EFFICIENT GEOGRAPHICAL ROUTING PROTOCOL USING BEACONLESS APPROACH IN VANET

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Candidate of **Master of Science in Computer Science (MSCS)** at the National University of Modern Languages do hereby declare that the thesis **Efficient Geographical Routing Protocol using Beaconless approach in VANET** submitted by me in partial fulfillment of MSCS degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution. I also understand that if evidence of plagiarism is found in my thesis/dissertation at any stage, even after the award of a degree, the work may be cancelled and the degree revoked.

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ABSTRACT

Title: Efficient Geographical routing protocol using Beaconless approach in VANET

Vehicular ad hoc networks (VANETs) include vehicles to communicate with each other and share the data with the central repositories. Intelligent transportation systems timely manage the traffic hazards and inform the nearby vehicles to ensure road safety. It is quite important to select the next relay node in VANET who can transmit the messages to next vehicles. For communication between vehicles, it is very important to select more accurate vehicles as next forwarder to avoid loops and increase the cost of the network. During the next forwarder node selection. BTA-GRP considers the long distance and large angle to choose the farthest node [4]. The main problem is that it does not consider all possible realistic scenarios like the node at largest distance with greater angle. Also, it was not defining the case if those vehicles which have smaller distance to source node along the small angle with destination node. In this research, these parameters are defined and calculate their values by considering different scenarios. In the proposed scenario, the network can achieve high throughput of the network and packet delivery ratio and reduce the delay in the network. The proposed beaconless protocol for vehicular network calculates the distance between node, angle of the nodes and traffic density of the road on the intersection point and set its priority according to the condition. Beaconless protocols are those protocols in which messages are not exchanged between the source and other nodes in the network to build up communication channel. The NS2 simulator is used to evaluate the performance of the proposed protocol. The proposed protocol achieved better throughput to 0.7, packet delivery ratio increased to 0.8 and reduced the delay to 1s as compared to BTA-GRP, IPN and IB.

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LIST OF ABBREVIATIONS

OTcl	-	Object Tool command Language
PO	-	Packet Overhead
Adhoc	-	Adaptive Power Control Routing
VANET	-	Vehicular Network
RSU	-	Road Side Unit
CP	-	Collector Packet
ETE	-	End to End
V2I	-	Vehicle to Infrastructure
V2V	-	Vehicle to Vehicle
AKG	-	Acknowledge Signal
GPS	-	Globle positioning System
NS2	-	Network Simulator version 2
CBR	-	Constant Bit Rate
N_{con}	-	Constant connectivity degree
TD_{value}	-	Traffic density
V_i	-	Initial vehicle
V_f	-	Destination vehicle
fit	-	Fit function
N_{pdr}	-	Packet delivery ratio
D_{elay}	-	Average delay

LIST OF SYMBOLS

Distance ND[i]	-	Loop of the Distance between the nodes
$Direction_{weightvalue}$	-	Loop of the Direction of the nodes
calculateMax	-	Function to calculate the maximum value from loop
calculateMin	-	Function to calculate the minimum value from loop
α_1	-	Priority value of the distance of the node
α_2	-	Priority value of the direction of the node
Min_distance	-	Minimum distance of the node is calculated and store in it.
Max_angle	-	Maximum angle of the node is calculated and store in it.
Min_angle	-	Minimum angle of the node is calculated and store in it.
Max_distance	-	Maximum distance of the node is calculated and store in it.
N (x2, y2)	-	Neighbor location information is stored.
S (x1, y1)	-	Source location information.
$Curr_{ND}$	-	Current angle distance.
$Curr_{NA}$	-	Current node angle
NEXT_Mode_Priority	-	Node priority is set according to condition.
Next_Forward_Node	-	Score function set the priority of the node.
Node_density_priority	-	Density of the road is set by using this variable.
TD_{valueD}	-	Traffic density of the road

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I shall also acknowledge the extended assistance from the administrations of Department of Computer Sciences who supported me all through my research experience and simplified the challenges I faced. For all whom I did not mention but I shall not neglect their significant contribution, thanks for everything.

DEDICATION

This thesis work is dedicated to my parents, supervisor associate. Prof. Dr. Ata Ullah and teachers who helped me to reach at this stage and give me guidance. Those teachers who inspired me by their knowledge and success in their life which help me to write this thesis.

CHAPTER 1

INTRODUCTION

1.1 Overview

VANET (Vehicular ad hoc network) is important to make fast communication in the future. It is a network of the mobility node to transfer data packet from source node to destination node by using relay nodes from the network. The focus of selecting the next relay node is which is the farthest node and has less communication cost by selecting it. V2V and V2I communication is occurred in this network. Vehicle to vehicle communication between two vehicles and Vehicle to Infrastructure communication between vehicles and antennas, RSU. In this research, the point on which work is to reduce packet overhead by selecting competitive highly reliable relay node. An ad hoc network is a collection of wireless mobile computers in which alliance nodes work for forwarding packets in the network to allow nodes to communicate beyond direct wireless transmission range. The VANET (Vehicular ad hoc network) is a high mobility network, it leads to the confusion in the selection of the next relay node.

VANET is a network in which there is no central point which helps to make important decision, how to select the next relay node to transfer data from one place to another, on the other hand all nodes make their decision for the selection of next relay node. Selecting the next relay node is crucial step in it? To find out the answer to this question, researchers present different solutions.

1.2 Architecture of Vehicular Adhoc Networks

Internet of Things (IoT) connects all the things to each other and make decision according to the information gather with other devices. Number of Vehicles are increased gradually on the road. It is very important to connect all the things to each other for better communication and reduced the destructions. IoT is integrated into VANET. VANET (Vehicular ad hoc Network) is a network which introduced to communicate data through vehicles on the road in an efficient way. It is the sub-part of MANET to enhance the reliability of traffic data which help to manage the traffic more accurately [1]. The figure 1.1 show the general structure of vehicular network.

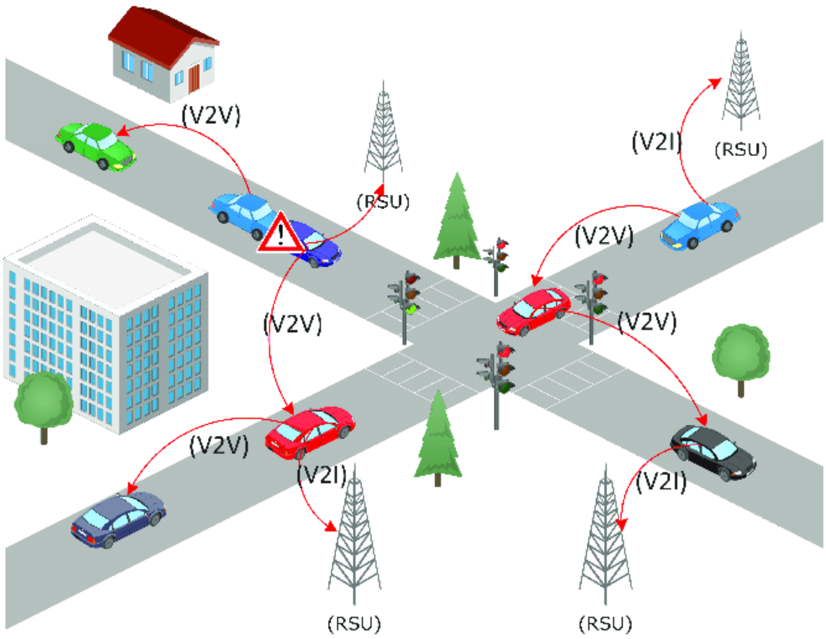

Figure 1.1. Structure of VANET

The VANET is high mobility network as vehicle nodes are moving or changing their position continuously. But there are several characteristics of VANET which make it differentiate from MANET as the movement of nodes, in mobile network nodes can move in any direction no route follow whereas in vehicular network follow some route as highway. In smart cities, vehicles have an important factor, so they are used to communicate current situation of road with each other to prevent road accidents or others travelling delay. For this type of communication, it is essential to develop high responsive protocol.

The protocols are divided into two different types including beacon-based and beacon-less. Beacon messaging may increase the cost, speed and energy of the network device rather than beaconless techniques reduce these disadvantages. VANET requires a faster communication because its information help to prevent the accidents and usage of roads more efficiently. Researchers work on it to develop beaconless protocol for better communication in VANET.

VANET has three important component in its architecture, one is OBU (on board unit) are used to transmit radio signal and processed them accordingly, RSU(Road side unit) are used to enhance the performance of network by supporting vehicle to vehicle and vehicle to infrastructure communication and communication channel have two standard, sepectrum resource allocation and divide band which are used in vehicular network. V2X and V2V are two type of communication techniques in VANET. V2X is a way to communicate between vehicles and all type of devices on the road such as Road Side Unit (RSU). Figure 1.1 show the overview of VANET structure. The other one is V2V which help to transfer data between vehicles [2]. Dedicated Short range communication (DSRC) is a method which is widely used in VANET with IEEE 802.11 [3]. It is an advanced technology which help the connected vehicles with latest networking architecture.

Road side unit (RSU) is important device which are located on some distance of the road to learn and update the situation of the traffic on the road. It store on the specific distance on the road to collec uodated information of the road. It has a high bandwidth and better bettary power. It support two way communication V2I and V2V. It will also help the data packet to cover a long distance which help in usage of the bandwidth in the network. V2I communication refer in VANET the data transfer between vehicles and infrastructure.

Intelligent transport system (ITS) is used the VANET technology widely for managing the traffic on the road in an organized manner. It applies to enhance the capability of the smart cities. The emergency messages can be share with other devices to maintain the traffic congestion on the road. The drivers are informed in advance about the congestion on the road and they will take action timely.

1.2.2 Applications of Vehicular Adhoc Networks

Smart cities have more vehicles which can be used to send information. Vehicles have an important factor in smart cities which can be used to build up network without applying much equipment. IoT has a wide range of usage in the different fields such as traffic maintenance, medical field, domestic usage and others. Humans being are facilitated by improving IoT technology. It helps to develop smart cities services more reliable and secure. VANET is one of the parts of IoT which is used to transfer data packets from one place to another to avoid delays in the network [4-6].

- To maintain the traffic on the road, it will help the drivers to eliminate those routes which are dangerous and where traffic jam.
- It also helps the vehicles to use their petrol and other resources of vehicles and roads accurately which will help in to attain sustainable development goal 12 and 13.
- Smart cities have based on the networking to connect all things with each other. To transfer data without any hindrance. Vehicles ad hoc network will help the access of the internet to everyone in the cities.
- By using traffic information sharing, both drivers and road maintenance companies are getting benefit by reducing the travelling distance.

1.2.3 Constraints in Vehicular Adhoc Networks

The problems of VANET (Vehicular Adhoc Network) are mentioned below to determine and resolve them to make efficient and effective the vehicular network [7-9].

i. *Limited Energy:* Every node in the network calculates the cost of transferring data from itself to next node. So, it is important to select the minimum factor for the selection of the next relay node to save the energy of the node.

ii. *Communication Space:* VANET is a high mobility network, communication space will be changing from time to time.

iii. *Packet overhead:* Packet overhead is increased due to the change of the topology in the network.

iv. *Packet loss:* If the reliable relay node is not selected then loss of packet will occur in the network.

v. *Looping:* The looping issue occurred in the vehicular network due to bidirectional movements of vehicles.

vi. *Movement of the vehicles:* the vehicle on the road moves variably and their location changes with time. So, maintaining the position information and speed of the vehicles is challenging term.

vii. *Directions of vehicles:* vehicles move in bidirectional on the road. So, selecting the vehicles which move in the direction of the source node.

viii. *Path specification:* the path of the vehicles is specified because they are moved on the road which are built already.

1.3 Problem Background

The farthest next vehicle is selected with larger distance and small angle of the vehicle with source vehicle [4]. The base scheme lacks in addressing the issues how to select the next relay, if its distance with source vehicle is larger and the angle of the next relay node to destination vehicle and source node is greater? [4]

1.4 Problem Statement

If the sender vehicle has many neighbors' vehicles how to pull out the number of vehicles from them. Select those vehicles which has less distance and move toward the destination vehicle to minimize the energy consumption of the network. The farthest node with smaller angle is not suitable because it may not be reachable due to the high mobility of the network. The nearest vehicle with larger angle is led to increase the number of hops in the network which greatly affect the performance and there is more chance that vehicle may be in the anti-direction. In this research, identified that vehicle which has smallest distance with smaller angle it may be reduce the packet overhead and lead the high packet delivery ratio in the network. Also evaluate the capability of the network, by selecting a far vehicle with grater angle. Due to the fast mobility of the network, it may be not reachable then how to make communication in the network. On the contrary, the data may be transferred with the two number of hops instead of single node which is not suitable.

1.5 Research Questions

These research questions are solved to improve the working of vehicular adhoc network.

i. How the forwarder node can be selected with less communication cost in dense scenarios?
ii. What will be the effect on packet overhead if the neighbor vehicle has greater distance with greater angle?
iii. How to process the case when the candidate next relay node has smaller angle?

1.6 Aim of the Research

Vehicular adhoc Network (VANET)is an enormous field of research. It is a critical to select next relay node in VANET due to the high mobility of the network. In this research, describe the solution which help to select such relay node which help to reduce the packet overhead, cost and enhance the reliability of network.

1.7 Research Objectives

The following objectives are defined to design and develop enhanced an efficiency of vehicular adhoc routing protocol.

i. To design and develop a scheme that reduced the packet overhead for dense scenario by considering direction parameter.
ii. To choose the next hop node at the communication boundary with farthest distance and less packet overhead.

1.8 Scope of Research Work

Simulation is an important component of the research, so it is selected accordingly to the research. Simulators are used to extract the protocol’s results in less time and cost effective. There are many simulators are available which create real world scenarios for testing the new protocols to get the more appropriate result. In this research, NS-2.34 simulator will be used to evaluate the protocol and compare its result with previous protocol result. NS-2.34 is a most popular simulator used in networking research area. The most of the networking researchers are used this simulator for evaluating their protocol.It is easy to install and inexpensive to evaluate the result of new research protocol. MOVE tool is used for the vehicles movement and help to add traffic light in the scenario. OTcl (object-oriented Tool Command languages) and C++ languages are used in the NS2 simulator. NAM (Network Animator) is executing to run the animation and Trace File is used to create graph as delay graph, complexity, energy efficiency etc.

IEEE 802 is a LAN technical standard which defined the policies to transfer data in the wireless local area network. IEEE 802.11 is a subpart of the IEEE 802 and it cover a large range of communication area. The policies of network and regulation are defined in physical layer, network layer and media access control (MAC). [5]

1.9 Motivation

To make fast and cost-effective communication, researcher focus on selected the next relay node. The selection of the forwarder node is an important factor in VANET to travel data with maximum throughput and packet delivery ratio in the network. The researchers used different parameter for the selection of next relay node in vehicular environment, hence distance, direction, angle and traffic density of the vehicle will be used in this research for selecting the competitive next relay node. Distance metric help to select the farthest node in the communication range. Direction variable is used to eliminate the anti-direction vehicles and remove the chance of looping problem in the network. Moreover, angle factor is very important to eliminate the unrelated vehicles from candidate node list.

1.10 Thesis Organization

The rest of thesis is organized as follows:

Chapter 2 provides background on the selection of next relay node by considering various parameters by researchers. The summary of the research papers is discussed in it and determined their limitation and how will they be improved. Categorized the research paper based on the attribute. Also discuss the detailed research gaps in the vehicular network and compared the various research paper which perform best.

In chapter 3 briefly explain the methodology of the efficient geographical routing using beaconless approach for VANET. Research design and architecture is explained with detailed diagrams in it. Simulation and its parameters are explained in it and research assumptions and Gaps are also discussed here.

Chapter 4 offers detail explanation of efficient geography routing protocol using beaconless approach for VANET includes problem identification, distance, direction and traffic density parameters equations, and score forward formula. Algorithm of the proposed protocol is represented in it.

Chapter 5 will provide performance evaluation of efficient geographical routing protocol using beaconless approach for VANET. The network overhead, packet delivery ratio and average delay performance parameters graph is represented in it against number of nodes and speed of the vehicles.

Chapter 6 will give summary of contributions in research of vehicular adhoc network and discuss the future research in this field.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Beaconless Geographical routing protocols for Vehicular network are discussed in this chapter. Write their summary and important points are mentioned in it. Vehicular networks are a vast field of research, and it is divided into proactive and reactive protocols. Vehicular networks are divided into proactive and reactive protocols. These types are discussed in this chapter. Proactive protocols are those which make decisions from the information of the route and reactive protocols send the packet to the neighbor node and make decision on their response.

2.2 Vehicular Adhoc Networks

Ad hoc network means built instantly a network without working on establishing and planning a huge network. Ad hoc network is built up for specific project or task without working on a lot of steps of installation. Vehicular ad hoc network is a type of wireless ad hoc network. It is a network which is made up of vehicles to transfer data from source node to destination node. In vehicular network, there are various path which can be used to reach the data to the destination node. It is very important to select such path which help to send the data in short time and without damage occur in it. Two types of communication occur in the vehicular network, vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). There are different problems arises which should be overcome for effective and efficient network.

In VANET, looping issues, packet overhead and communication cost problems are main problem due to the high mobility of vehicular network. Looping issue occur when source node selects the anti- directional node as a next relay node. Packet overhead problem arise when packet save a lot of information about network in its head, so it can be minimized by eliminating the irrelevant information from it. Packet overhead’s bits are also increased when number of the network topologies varies from source to destination which cause to add additional information in packet header to increase the reliability of the network. Communication cost takes place when usage of bandwidth increase. Packet loss and packet delivery ratio are calculated to check the performance of the network.

Vehicular environment network is an important factor in the building of smart cities. It has various features which make it special compared to other types of networks such as MANET and WANET. The vehicular network is consisted of the nodes which are not steady in one place, moveability of the node is one the most important attribute on which protocol are build [22]. When the data packet is not sent from source to destination with one hop then multi-hop communication occurs in the network. Some of the problem is discussed below:

- Battery constraints: The transmission of the packet requires a large amount of battery power when sent in a single hop to the destination. If the packet is sent to nearest node with less power than most of the battery power can be saved. It can be achieved if many vehicles are present in the network or select that path where density of vehicle is greater.
- Packet overhead: Due to the high mobility in the vehicular network, topologies highly change during the transmission of packet. It led to an increase in the overhead value. It would be reduced by eradicating unimportant information from header of the packet, which is not prime attribute.
- Throughput: The network throughput is affected due to the high mobility of the vehicular network, as the speed of the vehicles is unpredicted on the road, location of the vehicle and density of the vehicles. Select those parameters which have a great impact on the delivery of the data packet in the network.
- Reliability: the reliability of the network is greatly influenced by the unpredicted network architecture. It is unknown that density of the vehicles on the road, real time decision making, speed of the vehicles and find out the

shortest path in the network, connectivity of the link is not sure which lead untrustworthy network [4].

- Looping: vehicles are moving in both directions so, when the packet is transferring then eliminate those vehicles which move in the opposite direction to avoid the retransmission and unwanted delay in the network. This issue can be solved by considering the direction parameter.
- End-to-End delay: vehicular network cannot tolerate the delay in the delivery of the data packet, as the VANET is used for safety of the road. Selecting the shortest and most reliable path to transfer messages in the network is an important aspect in the vehicular network. [7]

Vehicular ad hoc networks are very useful technology in the smart city. It helps to automate the traffic lights and vehicles on the road. It’s also played an important role in the reduction of the road accidents and efficiently using the resources of the roads. The point of discussion in the research field how to improve the performance of the vehicular network. There are two different types of protocols are introduced are beaconless and beacon-based protocols.

2.3 Economically Reliable Vehicular Adhoc Network Routing Protocols

In this section, discuss the detail view of vehicular environment network protocol work and parameters are used in it to select the next relay node and how the researcher differentiate their work based on the working of the protocol. The main difference of the protocols, known in the research area, are beaconless and beacon-based protocol. Beacon less protocols are those in which less transmission packets required to make connection between two nodes. Therefore, vehicular ad hoc network is divided in reactive and proactive approach, As, proactive approach means the routing route is maintain in tables on every node to transmit packet from source node to destination. And reactive approach means to select the path of routing at a time when it is required.

Moreover, clustering-based routing, Geocast based routing and Broadcast routing are also approaches of routing in the VANET. The researchers used different routing approaches in their protocol to build an efficient and reliable protocol [22]. The multi-hop means hop-to-hop protocols transfer of data acknowledgement send between two nodes whereas data delivery acknowledgement is sent to the source node and last destination node which expect to receive the data packet, is end-to-end acknowledgement.

Further, VANET routing protocols are mainly focus on the selection of next relay node. The parameters are used to select the next relay node. Distance, angle and direction are main parameters which are important in the selection of the next relay node. BTA-GRP [4] used the distance and direction parameter for the selection of next relay node. However, researchers used different parameters are used in the selection of next relay node and the combination of parameter are used for it. The researchers [6, 7,8,9,10] used some perimeters to calculate the reliable and effective path for making communication through vehicles. For example, R^2P [11] used the vehicles velocity and predict the expected next position of the car for the selection of next relay node.

The other important parameter on which the researcher work is the direction of the vehicles. Due to the road structures, vehicles move in both directions. So, the selection of next relay node is not reliable if it was only considering the distance between the vehicles than looping issues arise which cause the communication cost and badly effect on the performance of the network. Most of the researchers considers direction parameters as [4,10,11].

Vehicular Environment Network are based on two different types of protocol; one of them is Topology base routing protocol and other is position based routing protocol. Topology base routing protocol which transfers data by using source and destination addresses. It is further divided into three categories; Proactive, Reactive and hybrid protocols. Position based routing protocol are those in which nodes get the information of other nodes location before transferring the data packet [9,24]. Beacon based and beaconed less approach are split to a greater extend of position base routing protocol. These protocols are using exact position of the node to be determined it for the next relay node. In beacon based, some packets are exchange before transferring the data packet whereas beacon less protocol, use the GPS system to get the information about the nodes location and select the appropriate next relay node. Cluster based, broadcast approach and Geocast approaches are also the types of VANET routing protocol.

2.3.1 Proactive VANET routing protocols

In this section, proactive routing protocols are discussed in detail. Proactive routing protocols are those which store the information of the neighbor's node in the routing table of every node. These protocols take much effort during the setup while, low latency is achieved during the execution process. Beacon messages are not required to be sent before transmission of the packet while routing tables should be updated time to time for achieving high results. Some of the protocols are combined with the Geocast protocol to get rid of beacons approach.

Nuruzzaman, M. T. Et al. [7] add the latest information about transmission range in the RTS packet, (Request to send). The HA-BGR protocol sent RTS packet from source node to candidate node to become the next node. From that node which send first CTS packet consider next hop. To calculate the distance between previous source node to destination node (PS-DN) and new source node to destination node (NS-DN), if the PS-DS distance is greater than NS-DN than it is consider a positive change. If no CTS packet receive by the source node than source node waits specific time to transmit again RTS packet. Evaluate the performance of the protocol on both way Analytical and simulator. The HA-BGR protocol is compared with the CDR-BGR protocol. The number of candidates which are present in the range to become next relay node, is more in CDR-BGR as compared to HA-BGR. Moreover, number of candidate attribute is used to minimise the communication cost. The HA-BGR protocol performance is calculated on these metrics, delivery ratio, energy consumption and latency. The protocols metrics value is higher than CDR-BGR protocols. This protocol is implemented in the software define network architecture in future and the protocol can be improve by making node independent by comparing some parameter on candidate node side.

Soleymani, S. Et al. [8] authentication of vehicles is introduced. By analysing ID authentication of sender, considering event time and calculating the distance between sender and receiver through GPS and RSS (Radio Signal Strength). In a mean time, the performance of the protocol is increased if the malicious vehicles are eliminated from the calculation. Another feature considers in decision making while node is trustworthy or not, is that history of node trust list on receiver side. Foggy computing technique used to make decision, there are three different units with each three different values on which trust value is based. In evaluating the protocol, its performance is 98% when there is only 10% malicious vehicle in the network and as malicious vehicle increase each 50% its performance reach 72%. This is a simple model for implementation and achieves an acceptable performance. This protocol's rate of performance can be increase by involving the RSU (roadside units) in the calculation. Nodes are making too much calculation and maintaining the data of previous trustworthy vehicles. It is a good approach if RSU units are involved of making all these calculations, the node is trustworthy or not.

Nooji Venkatramana et. al [9] CISRP (Connectivity-aware Intersection-based shortest path routing protocol) introduced which is based on the node connectivity of the vehicles. Every vehicle should maintain the table of neighbour's information (position, speed and road id) to select the next hop in the route. It is assumed that in this protocol that source vehicle is nearest to junction. The first step for the source vehicle to get the smallest path from digital map. That path helps to collect the information about neighbour's vehicles and junction in the path. If the destination vehicle is not located in the radio range than select the next relay hop by calculate the speed and distance of the vehicles in the rectangular cell by using equation (2.1,2.2,2.3). The equation (2.1) is used to compare the average distance and speed with current node by using x-axis value and y-axis value of the node is compared by using equation (2.2). The equation (2.3) is used to optimal next relay node $VC_{i.}$ These parameters are compared with the average speed and distance of the vehicles present in the rectangular cell. The following formulas are calculated the selected vehicle [9].

$$\left\{\left|x_{VC1} - \left(x_{VJcurrent} + \frac{R}{2}\right)\right| < \left|x_i - \left(x_{VJcurrent} + \frac{R}{2}\right)\right|\right\} \tag{2.1}$$

$$\left\{\left|y_{VC1} - \left(y_{VJcurrent} + \frac{R}{2}\right)\right| < \left|y_i - \left(y_{VJcurrent} + \frac{R}{2}\right)\right|\right\} \tag{2.2}$$

$$\left\{\left|SP_{VC1} - SP_{avg}\right| < \left|SP_i - SP_{avg}\right|\right\}$$

(2.3)

The selected vehicle has less difference between the speed of that vehicle and average speed of vehicle and vice versa for the distance. The performance is calculated by considering packet delivery, End-to-End delay, Normalise routing overhead and Average hop count parameters. This protocol has packet delivery ratio more than other protocol as the speed of the vehicles reach to 90 kmps. In this protocol, bidirectional condition of the vehicle is not implemented. This work will be improved by adding parameter of direction of vehicle in this protocol.

Oliveira, R. et al [10] Adaptive Data Dissemination protocol (AddP) is introduced to reduce the retransmission massage by selecting the appropriate candidate from neighbour's vehicles. In this protocol, local density and distance between the neighbour node and the source node are considered. AddP protocol used warning messaging aggregation mechanism to minimise the inessential messages in the network by considering the relay nodes in the network by all nodes. The protocol is closed to beacon-based approach, in which some messages are exchange before starting the broadcasting the data packet. This protocol is consisting of three distinct operations: one is *beacon control and sending,* second one is *determination of neighbour and* last one is *Efficient Data Dissemination modules.* The performance metrics are delivery ratio, redundancy ratio, propagation distance, total number of beacons, collision ratio, and dissemination efficient. AddP behaviour is compared with DOT, PGB, TBN, and pure flooding. AddP perform better in dense scenario and its beacon massages are also reduced in high vehicular environment. The performance of AddP protocol is measured in both scenario urban and rural areas. In the future work, direction parameter is used to reduce the usage of bandwidth and delay factor, and the effect of road interception is considered. This work can be enhanced by introducing the mathematical model of this work.

Saleh, A. I. et al [11] is introduced the reliability routing protocol for VANET. The Vehicular environment has a dynamic behaviour so, it is difficult to maintain the link life for a prolonged period. Thus, it is better to select reliable link for transmission of data packet to overcome the delay and minimise the communication cost. For this purpose, this protocol is divided into two parts: one is the Network setup phase and other is the Route Discovery and Maintenance phase (RDM). Network Setup phase routes are divided into zone and in route discovery and maintenance phase is discover the route when data packet is needed to send in the network and maintenance mean to maintain the route in each zone privately. The performance metrics are used packet delivery ratio, packet overhead, throughput, end-to-delay, and Normalized routing load to measure the capability of reliable routing protocol. The behaviour of reliable routing protocol is achieving a maximum throughput and minimum delay as compared to other protocol (SRS, OEB and DUBE). As the number of source node is increased its performance is improved as throughput is greater than 5000 kbps when the nodes are 60. The protocol enhanced by added the security parameter in it and considering the less calculation on the building up the routing tables and these tables maintenance required a lot of effort in the network.

Baiocchi, A. et al [12] is introduced the new mechanism for avoiding the spurious messages to broadcast in the vehicular network. The flooding and collision issues are appeared, when an emergency is occurred on the road than number of vehicles generate the message for broadcasting in the VANET. This mechanism is supposed to run in the environment in which packet is transmitted in the long range mean multi-hop vehicular communication. In multi-hop communication, Relay node is an important factor to deliver message in different ways as relay nodes range collide with each other than the message collision occurred in the network. So, select the relay nodes with the maximum distance to avoid this problem. Probabilistic and timer-base method is used to avoid the retransmission of the same message in the VANET. The Distance based forwarding (DBF) protocol and timer-based backbone network (TBN) model is used for forwarding the packet. The performance is measured using the SUMO simulator. The TBN and DBF protocol both perform almost similar when the time range is constant, and the range value of the relay node should be limited to achieve better result for the fitful time range. The future work is considered in this mechanism is to consider the direction of the vehicles because the vehicles which move in opposite direction, they do not require the information of the other roads.

2.3.2 Reactive VANET routing Protocols

The overview of the reactive routing protocol is discussed in this section. The reactive protocol does not require to manage the routing beforehand. In these types of protocol, when the transmission is required than initialization packets are send to the neighbor's node than select the next relay node. The multi-hop communication protocol required to select the reliable relay node to transfer data from source node to destination node. These types of protocols are more reliable, less delay, effective cost communication and high throughput value are observed.

Din, S. Et al. [4] are used distance and direction main parameters to define the protocol. By evaluating this parameter source node select the next hop to which data packet send. The direction of the vehicle helps to avoid the loop in the future work. The main problem in VANET is the intersection point where traffic load is high means more candidate nodes are present. For this, RSU (Roadside Unit) is used to update the traffic status and broadcast Collector Packet (CP) to update traffic map. BTA-GPA protocol performance measured by using the factor, quantity of node and speed of the vehicles against data overhead, packet delivery ratio and average delay [4]. The performance of the introducing protocol will be measured by taking into consideration of packet overhead, packet delivery ratio and average delay against the number of nodes and vehicle's speed. BTA-GPA protocol is reached less than 0.7 data delivery ratio against 40-70 kmph speed and almost 350 vehicles. At least its average delay is observed when the data is transfer between 350 vehicles with 70 kmph speed. During the evaluation of this protocol IEEE 802.11p MAC protocol was considered and 300m transmission range of vehicles is considered. BTA-GPA protocol performance is measured packet delivery ratio and average delay is increased as node increased but average delay is less than other comparative two protocol (IB beaconless and IPNs beacon protocol). The future work in this research is that add other parameters to improve performance of this protocol. It is not clear that which vehicle’s parameters value will be used to choose as next hop, if distance and angle between the vehicles. both are small or the value of these parameter are greater? What will happen in the protocol and which vehicle is best to used it as the next relay node?

Husain, k. et al [15] content based beaconless forwarding is introduced. This protocol includes various information in data packet’s header for making decision in selection of next relay node. Forwarding zone criteria and waiting time criteria are set. When the data packet is transmitted from any relay node, firstly redundancy of the packet is eliminated by allowing the node to overhear in forwarding zone area. The forwarding zone area is defined by the area in which nodes can share data packet to other node and eliminate other nodes in the range of transmission node. The one way to define the forwarding zone area to specify the angle. Geographical progress is used to set the waiting time criteria for the nodes. Contention mechanism and retransmission mechanism are introduced by storing the data packet in content buffer and retransmission buffer. When the data is sent to the destination node than it checks its availability in the buffer if the data packet is already in the buffer than it turns into *duplicate data packet reception*. The performance is calculated using packet delivery ratio, ETE delay and packet redundancy coefficient against Source transmission rate variation, number of nodes and node velocity variation. When forwarding zone angle is set to 60 degrees, it gives best trade-off of packet delivery ratio, ETE delay and packet redundancy. In the future work, it is best to define such algorithm which remove the duplication packet forwarding in the network and use that path which has minimum number of hops.

Rayeni, M. S. et al [13] is introduced the DPS protocol. In this protocol, the main mechanism is divided the road into different partitions and find the shortest path of one hop to transfer the data packet from the partition. This protocol is implemented in three different scenarios with heavy, moderate and low traffic. Determine the traffic density by using three various methods beacon massages, using vehicles velocity and acceleration and using a mixture of pipes' car flowing model and the two fluid theory. Secondly determined the priority of the data packets if the partitions are so small as in every partition there is one vehicle than achieve shorter delay, but the collision of the packet will rise. For avoiding collision, use busy tone parameters for alerting other nodes. DPS protocol use vehicle-to-vehicle communication rather than V2I communication because neighbour's vehicles share the information using beacon approach. This protocol starts working when an emergency occurs on the road. The main purpose of this protocol to alert about the emergency as many nodes on the road to avoid more damage. For the evaluation of the protocol used metrics are one-hop delay, multi-hop delay, massage delivery ratio, one hop message delivery, message dissemination speeds and reception rate. DPS is compared with BPAB, SB, DEEP, UMD, and eMDR protocols. DPS protocols delay is only 2s in the dense vehicular environment.

Olivia, D. et al. [6] divide the packet into four distinct types based on how much data is critical to send source node quickly. They use qSOFA medical score to identified and give score to their packet such as critical, Reliable, delay sensitive, best effort packet. In this protocol, they use beaconless routing mechanism where HELLO packet is not forwarded between the routers instead of that implement RREQ packet from sink node to its neighbour. In this packet, the node mentions primary cost from their node to sink node. The main purpose of this protocol is to increase throughput for critical packet. The delivery of the packet is very important to its destination as this protocol is implemented to alarm the nearest hospitals if there are the accidents occur on the road. The packet delivery rate is maximised in this protocol as the delivery of the packet is monitored from source node to destination node. DLQoS protocol performed well for critical data and achieved less delay. This protocol is best for MCI application. The future work is to add more medical data to characterize the packet more accurately and reduce congestion in network for critical packet to deliver them fast. If its protocol is combined with machine learning techniques, then it will perform more reliable and accurately.

Karabulut, M. A. Et al. [14] introduced OEC-MAC protocol for VANET to send SM (Secure Massage) and NSM (Non-Secure Massage). For SM, firstly directly data packet sends to destination node if the source node didn’t get AKG signal from destination node than it will broadcast CRM (cooperative Request massage) send to neighbour nodes which neighbour have good transmission condition send CAM (cooperative acceptance massage) to source node. ORM (optimal relay message) send to the select relay node by source node. Basic Service Set initialized by the source node to send NSM. This service advertised by WSA (WAVE service advertisement) which node have good condition of channel and SNIR. The overheard neighbour node which transmits data, more reliable, than it will send CWSA packet to source node. Source node will select the optimal relay which send CWSA packet by sending the ORM packet to the select optimal relay. OEC-MAC protocol has better throughput in heavy traffic load and number of packets drop also is less than other MAC protocol. It performs well as compared to other version of MAC protocol, but its performance is not calculated as capture effect and channel fading. This protocol performance can be evaluated by applying in its unsaturated condition of traffics in the future work. The other parameters can be considered to build up the new version of this protocol.

Husain, K. Et al. [17] Intersection-based link adaptive beaconless forwarding for city (ILBFC) protocol introduce for VANET. It selects the relay nodes for avoiding various issues as redundancy, loop prevention, waiting time consumption and forwarding zone. Firstly, source node adds information on header of data packet to decide the next relay node. Relay nodes check the criteria by calculating the angles and distance to the destination node. If they fulfil the condition then it will become a winner relay node, it will stay in this state until its distance is not increase to destination node. Destination node sends the ACK packet to the last hope node after receiving the packet to eliminate the timer. This protocol is beaconless because it is two- way data ACK send. ILBFC is compared with link-Adaptive beaconless forwarding (LBF), Distributed beaconless Dissemination (DBD) and Beacon-less routing (BLR). Packet delivery rate, ETE delays and packet redundancy coefficient is measured against source transmission range and number of nodes. ILBFC perform well in all situations because it does not consume much power on selection of relay nodes. The winner node transmits packets until it fulfils the conditions. The major drawback of this protocol is that nodes do not maintain the distance of relative nodes and destination node. If the distance is recorded than more accurate and less distance nodes to destination will be selected.

Rana, K. K. et al [16] Location Aware multi hope routing (LAMHR) protocol is introduced. Location prediction and next hop selection is considered in this protocol. For location prediction, it is assumed that every node has a digital map and global position system. By using the velocity and movement direction of vehicles are used to predict the location of vehicles in equation (2.4) and (2.5) respectively. The following formula used.

$$\beta = \tan^{-1} \frac{x_2 - x_1}{y_2 - y_1} \tag{2.4}$$

$$V = \frac{\sqrt{(x_2 - x_1)^2} + (y_2 - y_1)^2}{t} \tag{2.5}$$

For selection of next hop three main elements are considered inter- vehicle distance deviation, link quality and movement direction of node. Distance of the vehicles will be calculated by distance formula. Direction of the vehicle is calculated by using law of cosine in equation (2.6).

$$\cos(\beta) = \frac{-a^2 + b^2 + c^2}{2bc} \tag{2.6}$$

Movement direction of node is an important factor to reduce the distance to destination and number of hops will be less. The performance of this node is measured in path vanish, broadcast time, packet delivery ratio and throughput. The proposed protocol performs well in these matrices as compared to previous protocol introduced. The main advantage of this protocol is two-way ACK management when the destination receive packet than send ACK signal to last hope. The disadvantage of this protocol is that every node should calculate the next predicted position of the next relay node, it is better the predicted distance is calculated by RSU unit than network node life cycle will be increased because the communication cost will be minimised.

Al-Absi. Et al. [18] introduced Performance Enriched Channel Allocation (PECA) algorithm for shared and non-shared channel. In shared channel algorithm, channel can be used by other vehicles if their channel is not accessible so, contention window is introduced to reduce the collision in the transmission. For channel access two factors are consider maximizing throughput and minimizing overhead. The throughput is gained in shared channel is near to 1 (not less than 0.8). In this model, two algorithms are presented one for shared channel, set of users shared specific channel and other is for non-shared channel, bandwidth is not used efficiently because one user uses channel at a time. The overhead of the protocol is not frequently change in shared channel rather than non-shared channel. The metrics which is compared in this paper are throughput, number of packets transmission and number of packets collide. To use bandwidth efficiently, shared channel algorithm is used for maximizing throughput and minimizing overhead. PECA and ENCCMA are compared in term of successful packet transmission, collision, and throughput. PECA performed well and increased throughput 24.4%, average packet transmission 18.16% and 32% collision reduced in rural environment. In this paper, channels are used to transfer data from source node to destination node, but they did not mention about the direction of vehicles.

Shafi, S. et al. [19] is introduced the cross-layer cluster-based routing approach by adding relative velocity metric in the algorithm and finding the best path through which data packet send from source node to destination node. In this protocol, path stability is also measured to avoid the failure link disadvantage afterward. VANET are the most dynamic network, so it is important to calculate the link stability between two vehicles by using the following equation (2.7).

$$L = \int_{t}^{t+T} p(v)dt \tag{2.7}$$

't' represents time-period of the link between two vehicles and 'T' represent the continual availability of that link in the equation (2.8).

$$R\eta L = \Sigma_{j=0}^{n=1} \left(T_{dij} - T_{ai}\right)^2 \tag{2.8}$$

T_{dij} T_{dij} represent the time duration delay time of j neighbouring vehicle of *ith* T_{ai} T_{ai} accumulated delay time of vehicle *ith* in equation (6). Head of the cluster will be selected by comparing the average velocity of the cluster vehicles and mobility of the vehicles. Winner head vehicle have less relative average velocity. By establishing the link, the broadcast problem will be resolve but stability of the link is important factor. Due to the high mobility attributes of the vehicular network, determining the stability of the link is a demanding metric. The performance of this protocol is measured in the delay, throughput, packet loss ratio, average energy consumption and reliability. The energy consumption factor is reduced to 64% from the previous protocol CLARR (Cross Cluster based on demand routing protocol).

Bamhdi, A. M. et al [20] is introduced the new version of the Ad hoc On demand Distance Vector (AODV) protocol. AODV protocol is a cost-effective protocol, high throughput and less processing. It follows the distance vector algorithm. Moreover, intervening nodes are required to decide the route of the packet. Density factor is added in it and enhanced the capability of the AODV protocol in this paper. Density of the node help to use minimum power of the nodes and delay in the network is also minimise. The Dynamic power of Ad hoc On demand Distance Vector (DP-AODV) is used distance parameter and number of neighbour nodes for decided how much power is required to reach the next node. It is a beacon base protocol in which hello packet is send to the neighbours and calculate the distance between the nodes and density of the neighbour node to determine how much powerful signal is required to transfer data packet. Jitter, delay, throughput, and packet delivery ratio metrics are observed for evaluating the performance of the DP-AODV protocol. As compared AODV and DP-AODV protocol they delay factor is decreased to reach 1s at 200 densities of the vehicles. 30% of the packet delivery ratio improved by the DP-AODV protocol at the higher density of the vehicle. In the future, the protocol should add the direction parameter to improve the performance to use the transmission power more efficiently and accurately.

The vehicular network protocols are introduced for urban and rural areas as GTLQR (Greedy Traffic Light and Queue aware routing) protocol, URAS (unicast routing protocol based on Attractor Selecting), PPR protocol and so on which consider the parameter for the selection of next relay node. GTLQR [26] protocol considered the relative distance, queuing delay, street connectivity and channel quality for improving the delivery ratio in the network. It considered the map of the city in which vehicles direction and intersections are also recorded and used in making decision in the selection of next relay node. Whereas URAS protocol [27] focusing on such matrices which minimizing the candidate node for the selection of the next hop. The traffic aware geographical routing protocol (TARGET) [28] performance is measured in packet delivery ratio is less and end to end delay which is much higher than BTA-GPA protocol because TARGET protocol makes a lot of calculation than BTA-GPA. It used some metrics as distance, direction and angle to make decision in the delivery of the packet in the vehicular network. Whereas TARGET protocol divides the traffic into two different categories and delivered the packet in single hop to the destination but if the node is not reach than used alternate methods to reach the destination node. The higher packet delivery ratio and less delay in the network is gain by transferring the data packet in multiple hops as compared to single hop.

The vehicular ad hoc network faces various challenges which effect the performance of the system as movement of the vehicles, direction of the vehicles and so on. Meanwhile, numerous characteristics of vehicular network help to build efficient and reliable protocol for smart city. The vehicular environment is observed the variation in the number of nodes and topology, but the vehicular nodes have unlimited energy and high-quality sensor in the network. [23]. Some researchers used artificial intelligence techniques ant colony optimization in the development of the vehicular environment protocol [24,25]. By giving the weight or some value to the routes which are used frequently for transferring the data. The decision was taken according to the algorithm, ignore those routes which have higher values or lowered valued route. Most of the protocols are used different metrics to make decision for the section of the next relay node as distance, direction, velocity of vehicles, angle, density of vehicle and more.

2.4 Comparison of Energy Efficient Adhoc Network Routing Protocols

There is various technique represented in the following tables. All researchers are focusing on the selection of the next relay node. The protocol performance is measured by considering various metrics as delivery ratio, end to end delay, time consumption, and throughput. These metrics are calculated to evaluate the performance of the protocol. The researchers [4,7,10] are used distance perimeter to enhance the stability and reliable of the protocol and they are also focusing on increase the message delivery ratio. The performance of the protocol [8,10.15.19] is maintaining the energy consumption of the network by using distance and direction perimeters to eliminate the irrelative node from neighbors. Whereas some researchers [12,13] used vehicular velocity and acceleration to maintain the stability of the network which enhance the throughput and reduce delay in the network. The table 2.1 shows the summary of the literature review discuss in the previous section.

Table 2.1: Summary of the Literature review

ıce	**Scheme name**	**Problem focus**	**Mechanism**	**Advantages**	**Limitation**	**Performance**
Baiocchi, A. et al [12] (2015)	DBF TBN	Message can be sends in a long range.	Distance and time perimeters are used to select the next relay node.	The performance of the protocol is better.	The range value should be constant to achieve better results.	DBF perform 64% and TBN performance is 74% improved.
Rayeni, M. S.	DPS	Divide the road in	Relative velocity and	Message delivery	This protocol work when emergency	One-hop delay is improved 0.1s, multi-

et al [13] (2015)		parts.	Acceleration is used to make decision in the next relay hop.	ratio is improved in it	occur on the road.	op delay is improved 0.23s.
Olivia et al [10](2017)	AddP	Traffic density and distance between the nodes are considered	All nodes in the network get message when next relay node selected.	Energy efficient improve by avoiding retransmission of the message.	Direction perimeter can be used to increase the delivery ratio by avoiding looping problem.	Throughput of this protocol is improved 1.1.
Saleh, A I et al [11](2017)	RRP	Divide the protocol in two phases, setup and maintenance phases.	Maintain the route until data is send to the destination node.	Delivery ratio is improved y route define.	It takes much effort to maintaon the route. The security perimeters should be added to avoid network problems.	Throughput is increased as 5000kbps on 60 nodes.
Soleymani, S et al [8](2017)	STM	Calculate Distance to minimise the neighbours. Use neighbours' history if they are trustworthy.	Neighbour node must have positive response.	It is energy efficient to transfer data by eliminating untrusted nodes from neighbours.	Limitation in it if the new node is move on the road, it will not get a chance to add trust by other nodes.	Its performances reached at 74%.
Nooji Venkatramana et. al [9] (2018)	CISRP	Store neighbour's node information in every vehicle.	Consider the rectangular cell in which compare the vehicle speed and direction with each other.	Performance of the protocol is high.	Direction parameter is not considered which cause looping the packet.	Packet delivery ratio is 0.1s at 90kmph.
Husain, K. Et al. [15](2019)	ILBFC	Select the forwarding zone.	Forwarding zone area will be 60- degree.	Eliminate irrelevant candidates.	Distance parameter is not considered in it which increase the hop.	End to end delay is reduced to 0.1s to other comparisons protocols.
Al-Absi. Et al. [18](2019)	PECA	Chanel allocates for every transmission.	Shared channel and non- shared channels are considered in it.	Shared channel achieves high throughput and minimize overhead.	It is difficult to manage channel in VANET.	Average packet transmission 18.16%, 32% collision, 24,4% throughput.

Shafi, S. et al. [19] (2019)	CLCBR	Path stability metrics and relative velocity of the vehicles is considered to avoid the failure of the packet's transmission.	Link stability and relative velocity is calculated of all neighbours. Which neighbour has less link damage possibility select as next relay node.	Energy consumption perimeter is reduced.	Acceleration of the vehicles can be considered to improve the performance of the protocol.	Energy consumption factor increased 64%.
Din, S. Et al. [4] (2020)	BTA-GPA	Selecting next hop by considering different parameters.	Used distance and direction parameters for making decision to select next relay node.	Performance improved.	Define the parameter well. Consider different scenario to improve the performance.	Data delivery ratio is 0.7s at 40-70kmph speed of the vehicles.
Nuruzzaman, M. T. Et al. [7](2020)	HA-BGR	Calculate distance from source node to destination node and expected next source node to destination node.	Difference between them should be positive.	Take less time to decide about next hop. Eliminate many candidate's nodes by itself.	More parameters are considering on candidate side rather than sender node.	Energy consumption metrics is improved 60%.
Karabulut, M. A. Et al. [14](2020)	OEC-MAC	Selecting next hop by its response.	Sender node broadcast the massage to its neighbour node which node send back first reply it will be selected.	High throughput achieves. Less drop packet experience.	Unsaturated condition of traffic should be considered.	Throughput is increased by 7% and packet drop is reduced in it.
Rana, K. K. et al. [16] (2020)	LAMHR	Predict the position of vehicle.	Angle and velocity of the vehicle is used to predict next position of the hop.	By considering these parameters, performance of the protocol improved.	Predicted distance can be calculated by RSU unit rather than sender node.	Packet delivery ratio is increased 60% of it and packet vanish, throughput is improved.
Husain, k. et al. [17] (2020)	CBF	Time criteria is added with forwarding	Time criteria is added to prevent delay in packet	Performance is improved.	Decision can be improved by considering different parameter.	Packet redundancy coefficient is improved to 59% and Packet delivery ratio

		zone.	forwarding.	Also help to remove those hops which are unnecessary.		and end to end delay is also improved in it.
Olivia, D. et al. [6](2021)	DLQoS	Categorise the packet.	Sink node send their cost to travel the packet from it to destination node.	It works well with critical data.	enhance network congestion.	Throughput improved for critical path to 78% and packet delivery ratio is improved in it.

By studying and comparing the performance of different protocol, it is analyzed that the selection of parameters is important in the protocol performance. The distance parameter is most important to avoid the link failure and reduce the end-to-end delay. The direction of the vehicles helps to reduce the looping issue in the vehicular network. The angle parameter helps to eliminate the unwanted vehicles from the calculation. Traffic density is another important factor which help in the delivery of the packet to the destination. [4,22]

2.5 Research Gap and Directions

VANET has characteristics which bring out challenges to build the reliable and effective routing protocol as real time communication, not stable network, high mobility, and varying of the density. While the VANET also give compensation due to its network structure as the car move on the specific road, lifetime of network is greater, location of node can be predicted and network fellow specific infrastructure which is alongside of the road.

Researchers are developing such protocol which transfer data safely and reliable way. Some of the researchers work on selecting the most effective and functional relay node. By which time consuming, achieve high throughput, better packet delivery ratio and reduce overhead. By studying research area, distance between vehicles and direction of the vehicles are important parameter which should be defined clearly. What should be done if the candidate node has greater distance and angle with sending node? It is used to predict the next location of the vehicles which may lead more calculation on the sender side for selecting next relay node [4].

2.6 Summary

As studied the literature of the VANET, the selection of the next relay node is still a challenging factor. Due to the high mobility and unpredicted features of the vehicular network, using various parameters and attributes such as velocity of vehicles, distance, angle between source and destination vehicles and more, for the selection of next relay node. The base paper BTA-GPR perimeters are mentioned there for comparing the proposed protocol. The performance factors are discussed in detail which helps to build impressive protocol. By considering the various scenarios to make sure the reliability and effectiveness of the vehicular network.

CHAPTER 3

METHODOLOGY

3.1 Overview

The chapter will express the details of what is the problem and how can we solve it by using various metrics from the research field. Problem will be explained by using diagrams and phases of the research will make clear. Methodology of our research will also express in it by using the diagram. The operational framework is divided into three phases; one is analysis phase, design and development phase and operational phase. Analysis phase expresses the problem from the research area whether it is valid problem. Design and development phase is developing the methodology and protocol which will be able to solve the problem which is identified. Operation phase is the last phase in which testified the protocol by using the simulator. The overview of the simulator will be also represented in this chapter, which simulator will be used and what parameters will be considered during the processing of the simulator. The simulator diagram will be represented how it will be worked. Performance parameters will be represented on which the reliability and trustworthiness of the protocol will be measured.

3.2 Operational Framework

The protocols of previous research papers are working on the perimeter as distance direction. Velocity, acceleration for the selection of the next relay node to transfer the message packet from source node to destination node. For improving the performance of the protocol, these perimeters are playing crucial role, consume less energy of the network, high packet delivery ratio, minimum average delay, maximum throughput, and reduce network overhead. The geographical vehicular network protocols are considering various perimeters value to make decision in the selection of the next relay node as distance, direction, velocity, acceleration, traffic density and more. Distance parameter is used to measure the difference between the nodes and it consider those nodes which distance are not cause on the loss of the packet in the network. Direction parameter cut down the anti-directed nodes from the scenario. Traffic density help to select more density road for faster communication. Velocity parameter assist to calculate the how long the node stays in the communication range of the sender node.

The proposed protocol is used distance and direction parameter for the selection of the next relay node in the vehicular network. If the sender node is lie on the intersection range of the road than traffic density parameter is consider in the forwarding of the data packet. Some parameters or metrics are recorded to transfer data packet between the vehicles more efficiently, advantageously and effectively. The NS2 simulator is the software in which virtual network of vehicles is create to analyze and evaluate the performance of the node how they react on the particular scenario. Firstly, calculate the distance and direction of the neighbor nodes and select that node which has maximum distance and minimum angle difference as a next relay node.

Those parameters are distance, direction, velocity, displacement, location, angle and more, which are used to calculate the reliable and well-grounded path for transferring data packet in the vehicular network. In this research, measure the performance of the protocol in packet delivery ratio, average delay and network overhead. Packet delivery ratio is measured the ability of the protocol how much data can be send transfer from source node to destination node. Average delay perimeter shows the time taken by the data packet to reach its destination node. Network overhead perimeter represent the data in the header of the packet which effect the performance of the protocol.

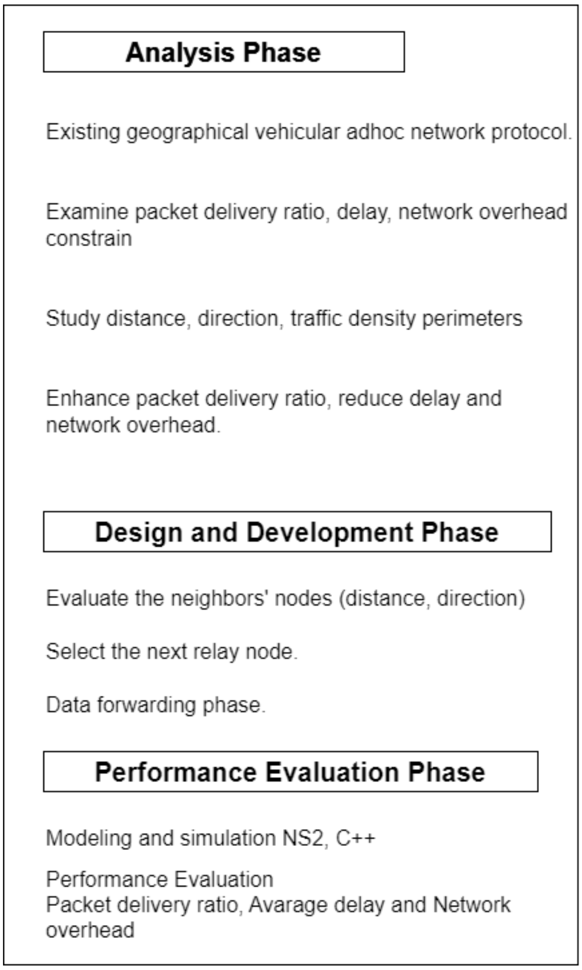

Figure 3.1: Operational Framework of the efficient geographical routing protocol using beaconless approach for VANET

3.3 Research Design and Development

The data packet transfer from one source node to destination node, it takes several actions to compete the task. Source node is going to check how far the destination node is located, if it is lie in the transmission range of the source node than data packet sends directly. But if the destination node is not found in the transmission range of the source node than relay node will be selected for transferring the data packet to the destination node. Relay nodes are those nodes in the network which select to send the data packet to the destination nodes or those nodes which are located between the destination node and source node. In the vehicular environment, vehicles are act as nodes and some specific devices are connected on the vehicles to record some data as speed of the vehicle, location of its vehicle and direction of vehicle.

The vehicular network face challenges in the selection of parameters which act more part in to identify the more dedicated relay node for transferring data packet from source node to destination node. The base protocol [4], which is followed in this network protocol used distance, direction and angle parameter for the selection of next relay node. The selection of next relay node is described in the base paper as if the angle is smallest and distance is larger than select that node as the next relay node. The question arise that what will happen of the node if its angle is smallest, and distance is also smallest? And other question is that if that node is selected as the next relay node which have greater angle and larger distance?

3.3.1 Phase 1: Selection of the next relay node

It is the first phase to build the communication link between the nodes of the network. In this phase, the hello packet is broadcast in the network to get the information of the node, where they are located, how strengthen their bandwidth, the collision problem is solved by alerting the transfer of data packet through hello packet broadcast. There are various strategies are discussed in the vehicular ad hoc network (VANET) as data-centric, beaconless, carry and forwarding strategies, and prediction mechanism, these techniques are used to improve the performance of the VANET protocol. The network overhead, link quality and energy consumption performance parameters are improved by reviewing different parameters as direction, distance, angle, traffic density and velocity. The following figure (3.2) represent the detail of the operational framework of the research. In the figure 3.2, represent the detail working of the efficient geographical routing protocol using beaconless approach in VANET. The data packet sends from source node to destination node by using beaconless approach, by sending CTS/RTS packet to the neighbor node to select the next relay node for the communication between source node and destination node.

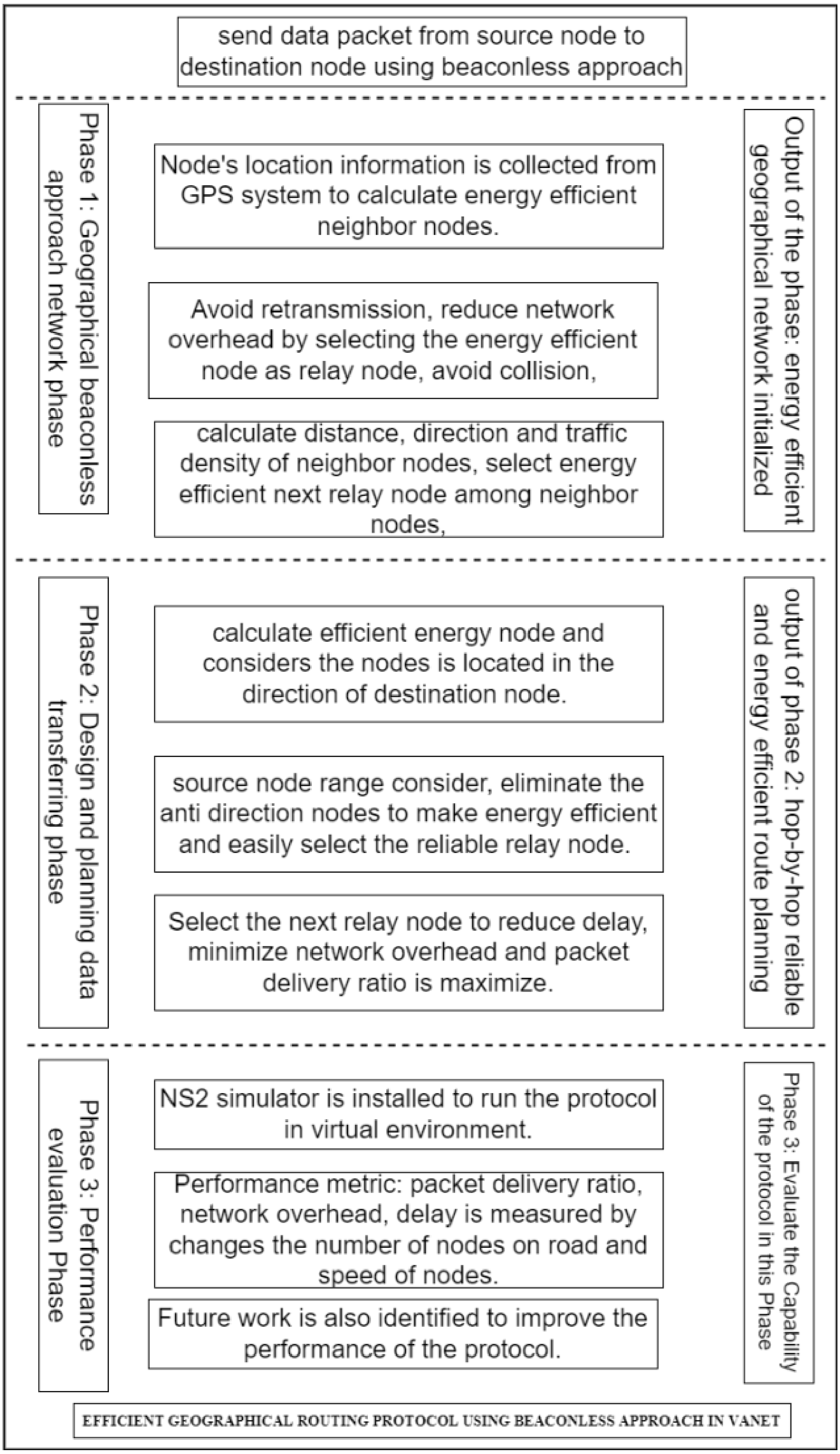

Figure 3.2: Research methodology plan for efficient geographical routing protocol using beaconless approach in VANET

GPS is used to collect the location information of nodes which is used to calculate the distance, and direction parameter for making decision in the selection of next relay node. Energy efficient and reliable routing protocol is dependent on the parameter as they used for the selection of the next relay node to prevent the retransmission and reduced network overhead and delay in the network and increase packet delivery ratio. The simulator NS2 is most popular simulator which used to measure the performance of the protocol to identified that how it will work in the real environment.

3.4 Simulation Framework

NS2 stand for Network Simulator 2 version that create the realistic environment for checking the working of the newly introduce protocol. The NS2 simulator is a popular simulator software for evaluating and analyze the performance and working of the networking protocols. It is widely used in the research field to check the performance of the protocols [4,13,15,32]. Animator files show the graphical representation of the trace file. OTcL and C++ programming languages will be used in the simulator NS2.

3.4.1 Performance Metrics

Metrics considered for this simulation to evaluate efficient geographical routing protocol using beaconless approach in VANET are:

i. *Packet delivery ratio* (N_{pdr}): packet delivery ratio means the number of data packets which receive by the receiver nodes successfully and transferred packets from source node, their ratio will be packet delivery ratio. The following equation (3.1) is used to calculate packet delivery ratio [38].

$$N_{Pdr} = \frac{\sum_{j=1}^{0} P_{receieved\,packet}}{\sum_{i=1}^{0} P_{send\,packet}} \tag{3.1}$$

Where $P_{send\ packet}$ is the total number of packets which transmitted from any one node to another, $P_{received\ packet}$ is total number of packets received at sink nodes.

ii. *Average Delay* (D_{elay}): it is a metric to measure the time taken by the packet to reach the destination node from the source node. The average delay is important to measure the reliability of the protocol as the VANET network is high mobility network, if the packet take more time to reach the destination node, it means the data packet may be loss. The avarage delay is given in equation (3.2).

$$D_{elay} = T_{received\ time} - T_{sent\ time} \tag{3.2}$$

iii. Packet overhead (PO): mean the extra bit required to transmit the packet into new topology of the network in the packet header. Due to the high mobility of the VANET, there are various topology are used in the network. So, packet overhead increase as the more node is used to transfer the packet from one source node to destination node. The equation (3.3) is used to measure the packet overhead [39].

$$PO = \frac{H_{header\ size} \cdot 100}{Payload - H_{header\ size}} \tag{3.3}$$

3.4.2 Simulation Parameter:

Simulation parameter is represented the environment of the simulator in which the proposed protocol will run and show its reliability and capability on the real environment. The parameters of the nodes as its speed, number of vehicles, movement and other are mentioned in the following.

- *Transmission range:* it means the nodes capability how far it can communicate with other nodes.

- *Propagation model:* Nakagami model is a vast model used in the research field due to its high accuracy.
- *Traffic type:* CBR mean constant bit rate means generate constant traffic on the road.

3.4.3 Assumptions and Limitations

In this protocol, there are some assumptions are considered to improve the performance.

- GPS (Global positioning system) is available on every vehicle which enable the vehicles to get the information about each other exact position to calculate the distance between them.
- Digital map is installed on the RSU unit where it calculates the road information.

3.5 Summary

It is clearly explained in this chapter what problem will be selected from the research areas and how to solve it. Briefly describe about the selected problem from the research area. Research methodology and design and development of this protocol. Parameters of the protocol are discussed to solve the problem. The simulator NS2 will be used for the protocol analysis which is widely used in the research field. Performance parameters and Assumptions are also mentioned in it.

CHAPTER 4

EFFICIENT GEOGRAPHICAL ROUTING PROTOCOL USING BEACONLESS APPROACH IN VANET

4.1 Overview

This chapter represent the detail of the efficient geographical routing protocol using beaconless approach for VANET. Overview of the proposed protocol and its background includes problem identification. Represent how the problem can be solved by using different parameters as distance is used to select the reliable node which save the network bandwidth and link do not break during massage broadcasting. Direction parameter help to eliminate the irrelevant nodes of the road. Traffic density help to select the road which have more vehicles as compared to other node. Explain the algorithm how it works step by step and which function are used in it to solve the problem.

4.2 Efficient Geographical Routing Protocol Using Beaconless Approach In VANET

The VANET (vehicular network) is a vast field in the research area due to its usage in daily life. Vehicles need to be intelligent in this world due to its value and they lead technology in beyond stage. As the vehicles are used for transportation but when using them in the technology, they can help in various way like time saving in transportation, important massage transfer by using vehicle devices, maintain blockage of the road, analyze the damage of the road, which will be sharing with authorities to rebuild those roads and other various usage of vehicular network.

Various ways to make efficient communication between the vehicles. The researchers used several metrics for making decision in the selection of the path to transfer message in the vehicular network. Vehicular network is a mobility network which is a great challenge for the researchers to select parameter. In this protocol, beaconless approach and distance, direction, and traffic density metrics will be followed for better performance. Distance metrics used to avoid the loss of the packet during communication, as the vehicular network's important feature is mobility, the selected next relay node may be move away from communication range. So, distance metrics help to select such relay node which may present in the communication range longer for avoiding the loss. Direction parameter helps in the bidirectional road, by getting the information about vehicles direction the anti-direction vehicles may be ignore during the calculation of the next relay node selection. Traffic density metric helps more packet to reach its density as compared to low traffic density road and loss also minimized in these roads. By analyzing the BTA-GPR [4], the researcher used different metrics on intersection point of the road and between the two intersection roads. The researcher used distance and direction parameter and calculate the score by calling the function between the two-intersection area of the road. If the node is lies on the intersection point of the road than traffic density parameter is considered and select the next relay node which lies on the more density node. It led to delay, increase communication cost, maximized the bandwidth usage and data overhead increased. As the road select which lead the distance greater than other road who has less traffic density.

There are various simulators available to run the proposed scheme behavior in the real world before implementing it. One of them is NS2 simulator will be used in this research thesis to analyze, determine and explore the working and behavior of new scheme. It is a most popular simulator which used to determine the performance of the protocol in the real world.

Nakagami model is the propagation model which is used to define the wireless signal distribution in the area. Average power and fading parameters are adjusted according to the environment.

4.2.1 Identified Problem

The vehicles on the road move bidirectional, varied speed and density of the traffic vehicles varied time to time. Due to these features of the road, it is most demanding, exacting and challenging to define the vehicular protocol. Beaconless traffic aware geographical routing protocol (BTA-GRP) [4] are used relative distance, angle attribute and traffic density matrices to enhance the performance of the protocol in urban area. The selection of the next relay node is an important factor to transfer data from one place to another in the vehicular environment. The figure 4.1 represent the angle between node A to node B and angle between node C to node A. In this research, some questions arise, which node will be selected if the neighbor node have smallest angle and smallest distance? Other one is how to select the next relay if the nodes have greatest distance and greater angle?

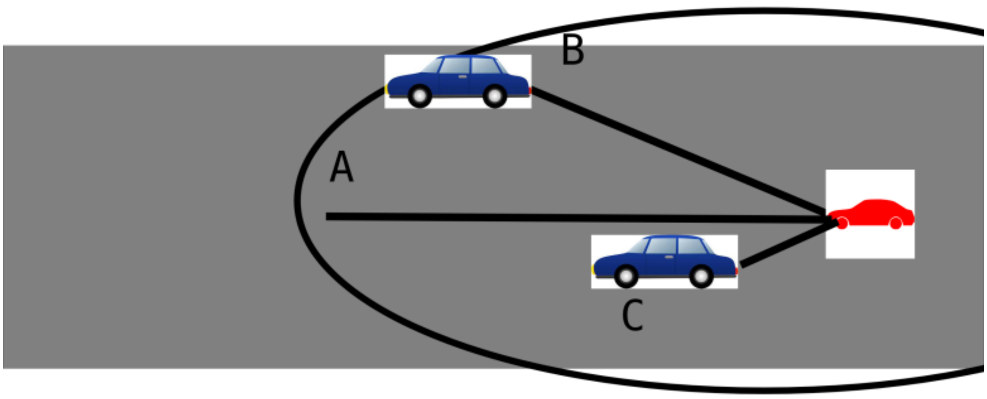

Figure 4.1 Problem identification

In this figure, the distance ‘d’ from red car to car ‘B’ is greater and the angle is also greater, between the line A and Red car and Car ‘B’. The other car ‘C’ is represented in the figure which angle between the line ‘A’ and Car ‘C’ to red car is smaller, and the distance ‘d’ to red car is also smaller. So, in the base paper [4], it is not mentioned what will be happen if this type of situation is occurred. Which node will be selected and how to decide which node is more reliable?

For the selection of the next relay node, it is important to consider the communication cost, if car 'C' is selected than the number of hops will be increased which lead to increased communication cost, packet overhead and delay.

4.2.2 Distance parameter

The position difference between the vehicles and the space between vehicle and the (Roadside Unit) RSU unit is consider a distance value which will be used for making decision in the selection of next relay node and its value is used to calculate the best path for data transferring. It is an essential parameter which is used in making decision. The researchers of this paper also used Euclidean distance formula equation 3.1 [4,29] and it gives the accurate value through decide about the vehicles is efficient and easy. The following equation (4.1) is used to calculate the distance between source node and neighbor nodes.

$$d(a,c) = \sqrt{\sum_{i=1}^{n} (c_i - a_i)^2}$$

(4.1)

The distance between two node is calculate using fit function in the paper [30]. Calculate the distance between all adjacent nodes and neighbor node of the sender to select the minimum distance node. The fit function (4.2) is represented below. This equation is taking from the previous research paper [30].

$$fit_i = \sum_{j=s}^{d} dist \ . \ a_j + a_{j+1}$$

(4.2)

4.2.3 Direction Parameter

The movement of the vehicles is vital part in the selection of the next relay node from sender node. As the node select which have small distance but move in opposite direction to the destination node, it may lead delay, high throughput and delivery ratio will be decreased. There are different ways to evaluate the direction of the nodes while the angle between the nodes is considered to evaluate the direction of the nodes. If the angle between the source node to neighbor node is greater than 180 degree or 0 degree than it is obviously that it moves in opposite direction.

$$direction_{weightvalue} = \left[direction_n,\ direction_{packettransmitter}\right] \tag{4.3}$$

This equation 4.3 is used in the [4] paper to find out the smallest angle node from the neighbor node. The node which selects move probably toward the destination node.

Geographical routing protocol is a position-based routing protocol to support the high mobility and wireless communication in the network, it is the most appropriate technique for vehicular environment. As the vehicular network is experienced more variance and changes in topology [31]. Direction parameter is used to learn the movement of the vehicle on the road, is it move on the way of the destination or not? [32] O Alzamzami et al [33] measured the direction by referencing the position of the destination vehicles to the initial vehicle. As the angle measured between the destination vehicle and initial vehicle (V_iV_d). The following equation (4.4) is used for measuring the angle

$$Direction_{norm} = \cos\theta = \frac{V_i \,.\, V_iV_d}{|V_i||V_iV_d|} \tag{4.4}$$

If the value of the Direction norm is greater than 0 than it means it move toward the vehicle otherwise the data packet is moved away from the destination vehicle. In the other research paper [34], the angle is considered to evaluate the movement of vehicles by using the same formula is mentioned in equation (4.4).

4.2.4 Traffic density

The traffic density matric is updated when the intersection point met on the road, intersection point is consisting of RSU (roadside unit). In the base paper, collector packet is forwarded to the destination node and source node in which traffic density information is also mentioned, the number of vehicles which moved toward the destination vehicle is mentioned in it due to the direction matrices other vehicles are ignored by protocol. When the road density is received by source node than it calculates the traffic density for the selection of next relay node by using below equation (4.5).

$$TD_{value} = \frac{2.T_{\ density}}{3.no\ of\ vehicles\ nodes\ .\ N_{con}} \tag{4.5}$$

N_{con} represent the constant Connectivity Degree on the road. TD_{value} is the important factor to the selection of the next relay node, the candidate of the higher density road will be selected.

In this paper, [35] traffic density, inter-vehicle connectivity and network load metrics are used to select the next forward road on the intersection point of the road. Traffic density metric assist the protocol to improves the performance and reliability.

4.2.5 Score function

The score function sum up all the parametric values as distance, direction and traffic density which effect in the selection of the next relay node. The equation (4.6) is used for calculating the score function of the nodes. By giving the weightage of each metric as the researcher giving it in base paper [4].

$$Next\ forwarder\ Score\ =\ \alpha_1 + \alpha_2 \tag{4.6}$$

The researchers are used to score metrics to determine the best option from various roads as when two or more metrics are used in making the decision. In this paper, [36] also used the score value to select the road by using the 4.7 equation.

$$road\ score\ =\ \beta_1.\ LRE_{result}\ + \beta_2.\ PD \tag{4.7}$$

Where $\beta_1 + \beta_2$ and LRE stand Lightweight Road Evaluation which is updated when the road used for communication previously. PD refer the progressive distance as the next forward node to destination node distance.

4.3 Algorithm for routing:

In the following figure 4.1 algorithm is represented. It shows the process of the routing protocol step by step. In the first step, RTS packet is broadcast to the neighbors' nodes instead of beacon message. The nodes check rather they lie on the intersection of the road or not. If the condition is true mean they are not lie on the intersection point of the road than while loop start where all neighbors' node distance and direction is calculated. In step 11 and 12, calculateMax function call to find the maximum distance node and calculateMin fuction to find the minimum distance node respectively. Further maximum angle node and minimum angle nodes are found out. By checking the conditions of the node, priorities them. Select the high priority node for next relay node. Score function is called to weight the distance and direction score.

If the condition is false, node is on the intersection point than it collects the roads information from RSU (Roadside Units). The road which has highest traffic density, the node located on its priority set highest, selected as next relay node. After that CTS packet is forwarded to the next relay node. The selection of the next relay node is an important factor and the protocol's performance is lie on it. The two parameters (distance and direction) are considered for the selection of the next relay node which help to minimize the time consuming of the processing of the protocol. Following the algorithm is presented in 4.2.

Algorithm

1. Broadcast RTS frame to neighbour node
2. **If** Intersection check = 1 than
3. Set i to 0
4. **While** (i < Number_of_Neighbor_Nodes) **do**
5. Taking source node location information S (x_1, y_1).
6. Neighbor node location information N (X_2, y_2).
7. Calculate distance ND[i] $= \sqrt{[(x_1 - y_1)^2 + (x_2 - y_2)^2]}$
8. // Angle of the node
9. $Direction_{weightValue}[i] =$
   $(Direction_n;\ Direction_{PacketTransmission})$
10. **End While**
11. Set max_distance = calculateMax (ND[i])
12. Set min_distance = calculateMin (ND[i])
13. Set max_angle = calculateMax ($Direction_{weightValue}[i]$)
14. Set min_angle = calculateMin ($Direction_{weightValue}[i]$)
15. //$Curr_{NA}$ is Current node angle
16. //$Curr_{ND}$ is Current node distance
17. **If** ($Curr_{ND}$Equals min_distance AND $Curr_{NA}$ equals min_angle **then**
18. Set NEXT_Mode_Priority = 3;
19. **Else If** ($Curr_{ND}$Equals max_distance AND $Curr_{NA}$Equals max_angle)
20. Set NEXT_Mode_Priority = 1;
21. Else If ($Curr_{ND}$Equals max_distance AND $Curr_{NA}$Equals min_angle)
22. Set NEXT_Mode_Priority = 2;
23. Call Score function
24. Next_Forward_Node = $\alpha_1 + \alpha_2$
25. // $\alpha_1 + \alpha_2$ are weight value for distance and direction respectively.
26. **Else**
27. Received traffic update from RSU unit
28. Calculate traffic density $TD_{value\ D} = \frac{2 \cdot T_{Density}}{3 \cdot No\ of\ vehicle\ nodes \cdot N_{con}}$
29. Node_density_priority = 1;
30. **End if**
31. CTS packet broadcast

Figure 4.2: Algorithm for Selecting the Next Relay Node

46Click here to enter text.

4.3 Summary

In this chapter, the proposed protocol is defined and explain in detail include problem identification and how to solve this problem. The parameters detail is mention in this chapter. The formulas of distance, direction and traffic density formula is expressed in it. The algorithm of the proposed protocol is explained and represent.

CHAPTER 5

PERFORMANCE EVALUATION OF EFFICIENT GEOGRAPHICAL ROUTING PROTOCOL USING VANET

5.1 Overview

After developing the protocol's algorithm, it is necessary to analyze the performance of the protocol. Is it able to give the appropriate and the realistic results? The simulator which is used to evaluate the protocol performance is represented in this section and the simulator parameters is also listed there. This information is very helpful to understand the performance of the protocol how it performs in this environment. The graph is represented in the results and analysis section, it represents the packet delivery ratio, average delay and network overhead parameter with node mobility and vehicular speed. The packet delivery ratio means how much packet can be send in specific time to the destination. Average delay means how much time is take by the data packet to reach its destination. Network overhead means the additional information is added in the header of the data packet for reaching the destination node.

5.2 NS2 Simulator

The simulator is a software which create real time scenario for the researchers to run their protocols to check the performance. There are many simulators available for different field. The NS2 simulator is the most popular network simulator for measuring the performance of network protocol. In this research, NS2 simulator is used to analyze the behavior of the "efficient geographical routing protocol using beacon approach in VANET" protocol. It is used two popular languages Python and C++ which are easy and general-purpose languages.

5.3 Simulator parameters

There are different parameters which are defined before the experiment as how much nodes are available on the road, their speed, direction, distance between the RSU units and so on.

Table 5.1: Simulation Parameters

Parameter Descriptions	**Notations**	**Values**
Node Deployment Area	*Area*	35000x3500 m^2
Number of Nodes	*N*	100-350
Packet Generation Rate	T_{gr}	1 packet/s
Packet Size	P_{size}	512 bytes
Transmission range	R_{tr}	300m
Traffic type	*Trf*	CBR
MAC protocol	*Pcl*	IEEE.802.11p
Simulation time	*ST*	500s(each round)
Mobility model	*Mob*	MOVE
Vehicle Speed	*V*	40/70 km/h
Antenna model	*ANT*	Omnidirectional
Intersections	*int*	10
Propagation model	*model*	Nakagami radio

In the given table, the detailed parameters are represented with their appropriate values which is used in simulator during the protocol running. The traffic type, transmission range of the vehicle, mobility model for the vehicles, vehicles speed and so on.

5.4 Results and Analysis

The efficient geographical routing protocol using beaconless approach for VANET's performance result is measured and represented in this section by graph. There are three graphs in which show relationship with number of nodes to packet delivery ratio, average delay and network overhead. The other three graphs which show the relationship speed of the velocity with the performance of perimeter are to packet delivery ratio, average delay and network overhead.

5.4.1 Node Mobility

Node mobility means change in number of nodes. It is used to measure the performance of the protocol in various traffic density of the road.

5.4.1.1 Packet delivery ratio

The packet delivery ratio parameter shows the performance of the protocol by calculating the total data packet send by the sender to the total data packet received by the destination node. The formula is represented in equation (4.1)

$$N_{Pdr} = \frac{\sum_{j=1}^{0} P_{receieved\,packet}}{\sum_{i=1}^{0} P_{send\,packet}} \tag{4.1}$$

The effect of number of nodes on packet delivery ratio is depicted in Figure 5.1. The graph shows that packet delivery ratio value increases with the increase in number of nodes.

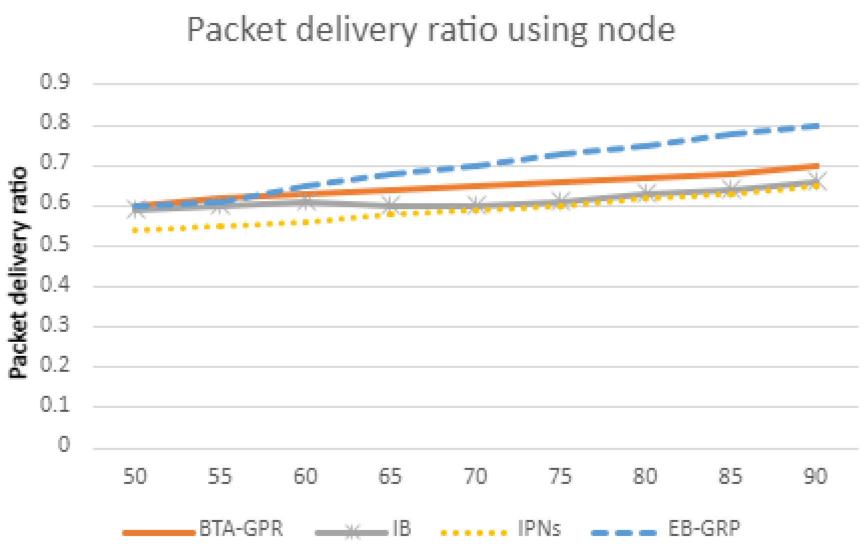

Figure 5.1: Number of nodes effect on packet delivery ratio in Efficient Geographical Routing Protocol using Beaconless approach in VANET.

As the nodes are increased on the road, there are more trustworthy paths for the data packet to reach the destination node. So, it is best for the source node to select the reliable relay node from the candidate relay node. As shown in the figure, when the number of nodes is 50 then packet delivery ratio of the proposed protocol is 0.6 because it follows the RTS/CTS mechanism as the IB and BTA-GPR protocols. IPNs protocol work on the prediction mechanism which is not suitable for VANET environment.

5.4.1.2 Average delay

The average delay is defined as the total time taken by the data packet, which is sent by the sender to the receiver, to reach the destination node. This time is average delay, it should be minimum for better performance of the protocol. The following formula is used to calculate the average delay.

$$D_{elay} = T_{received\ time} - T_{sent\ time} \tag{4.2}$$

The second performance metric is average delay which is measured against variation in the number of nodes. As shown in figure 5.2, the average delay increases when the number of nodes increases because there is more path for the protocol to consider in the calculation of the best relay nodes. When the number of nodes is 50, the average delay is 0.5 for the proposed protocol. It is less than as compared to IB, IPNs and BTA-GPR protocol. The average delay is increased to 1.5 when the number of nodes reached 90. It is represented in figure 5.2.

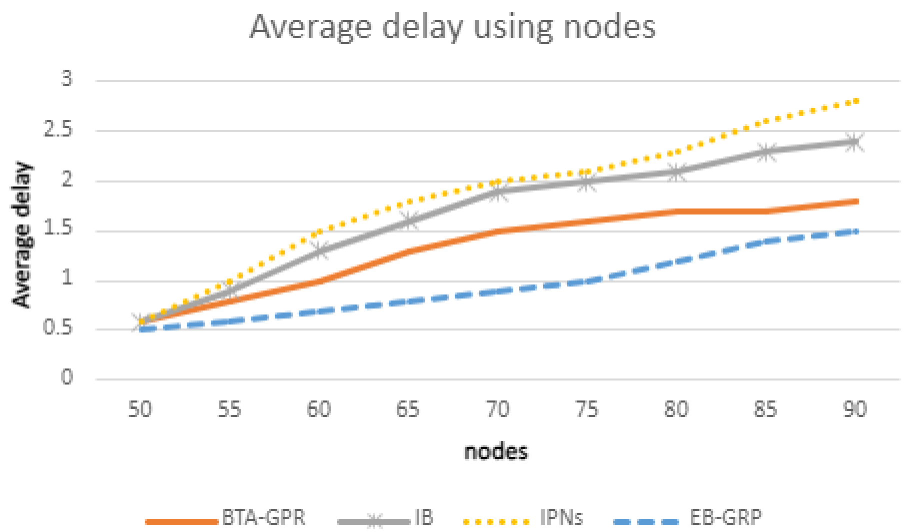

Figure 5.2. The number of nodes effects on average the delay on the number of nodes in Efficient geographical routing protocol using beaconless approach in VANET.

5.4.1.3 Network overhead

Network overhead is the performance parameter, it is data which is added in the header of the data packet when there is changing occur in the topologies of the networks. This data helps the data packet to reach its destination successfully. Its value should be minimized for the efficient protocols. It is calculated by the following formula.

$$PO = \frac{H_{header\,size} \cdot 100}{Payload - H_{header\,size}} \tag{4.3}$$

PO means packet overhead. The header size is multiplied by 100 and payload is subtracted by the header size. Taking the ratio of both values gives the network overhead.

The BTA-GPA and proposed protocol show almost the same results of network overhead, increased the header information of data packet due to change in topology of the networks, as the number of nodes 65 and at 90. From the number of nodes 70 to 85, the network overhead of proposed protocol is better than BTA-GPA. The IB and IPNs protocol show more overhead because these protocols make decisions on distance, direction and signal strength. In the dense traffic, the beacon overhead is risen due to the signal strength of the vehicles. The proposed protocol studies this problem and selects the higher traffic density road on the intersection. Figure 5.3 shows the relationship of the number of nodes and network overhead perimeter.

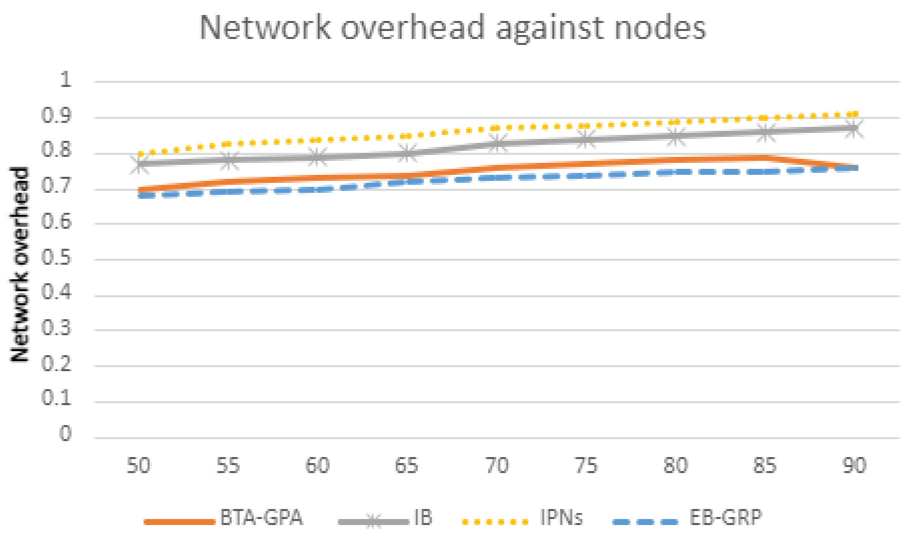

Figure 5.3 The number of nodes influence on the network overhead.

5.4.2 Vehicular Speed

The performance of the protocol is measured on different vehicular speed against various perimeters such as packet delivery ratio, network overhead and average delay.

5.4.2.1 Packet delivery ratio

The change in vehicle speed effect on the performance metrics are packet delivery ratio, average delay and network overhead is represented in this section. Figure 5.4 shows the relationship between change in velocity and packet delivery ratio.

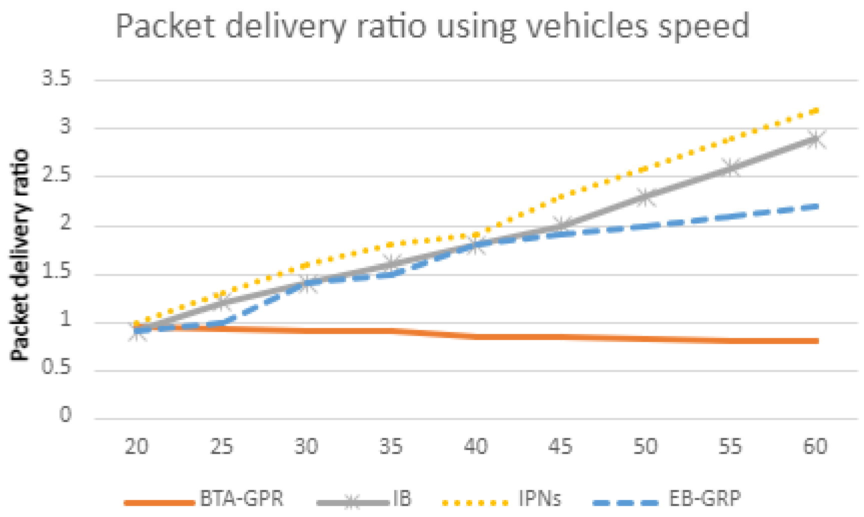

Figure 5.4 The relationship between packet delivery ratio and speed of vehicles.

The packet delivery ratio shows a decreased trend as the speed of vehicles increases. The proposed protocol and BTA- GPA protocol have better results as compared to IB and IPNs. Because they follow the beaconless techniques in the selection of the next relay node. IPNs protocol used prediction scheme to select the best path on the road which show increased drop when the velocity of the vehicle increased. The packet delivery ratio is highest when the speed of the vehicles is 20km/h, but it continuously decreased and reached at 0.84 as the speed of the vehicle is 60km/h. The beaconless techniques help the protocol to make decision faster because it is not required to transfer multiple messages as in handshake techniques.

5.4.2.2 Average delay

Figure 5.5 shows the relation between the average delay in the network when the vehicle's velocity changes from 20km/h – 60 km/h.

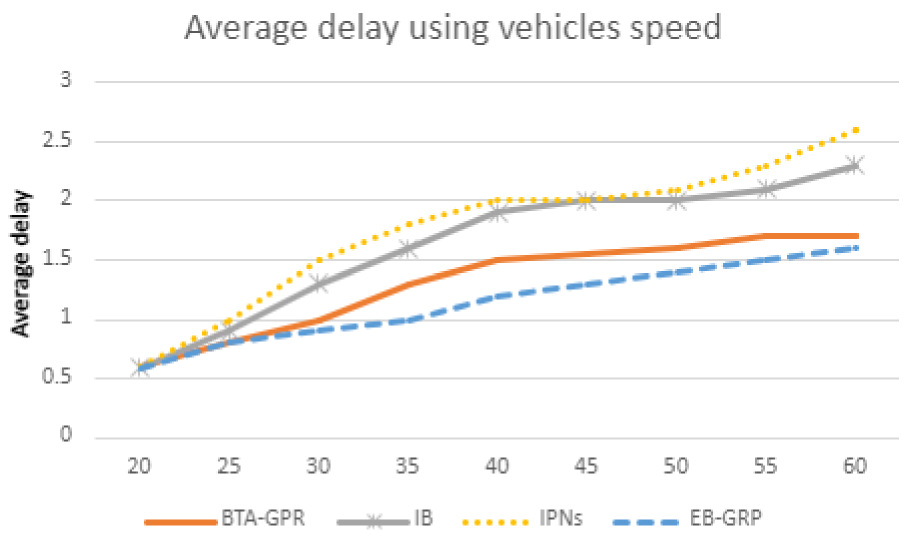

Figure 5.5 The relationship between average delay and speed of vehicles.

As the average delay shows, the trend rises when the speed of vehicles increases. As the vehicle's velocity increased then average delay increased. Because the vehicles change their location continuously, it is difficult for the vehicles to select the next relay node. IPNs used prediction techniques which show inadequate results in this unpredicted environment of the vehicular. So, the proposed protocol overcomes this problem by using beaconless techniques and direction, distance and traffic density perimeter used in the selection of the best path for the data packet to travel in the vehicular network. When the speed is 20km/h then it shows average delay is 0.5 and reach at 1.5 when the velocity is 60km/h.

5.4.2.3 Network overhead

Figure 5.6 shows the relationship between the network overhead and speed of the velocity. The network overhead is increased when the speed of vehicle increased because there are change in the topology of the network varies continuously. The BTA-GPA shows less network overhead because it used the distance, direction and traffic density perimeter in the selection of next relay nodes. IPNs protocol show highest network overhead because it follows the predicted scheme as compared to beaconless technique protocol (BTA-GPA and IB) show better results. The network overhead has a great effect on the performance of the protocol, it shows how many resources of the network (bandwidth, energy, time) are used. When the speed of the vehicle is 20km/h then its network overhead is 0.6 but when its speed is 60km/h then its network overhead is 0.7.

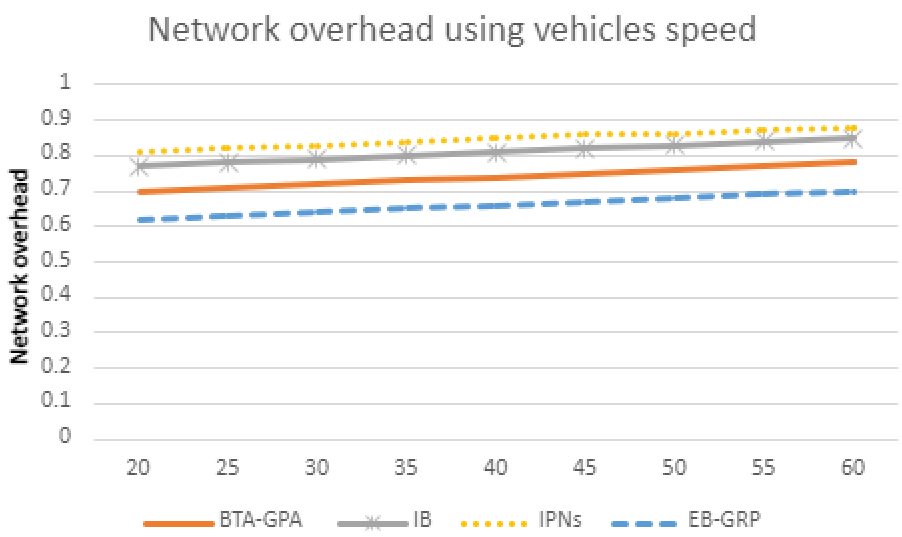

Figure 5.6: The relationship between the speed of the vehicles and network overhead.

5.5 Summary

The proposed protocol performance is studied in the NS2 simulator. The proposed protocol performance is better when there is high traffic density as compared to previous protocols. When the vehicular speed varies then it shows that when the speed of the vehicles is increased then the proposed protocol performance is affected.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Overview

The focus of this research is to identify a reliable and efficient protocol for the vehicular network. Vehicular networks contribute to the development of the smart city and help vehicles to travel safely on the road. If there is any emergency occur on the road, by using vehicular protocols, it is easy to transfer the message to the other vehicles and those institute which help the victims, destination place. In this research, the centerpiece of this research is to find the most reliable next relay node from the candidates' nodes. The next relay node is an important factor to transfer data from one vehicle node to other vehicle nodes.

6.2 Conclusion

In this research, the focus is on the selection of the next relay node through which communication occurs. The previous researcher does not consider the other neighbor node which exists in the communication range of the source node. It is used to select the next relay node which has maximum distance and smaller angle. The proposed vehicular network covers almost all nodes of the neighbor node which can be selected as a next relay node and evaluate the priority of other nodes which help in the selection of the next relay node. In the proposed protocol focuses on other neighbor vehicle nodes which are present in the communication range and give priorities all the neighbor nodes. Set the priorities of the nodes on the road and select the highest priority node for communication in the network.

For the selection of the next relay node, the algorithm is modified by adding the three different scenarios as greater angle with greater distance, smaller angle with smaller distance and smaller angle with greater distance. The second step is to set the priorities of the candidate neighbor nodes and select the highest priority node from them. Every node on the road gives different priorities and selects the highest priority node among them as the next relay node. The most appropriate node among them will be selected as the next relay node. By considering all the neighbor nodes, it can achieve the minimum network overhead, maximum packet delivery ratio and minimum average delay. The packet delivery ratio is increased by 0.2s when the nodes are varied. Network overheads have slightly increased from 0.7 to 0.78. Average delay has increased from 0.5s to 1.5s.

6.3 Future Work

In this research, geographical routing protocol used three parameters are distance, direction and traffic density. Consider three different scenarios related two distance and direction parameters, first is maximum distance and maximum angle, second maximum distance and minimum angle and minimum distance and minimum angle. This protocol can be expanded by adding more role of the RSU unit and adding parameters. Geographical routing protocols are dense field which can be explore in different ways. More specified the role of the intersection point. The effective usage of the road map. Adding more role for the RSU unit.

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