

An Efficient Route Selection and Data Transmission in Vehicular Ad-hoc Network Using Cooperative Broadcast based Directional Routing

Aduomer Girmay Gebray¹, Dong Wang²

P.G Student, College of Computer Science and Electronic Engineering, Hunan University, Changsha, P.R.China¹

Professor, College of Computer Science and Electronic Engineering, Hunan University, Changsha, P.R.China²

ABSTRACT: In recent years, rapid growth in the number of vehicles on the road has increased demands for communication on the move. A new kind of Ad-hoc network with an enormous improvement in technological innovations is emerging these days known as Vehicular ad-hoc network (VANET). It is a technology that has moving vehicles as nodes in a network for creating a mobile network and has vibrant applications. VANET applications competence and achievement depend mainly on the way in which information are disseminated between the vehicles. The fundamental component for the success of VANET application is data dissemination because it handles rapid topology changes and a distributed network efficiently and reliably. In VANET, data dissemination is a difficult task to do because of the high mobility of nodes, which causes rapid changes of topology, restricted nodes movement and inconsistent nodes velocity and density are such characteristics of the VANET network that make data dissemination decisions more challenging. Several data dissemination techniques have been constructed for communication between the vehicles in an ad-hoc environment. However, those different techniques have problems regarding performance on packet delivery ratio, end to end delay and throughput. Therefore, after reviewing those several articles regarding data dissemination techniques in VANETs, we design and develop our own route selection algorithm and data dissemination technique on this paper. To this end, the state-of-the-art data dissemination technique which we proposed donated as Cooperative Broadcast-based Directional Routing (CBDR) data dissemination technique. Therefore, the simulation result shows that our CBDR data dissemination schema is simple and achieved good performance regarding packet delivery ratio while significantly reducing the bandwidth consumption and reduces end to end delay.

KEYWORDS: Vehicular ad-hoc network; VANETs; Data Dissemination; Broadcasting; Route selection algorithm; CBDR

I. INTRODUCTION

In the last twenty years there has been a huge increase of the number of passenger cars worldwide. In 2016 there were approximately 1.32 billion cars and light trucks on the roads and the numbers are increasing rapidly, especially in China and India [1]. If that staggering rate of growth continues, the total doubling every 20 years, then we can expect to see some 2.8 billion vehicles on the planet in 2036 [1]. The usage of automobile provides many societal benefits, including economy benefits such as job and wealth creation of automobile production and maintenance, transportation provision, society wellbeing derived from leisure and travel opportunities, and revenue generation from tax opportunities. However, there are many negative effects of the excessive use of automotive such as maintaining roads, land use, pollution and disposing of the vehicle at the end of its life. The most serious effect is of course, the road traffic injuries and deaths which are caused by accidents due to increasing population, driver carelessness, and heavy traffic congestion, violation of traffic rules and lack of information about street. According to reports published by the World Health Organization (WHO) worldwide, an estimated 1.35 million people are killed in road crashes each year and as many as 20 to 50 million injures, with many incurring disability as a result of their injury [2]. Road traffic crashes cost most countries 3% of their gross domestic product [2]. According to several researches conducted in the past and recently, it has been concluded that over-speeding and the road status are the contributors of the high numbers of accidents and deaths [3]. The number of road accidents has been increasing over the years. Projections indicate that these figures will increase by about 65% over the next 20 years unless there is new commitment to prevention. Therefore, there must be an intelligent traffic and transportation facility to avoid these incidents. In this regard,

Vehicular ad-hoc network (VANET) is such an advance network technology solution that pursuits to offer Intelligent Transportation System (ITS) services to the end users and is useful for reducing traffic congestion and injuries[4].

In recent years, rapid growth in the number of vehicles on the road has increased demands for communication on the move. A new kind of Ad-hoc network with an immense improvement in technological innovations is emerging these days which are known as Vehicular ad-hoc network (VANET). VANET transmit its information to other nodes with the help of cooperative multi-hop relaying. The fundamental component for the success of VANET applications is data dissemination, because it handles rapid topology changes and distributed network efficiently and reliably. Although, there are several data dissemination protocols available for Mobile Ad-hoc Networks but these data dissemination protocols fails to fully address the specific needs of VANET especially in city environments (i.e. nodes distribution, high mobility of nodes, signals transmission blocked by obstacles, etc). Therefore, on this paper we propose the state-of-the-art data dissemination protocol for VANETs which we donated as Cooperative Broadcast based Directional Routing (CBDR). The detail of our proposed data dissemination protocol is described on section three the paper.

a) Needs of VANET

Vehicular Ad-hoc Network is a technology that has moving vehicles as nodes in a network for creating a mobile network. We can say that VANET turns each and every vehicle into a wireless node, allowing vehicles to connect to each other which are 100-300 meters apart and, in turn, create a wide range of network. Vehicles found within that range are therefore able to exchange information about their situations, velocities and positions[5]. This information is helpful at critical sites such as crossroads or the entrance of a highway and may prove efficient to reduce road accidents and to manage city traffic with high efficiency. As vehicles fall out due to signal range and drop out of the present network, other vehicles can join in to connect vehicles to one another so a mobile Internet can be created. It is assumed that the first system in which it is integrated are police and fire vehicles to communicate with one another to provide safety. It is a term which is used to describe the spontaneous ad-hoc network that is formed over vehicles moving on the roads. Vehicular networks are very fast emerging for deploying and developing new and traditional applications. It is characterized by rapidly changing topology, high mobility, and temporary, one-time interactions.

There are various needs of VANET such as:

- **Lack of connectivity:** There is need of connectivity between the fast moving vehicles as there is disconnection on high speed of vehicles.
- **Fast communication:** There is need of fast data communication while travelling ranging from safety to non-safety.
- **Safety:** There is need of safety on roads while travelling and to keep track of predecessor and the succeeding nodes to avoid accidents and track of their movement on the roads. This will help in the proper safety on roads related to driving.
- **Infotainment:** This includes all sorts of activities related to other than safety such as online gaming, data sharing related to music and other kind of activities in the day to day life.

b) Characteristics of VANET

Many different and sometimes competing design goals have to be taken into account for VANETs to ensure their commercial success. When equipped with WAVE (Wireless Access for Vehicular Environment), a novel type of wireless access dedicated to vehicle-to-vehicle and vehicle-to-roadside communications, in **Figure 1.1** it forms a highly dynamic network.

VANET is an application of MANET but it has its own distinct characteristics which can be summarized as:

- **Mobility modeling and Prediction:** The prediction of vehicle position and their movements is very difficult. This features of mobility modeling and prediction in VANETs is based on the availability of predefined roadmap models. The speed of the vehicles is again an important for efficient network design.
- **Highly dynamic topology:** The high speed of the vehicles along with the availability of choices of multiple paths defines the dynamic topology of VANETs.
- **Communication Environment:** Once we are having a mobility model, yet we are not done. As the mobility model may have different features depending upon road architecture, highways, or city environments. Communicating in these situations has to be taken care.
- **Interaction with onboard sensors:** Sensors are the means of communications in VANET. Sensors can communicate to the main data center by reading data associated to velocity and direction of the vehicle. Therefore, for link formation and in routing protocols sensors can be used.
- **No constraint on Battery Power and Storage:** The nodes in VANETs have better battery power and storage compared to sensor networks; therefore, optimizing duty cycle is not as relevant as in sensor networks.

c) VANET Challenges

VANETs are one of the fundamental technologies now a day for efficient, safe, informative, and entertaining transportation system. However, VANET possess several challenges which need attention as we indicated on this paper hereunder:

- **Hard delay constraints:** At the time of emergency, delivery of messages on time is a critical problem. Therefore, handle such situations rather talking only about high data rates is not sufficient.
- **Frequent disconnected network:** The speedy nature of the vehicles describes the dynamic topology which in turn requires an infrastructure (RSU) to be connected (V2V, V2I).The lack of such infrastructure results in frequent disconnections stringent.
- **Mobility modeling:** As one of the characteristic of VANET is dynamic topology, to develop VANET environment effectively and efficiently, a perfect mobility model is required.

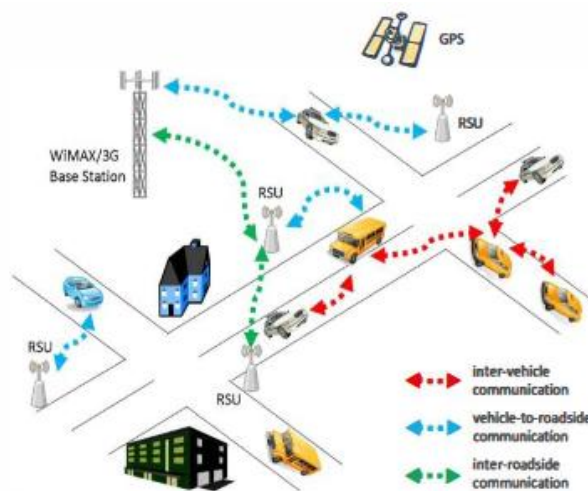


Figure 1.1: Vehicular Ad-hoc Network formation

Henceforth, it may sound reasonably simple to let vehicles communicate with each other; the design and deployment of VANET actually face significant technical challenges, for example:

1. **Unpredictable Wireless Communication Environment:** VANET has to cope with unfavorable characteristics of wireless communication, such as multi-path propagation, fading and the Doppler Effect.
2. **Decentralized and self-organized Topology:** The highly dynamic changes in VANET and the mobility of vehicles make it hard to synchronize and manage the transmission events, thus resulting in channel efficiency and frame collision.
3. **Security and Privacy Issue:** many potential protocols for VANET are heavily based on broadcasts and are without a normal authentication mechanism for a time-critical application purpose. These attributes will inevitably bring about security issues, such as a broadcast storm.

II. APPLICATION OF VANETS

The concept of equipping future vehicles with sets of wireless sensors, on-board units, GPS or DGPS receivers and network interfaces presents an ample opportunity to achieve intelligent transportation systems(ITS) with wireless enabled vehicles capable of sending and receiving kinematic data on the road.

VANETs support a wide range of applications from simple one hop information dissemination, e.g., cooperative awareness messages (CAMs) to cooperative multi-hop dissemination of messages over vast distances. Most of the concerns of interest to mobile ad-hoc networks (MANETs) are of interest in VANETs, but the details differ[6], rather than moving at random, vehicles tend to move in an organized fashion. The interactions with roadside equipment can likewise be characterized fairly accurately. And finally, most vehicles are restricted in their range of motion, for example by being constrained to follow a paved highway.VANET is the bedrock upon which vehicles will be able to gather, process and distribute information both for safety-related and non-safety related purposes on our motorways. There are mainly two types of applications used in VANETs, safety and non-safety related applications. Let us discuss the details hereunder.

a) Safety Related VANET Applications

Traffic safety applications for vehicles are focused on decreasing the probability of accidents between vehicles. Such applications are based on transmission of safety warning messages to vehicles/drivers about various possible incident situations, such as the collision avoidance, lane changes, overtaking vehicle warning, emergency electronic brake lights, emergency vehicle warning, wrong way driving warning, stopped or slow moving vehicle warning, traffic condition warning, hazard warnings etc.[7]

Safety-related VANET applications are classified into three basic categories, namely: driver assistance (cooperative message transfer, cooperative collision avoidance, road hazard control notification and lane changing), alert information (work zone and speed limit alert information) and warning alert (road obstacle, post-crash and other life-threatening traffic condition warning). Let us see driver assistance categories as detail hereunder:

- **Cooperative Message Transfer:** Slow/Stopped Vehicle will exchange messages and cooperate to help other vehicles. Though reliability and latency would be of major concern, it may automate things like emergency braking to avoid potential accidents. Similarly, emergency electronic brake-light may be another application.
- **Cooperative Collision Avoidance:** Alerts two drivers potentially under crash route so that they can mend their ways [8].
- **Road Hazard Control Notification:** Vehicles notifying other vehicles about road having land slide or information regarding road feature notification due to road curve, sudden downhill etc.
- **Lane Change Warning:** is an application that is expected to be implemented in the mid-term and assist a driver while changing lanes. The lane change warning application is a vehicle-to-vehicle application.

Each vehicle receives periodic broadcast from the surrounding vehicles. Also, each vehicle maintains a table containing the vehicles in the immediate proximity. For this application to be successful, the vehicle locations maintained in the table must be very precise. When the driver signals his or her intent to change a lane, the OBU uses the received data to determine if the road conditions are safe to perform a lane change. One means triggering the application is when the turn signal is applied by the driver, which then invokes the lane change algorithm. If the attempted lane change puts the driver in danger, a warning is generated. The main drawback of the lane change warning application is that it requires that a high percentage of vehicles are DSRC equipped.

A robust wireless communication network is required to enable traffic safety applications. The most significant network requirements for traffic safety applications include the following[7, 9]:

- Traffic safety messages should have maximum end-to-end latency of 100 ms,
- Messages generation frequency is up to 10 messages per second (10Hz),
- Messages should be transmitted accurately on short to long coverage distances (300 m up to 20 km),
- Low data rates are usually required (1 to 10 kb/s).

In addition, some other network requirements should be fulfilled for implementing traffic safety applications, such as the following[9]:

- **High communication reliability (10^{-x}):** express a maximum tolerable packet loss ratio (PLR), for example, with PLR=10⁻⁵ (only one packet from 100000 received packets is not successfully received within the maximum tolerable latency) the reliability is as high as 99.999%.
- **High node mobility (km/h):** maximum relative speed under which the specified reliability should be achieved,
- **High network density (vehicles/km²):** maximum number of vehicles per unit area,
- **High positioning accuracy (cm):** maximum positioning error tolerated by the application,
- **High security:** specific security features required by the application.

b) Non-Safety Related VANET Applications

None-safety related applications are expected to create new commercial opportunities by increasing market penetration of the technology and making it more cost effective. Typically, these applications aim to improve traffic efficiency, passenger comfort and commercial platforms in terms of advertisements and electronic toll collection (ETC). These applications include provision of weather information, current traffic and the ability to locate various Points of Interest (PoI) such as nearest parking lots, gas stations, shopping malls, hotels, restaurants, etc. The owners of these aforementioned businesses can install some stationary gateways to transmit marketing adverts for the mobile customers travelling via the VANET enabled vehicles. The compelling argument in allowing comfort and commercial VANET applications is that of distraction and interference with safety related applications thereby defeating the aim of improving safety and traffic efficiency in our motorways. Consequently, a possible solution would be achieved by using separate physical network channels for safety and non-safety applications or by applying traffic prioritization where safety related messages are accorded higher priority than non-safety related messages.

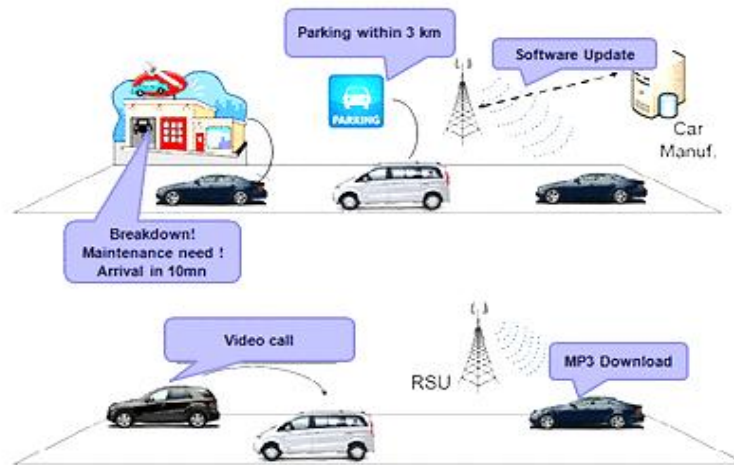


Figure 2.1:VANET Applications [10]

There are many commercial applications that are benefited with the deployment of VANET’s. The applications where VANET can play major roles with its example as described in different researches are summarized on this paper on the following table 2.1.

Table 2.1: Overview of Applications in VANETs

	Situation/Purpose	Application Example
A. Active Safety	1. Dangerous road features	1. Curve speed warning 2. Low bridge warning 3. Warning about violated traffic lights or stop signals
	2. Abnormal traffic and road conditions	1. Vehicle-based road condition warning 2. Infrastructure-based road condition warning 3. Visibility enhancer 4. Work zone warning
	3. Danger of collision	1. Blind spot warning 2. Lane change warning 3. Intersection collision warning 4. Forward/Rear collision warning 5. Emergency electronic brake lights 6. Rail collision warning 7. Warning about pedestrians crossing
	4. Crash imminent	1. Pre-crash sensing
	5. Incident occurred	1. Post-crash warning 2. Breakdown warning 3. SOS service
B. Improved Driving	1. Enhanced Driving	1. Highway merge assistance 2. Left turn assistance 3. Cooperative adaptive cruise control 4. Cooperative reduction 5. In-vehicle signage 6. Adaptive drivetrain management
	2. Traffic Efficiency	1. Notification of crash or road surface conditions to a traffic iteration center 2. Intelligent traffic flow control 3. Enhance route guidance and navigation 4. Map download/update 5. Parking spot locator service
C. Public Service	1. Emergency response	2. Approaching emergency vehicle warning 3. Emergency vehicle signal pre-emption

		4. Emergency vehicle at scene warning
	2. Support for authorities	1. Electronic license plate 2. Electronic driver’s license 3. Vehicle safety inspection 4. Stolen vehicles tracking
D. Business Entertainment	1. Vehicle Maintenance	1. Wireless diagnostics 2. Software update/flashing 3. Safety recall notice 4. Just-in-time repair notification
	2. Mobile Service	1. Internet service provisioning 2.Instant messaging 3.Point of interest notification
	3. Enterprise Solutions	1. Fleet management. 2. Rental car processing 3. Area access control, 4. Hazardous material cargo tracking
	4. E-Payment	1. Toll collections, 2.Parking Payment 2. Gas Payment

III. COOPERATIVE BROADCAST-BASED DIRECTIONAL ROUTING (CBDR) IN VANETS

According to the definition presented in[11]cooperative broadcast communication refers to the processing of overheard information at the surrounding nodes and retransmission towards the destination to create spatial diversity. More specifically, cooperative broadcast communication can assist in achieving a higher spatial diversity[12], lower transmission delay[13], higher throughput [14], adaptability to network conditions, and reduced interference[15]. Considering these features, cooperative broadcast communication technology can play an important role in improving the overall performance of vehicular networks. Vehicular networks are promising for a safer roads and a smooth driving by implementing a several number of safety applications. Packet delivery in vehicular network is one of a crucial task since current applications require the cooperation of each and every vehicle on the road needs to disseminate packets. These latter require that their alert information is disseminate to the concerned vehicles (located in the hazardous zone) with a little delay and a high reliability. For these reasons, this category of applications is considered as delay sensitive and broadcast-oriented nature. In order to make this vision coming true, a surplus of multi-hop broadcast protocols have been proposed in the VANET literature. In this paper, we first focus on broadcast communications based on directional antennas to disseminate messages in a vehicular wireless cooperative multi-hop network conditions. And then we propose the state-of-the-art data dissemination schema donated as Cooperative Broadcast-based Directional Routing (CBDR) scheme that combines route Neighbor-knowledge–based approach and directional antennas to route the data packet toward the final destination as indicated on figure 3.1. A communicating node, using CBDR, calculates its route based on a route selection algorithm and then disseminates the message on the set of nodes within its transmission range and located in its beamforming area. Our proposed CBDR schema does not introduce overhead, and it is simple and it only requires the presence of a GPS receiver and a directional antenna in the vehicle. Our proposal aims to achieve good ratios of packet delivery while significantly reducing the bandwidth consumption and reduce end to end delay. The efficiency of our proposal is studied using real road simulation scenario using OMNeT++ and SUMO model.

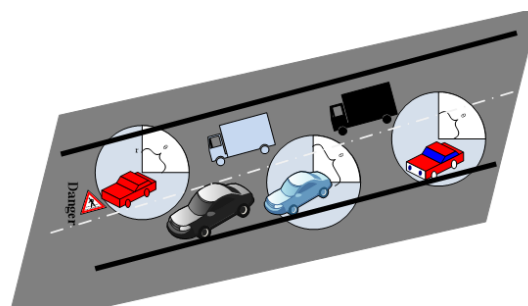


Figure 3.1: Cooperative directional beam formation broadcast scheme

We assume that the first node (in this case red vehicle) broadcasts the message with an angle θ and a radius r_1 . In the following sections, we present the key properties of our route selection algorithm. Then, we discussed detail functionalities of our proposed technique and present relevant simulation results.

a) Route Selection Algorithm

We consider a VANET environment where nodes are positioned along roads and highways. Vehicles are able to determine their geographic position using a Global Positioning System (GPS) receiver. We assume also that vehicles are equipped with a digital map that reflects the road structure of a city and can run the route selection algorithm aiming at providing a suitable route. Generally, such kind of algorithms are already used by some tools such as Mappy[16]. Indeed, an algorithm proposed in different literature uses geographical information such as vehicle location and the hotspot map to route vehicles toward a destination. It builds an oriented graph where nodes represent a portion of a route covered by a hotspot and edges account for possible routes between nodes with a weight function.

In our case, the situation is different since we do not want to guide drivers but we aim to find a path for a packet to reach the destination. More precisely, a directed graph $G = (V, E)$ is built where the set of nodes V represent either road intersections, or some turning points, or some special nodes (control centre, RSU, etc.) as indicated on figure 3.2.

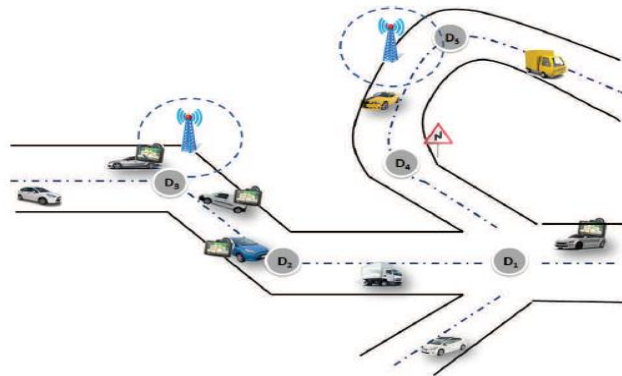


Figure 3.2: Road Map Representation

Perceive that since we are going to use directional broadcasting with a possibly small beamforming angle, the roads are supposed to be straight lines. That is why turning points of roads are considered as graph vertices to make this assumption valid. Each road between two points of V will be represented by an edge. The weight of this edge might be equal to the geographical distance between the extremities of the edge. One can also consider more complicated weights taking into account the vehicle density or jam. In fact, roads with a large vehicle density can be more convenient to transmit the packet since the probability of transmission success increases with vehicle density. Then the edge weight might be a well-chosen function which is decreasing in the vehicle density and increasing in the distance. If a vehicle wants to communicate with a node having a known location (another vehicle, an RSU, etc.), it has to compute a minimum-weight path between its position and the destination. This path will be used to send the packet. Since there are generally many packets to be sent to the same destination, this path does not need to be computed for each packet. If the destination is also moving, the path might be updated from time to time.

We assume that each geographic point has a unique identifier, called PID. The unicity of this identifier is a valid assumption since each geographic point is characterized by a unique couple of GPS coordinates. Thus, the identifier PID may be this couple of values. The sequences of these points are put into the first packet header to transmit as shown on figure 3.3

Source Address	Destination Address	PID1	PID2	PID3	PIDi	PIDN	Data
----------------	---------------------	------	------	------	------	------	------	------

Figure 3.3: Packet Structure

Thus, the broadcasting technique is considered as a next stage to this route selection algorithm.

b) Broadcasting Technique

The effective way to communicate in VANET is through broadcasting critical messages to nearby nodes or vehicles. Reliable local information dissemination is the primary concern for broadcasting in VANETs. The communication method involves sending and receiving message. In VANET, maintaining high connectivity and high broadcast reliability is difficult, especially in dense networks and with non-homogeneous vehicle mobility [17, 18]. Hence, using route selection algorithm, we suppose that the source vehicle, before sending the message, knows in advance the adequate route that the message should follow in order to deliver it to the destination node (control center, RSU, etc). The global route is composed of a number of sub routes $r_i, 1 \leq i \leq N$, where N is the total number of subroutes. At the end of each subroute, there is a cooperative intermediate point namely, D_i , as shown in Figure 3.4. The message should

go through these intermediate points, considered as intermediate destinations, in order to reach the final destination. Hereafter, upon receiving an intermediate packet, each node must decide whether this packet should be forwarded using Neighbor-knowledge-based approach and where to forward. Therefore, vehicles that receive an intermediate message will broadcast it on their turn unless they have seen it before, or unless they are the destination vehicles. The system ends broadcasting when there are no more relays to broadcast. In this case, we assume that the message has arrived or that the system has encountered a transmission failure. The transmission failure is a situation when there is not any intermediate relay to reach the destination.

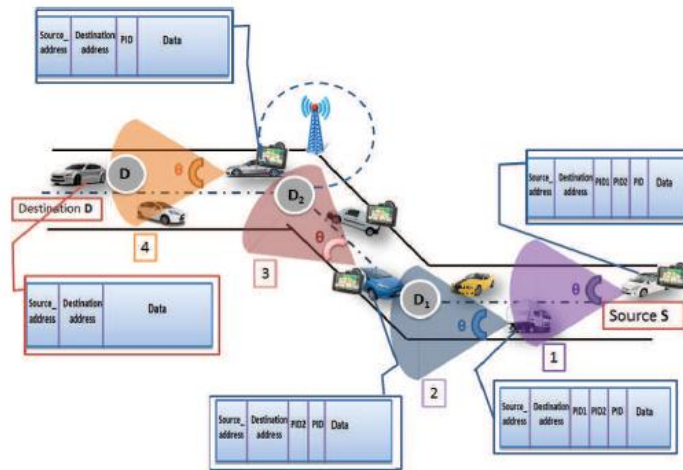


Figure 3.4: Packet propagation mechanism on VANET

On our Cooperative Broadcast-based Directional Routing (CBDR) schema the source node forwards packets through the sequence of streets carried out using the route selection algorithm. Then each node that received a packet compares its current geographic position to the values of the intermediate points present in the packet header. This comparison allows the forwarding node to locate itself within the forwarding process and specially know the next geographic point to which the message have to be transmitted. Afterward, the vehicle removes the list of points that are already reached by the transmission operation (eg. nodes located behind the forwarding node) and points its directional beam toward the position of the intermediate point D_i and makes an angle $\theta/2$ with each side of the central axis linking the relaying node and the next intermediate point D_i . This mechanism is repeated until the message reaches the final destination D as indicated on figure 3.4.

The functioning of our proposed technique for route selection and data dissemination is summarized in Algorithm 1. The broadcasting technique might be enhanced by asking the destination to send an acknowledgment of receipt (for each packet, or for each group of packets). Since the received packets contain the position of the source, the destination can apply the same algorithm to compute a path to the source (or it can be the reverse path). This path is used to send an acknowledgment with the exact position of the destination. Since the destination can be a moving vehicle, the new position can help the source to update the path from it to the destination. If the source node does not receive acknowledgment for a long time, then it can deduce that the chosen path is not convenient to transmit information, and it may use a second path (a shortest disjoint path for example) to broadcast packets.

Algorithm 1:
1: Start procedure
2: Phase 1: Action of the source node
3: The source node S runs the route selection algorithm.
4: The set of intermediate destinations $\{D_i\}$ is determined using the route selection algorithm.
5: S puts the sequence of the cooperative intermediate destinations D_i in the header packet.
6: Dissemination of the packet by S using beamforming angle toward the first D_i .
7: for each node i do

8: if Packet already received or node <i>i</i> is the final destination Then
9: the packet is removed and not transmitted
10: else
11: repeat
12: node <i>i</i> compares its current position to the geographic positions of <i>D_i</i> .
13: node <i>i</i> removes the sequence of <i>D_i</i> already reached from the packet header.
14: node <i>i</i> points its directional beam toward the next intermediate node <i>D_i</i> .
15: node <i>i</i> make an angle $\theta/2$ with each side of the central axis linking <i>i</i> to <i>D_i</i> and transmits the message.
16: until $D_i = D$
17: end if
18: end for

The pseudocode for route selection algorithm between neighboring vehicle are described on the following figure 3.5

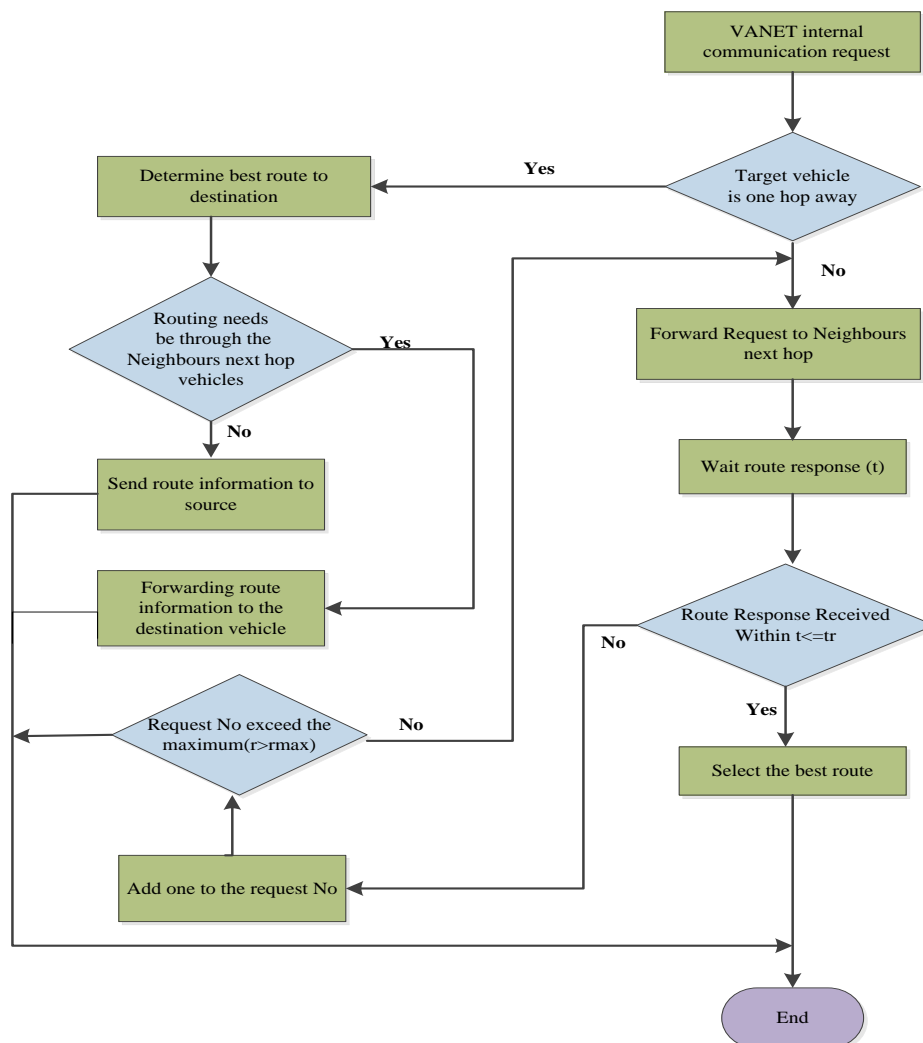


Figure 3.5: Route selection algorithm between neighbouring nodes

IV. SIMULATION SCENARIOS AND RESULTS

On this section of the paper we develop our simulation scenario based on the mobility simulators and network simulators, we create a VANET network scenario which has a RSU and 200 vehicles based on sumo model, the location of the vehicles are generated based on the sumo model. Next, Randomly Select the Source and Destination of the vehicles from the network. Then detect the nearest node and if the destination is in one hop of the source then pass the value based on the Neighbor-knowledge-based approaches. Perform the data dissemination process between Source and Destination by using the Cooperative Broadcast-based Directional Routing (CBDR) Approach that we develop. After the path is connected between the source and the destination the packet transmission is performed. While the data is disseminating on the line if there is any loss of packet transmission, the re-transmission of the packet performed based on the probability-based approach, the probability value based on the flag value and the flag values are transferred with the data's. After all those processes passes finally, perform the packet transmission successfully to its destination. Hereafter, on this section we generate the graphical results of our proposed CBDR data dissemination approach for Packet Delivery Ratio vs Number of Vehicles, Throughput vs Number of Vehicles and End to End delay vs Number of Vehicles. To perform the simulation we use OMNeT++ and SUMO simulation.

Figure 4.1 demonstrates the relationship within the vehicles and the successful packet delivery ratio. Whenever the number of vehicles is increased on the road, the successful packet delivery ratio is also considerably increased.

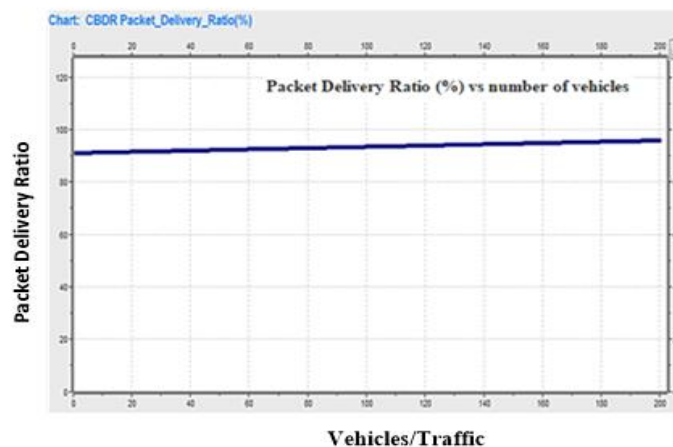


Figure 4.1: Packet Delivery Ratio (%)

Figure 4.2 illustrates the relationship within the throughput requirement and successful broadcasting ratio; whenever the throughput requirement is increased, successful broadcasting rate is increased. Additionally, the route is more; the Throughput requirement is also higher. Moreover, the lesser amount of routes is established in the proposed method in finding the alternate nodes for calculating the throughput requirement.

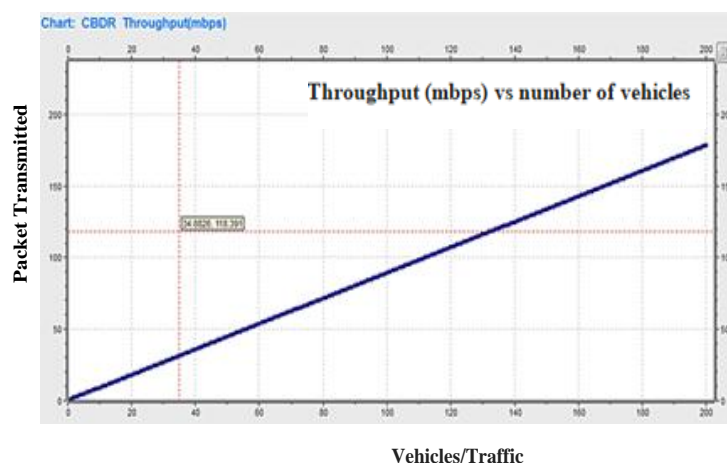


Figure 4.2: Throughput (mbps)

Figure 4.3 demonstrates the relationship within the speed of mobility and the successful broadcasting rate. As shown, the mobility speed is increased; Cooperative multi-hop delay at every vehicle, averaged over the network. In our CBDR data dissemination protocol, even when the number of vehicles increased it does not produce much delay as shown in figure 4.3

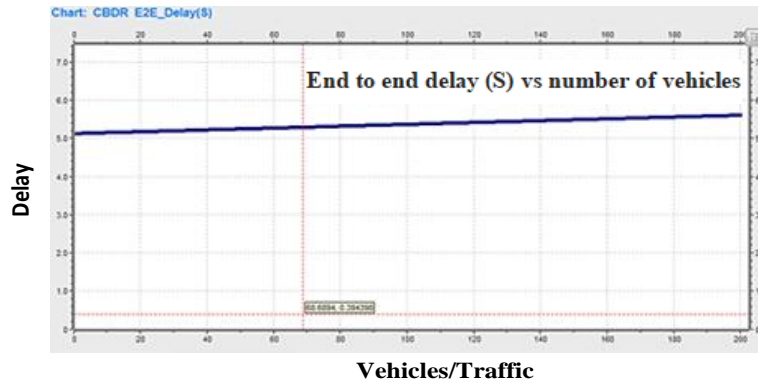


Figure 4.3: End to End delay (S)

V. CONCLUSION

Recently, with the development of vehicle industry and wireless communication technology, vehicular ad-hoc networks are becoming one of the most promising research fields. The intense social and economic impacts of road accidents have motivated the research towards Vehicular Ad-hoc Networks (VANETs). This technology is essential in the deployment of the intelligent transportation system, which is targeted to improve safety and efficiency of traffic. The implementation of VANETs can be effectively executed by transmitting data among vehicles with the use of cooperative multiple hops.

Data dissemination in VANET environment usually involves challenging issues regarding the characteristics of the medium and data dissemination techniques. Several multi-hop data dissemination protocols have been proposed for VANETs on different articles. However, it has a problem on the performance of packet delivery ratio, throughput and end to end delay. Therefore, after reviewing the several articles regarding data dissemination techniques in VANETs and to address the indicated problems, we design and develop our own route selection algorithm and data dissemination protocol on this paper. To this end, the proposed state-of-the-art data dissemination technique donated as Cooperative Broadcast-based Directional Routing (CBDR) data dissemination technique. Therefore, the simulation result shows that our CBDR data dissemination scheme is simple and achieved good ratio of packet delivery while significantly reducing the bandwidth consumption and reduces end to end delay.

REFERENCES

- [1] Sarah Petit. *World Vehicle Population Rose 4.6% in, 2019*; Available from: <https://wardsintelligence.informa.com/WI058630/World-Vehicle-Population-Rose-46-in-2016>.
- [2] WHO. *Road traffic injuries* Accessed November 2019; Available from: <https://www.who.int/news-room/factsheets/detail/road-traffic-injuries>.
- [3] Menouar, H., F. Filali, and M. Lenardi, *A survey and qualitative analysis of MAC protocols for vehicular ad hoc networks*. *Wireless Communications, IEEE*, 2014. 13: p. 30-35.
- [4] Cuomo, F., et al., *Enhanced VANET broadcast throughput capacity via a dynamic backbone architecture*. *Ad Hoc Networks*, 2014. 21: p. 42-59.
- [5] Bali, R.S. and N. Kumar, *Secure clustering for efficient data dissemination in vehicular cyber-physical systems*. *Future Generation Computer Systems*, 2016. 56: p. 476-492.
- [6] Chouhan, P., G. Kaushal, and U. Prajapat, *Comparative Study MANET and VANET*. *International Journal Of Engineering And Computer Science*, 2016.
- [7] Karagiannis, G., et al., *Vehicular Networking: A Survey and Tutorial on Requirements, Architectures, Challenges, Standards and Solutions*. *IEEE Communications Surveys & Tutorials*, 2011. 13(4): p. 584-616.
- [8] Yang, X., et al. *A vehicle-to-vehicle communication protocol for cooperative collision warning*. in *The First Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services, 2004. MOBIQUITOUS 2004*. 2004.



- [9] Hameed Mir, Z. and F. Filali, *LTE and IEEE 802.11p for vehicular networking: a performance evaluation*. EURASIP Journal on Wireless Communications and Networking, 2014. 2014(1): p. 89.
- [10] Stefano, B., et al., *A Taxonomy of Data Communication Protocols for Vehicular Ad Hoc Networks*, in *Mobile Ad Hoc Networking: The Cutting Edge Directions*. 2013, IEEE. p. 1.
- [11] Li, Q., et al., *Cooperative communications for wireless networks: techniques and applications in LTE-advanced systems*. IEEE Wireless Communications, 2012. 19(2): p. 22-29.
- [12] Gharavi, H. and B. Hu, *Cooperative diversity routing and transmission for wireless sensor networks*. IET Wireless Sensor Systems, 2013. 3(4): p. 277-288.
- [13] Li, Y., et al., *Joint channel allocation and relay selection with multi-QoS provisioning in cognitive cooperative networks*. 2013. 191-195.
- [14] Gupta, N. and V.A. Bohara, *An Adaptive Subcarrier Sharing Scheme for OFDM-Based Cooperative Cognitive Radios*. IEEE Transactions on Cognitive Communications and Networking, 2016. 2(4): p. 370-380.
- [15] Zhang, Q., et al., *Optimal Power Allocation and Relay Selection in Multi-hop Cognitive Relay Networks*. Wireless Personal Communications, 2016. 86(3): p. 1673-1692.
- [16] Mappy. *openstreet map*. December 2019; Available from: <http://www.mappy.com>.
- [17] Chen, R. and A.C. Regan, *5 - Broadcasting in vehicular networks*, in *Vehicular Communications and Networks*, W. Chen, Editor. 2015, Woodhead Publishing. p. 95-112.
- [18] Ahmad, A.-M., et al., *A reliable broadcast approach for VANET's safety messages*. 2017. 1-5.