes and secure ring nodes. Nodes closure to source node are known as inner nodes. Nodes that are far away from source node are known as outer nodes and node that are at preferable distance from source node are known as secure ring nodes. This protocol minimizes number of retransmissions and makes more stable routes. In this protocol retransmission is restricted secure ring nodes to minimize rebroadcasting.

IV. COMPARATIVE ANALYSIS OF VANET ROUTING PROTOCOLS

The following four parameters are used to analyse the performance of above mentioned VANET broadcast routing protocols. Received distance and network reachability determines the effectiveness and reliability of the protocol. Efficiency of a routing protocol is measured with help of transmission and reception overhead parameters.

a) **Network Rechability** is equal to percentage of vehicles out of total vehicles who received message in region of interest. A good protocol must ensure reception of message to maximum vehicles if not possible for all vehicles in region of interest.

b) **Received Distance** is equal to distance covered by vehicle between message broadcast and message reception. For example vehicle was at point A when message was broadcasted and now vehicle is at point B when vehicle actually received message. Distance between point A and point B is known as received distance. While network rechability help us to determine whether all vehicles have received message or not, received distance metric determines whether vehicles received message well in time or not so that vehicles can choose for alternate route to avoid accident scene or jam situation

c) **Transmission Overhead** is equal to total no of messages transmitted all vehicles in the network. This parameter is important because it is used to indicate that whether excessive amount of bandwidth is consumed by vehicles or not.

d) **Reception Overhead** used to determine average no of duplicate message received on each vehicle. This

parameter is used to determine whether routing protocol is able to deal with broadcast storm or not.

Table 1: Comparative analysis of VANETs broadcast routing protocols

Parameters / Routing Protocol	Network Rechability	Received Distance	Transmission Overhead	Reception Overhead
UVCAST	High	Low	Low	High
EAEP	High	Medium	Low	Low
DVCAST	Medium	High	High	Low
UMB	High	Low	High	Low
BROADCOMM	Medium	High	Medium	Medium
DADCQ	Medium	Medium	High	Low
SRB	High	Low	Medium	Low

V. CONCLUSION and Future Scope

Vehicular ad-hoc network is gaining lots of attention from last few years. A lot of research work is going on in this area. Broadcast approach is good for delivery of message in emergency situations like accident and also helpful in rescue operation if it is able to send exact location of accident. In this paper we have studied various VANET broadcast routing protocols with their advantages and disadvantages. We have also done comparative analyses various VANET broadcast routing protocols by using some parameters. In future we will try to improve efficiency of any one of protocol mentioned above and will compare improved protocol with existing schemes.

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