ENHANCEMENT OF ROUTING PROTOCOL IN OPPORTUNISTIC NETWORK (VANET)

Dissertation submitted in fulfilment of the requirements for the Degree of

MASTER OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

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TOPIC APPROVAL PERFORMA

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PROPOSED TOPIC : Enhancement of routing protocol in opportunistic Network (VANET)

Qualitative Assessment of Proposed Topic by PAC		
Sr.No.	**Parameter**	**Rating (out of 10)**
1	Project Novelty: Potential of the project to create new knowledge	6.25
2	Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students.	6.75
3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	6.75
4	Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills.	7.00
5	Social Applicability: Project work intends to solve a practical problem.	6.50
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Final Topic Approved by PAC: **Enhancement of routing protocol in opportunistic Network (VANET)(Remarks:: Mention the detail of protocol)**

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ABSTRACT

Vehicular ad-hoc network (VANET) is one of the recent and promising technologies to revolutionize the transportation system where vehicles can communicate by exchanging messages via wireless medium. It has received a lot of interest in the last few years. But still there are many challenges that need to be resolved for its efficient use in the transportation system. Though, in case of selection of street at the intersection and relay node selection in intra-street is of major concern whenever we talk about communication between entities in a network, therefore it needs to be addressed perfectly. In my dissertation-2, I present a routing enhancement which when deployed will produce efficient results in the intra-street communication and selection of street at intersection. With the selection of optimal relaying nodes, we will improve the ratio of packet delivery, network yield, reduce the end to end delay, and reduce the routing overhead.

DECLARATION STATEMENT

I hereby declare that the research work reported in the dissertation entitled "ENHANCEMENT OF ROUTING PROTOCOL IN OPPORTUNISTIC NETWORK (VANET)" in partial fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mr. Harwant Singh. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

Signature of Candidate

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SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation entitled **"ENHANCEMENT OF ROUTING PROTOCOL IN OPPORTUNISTIC NETWORK (VANET)"**, submitted by **Dhanveer Kaur** at **Lovely Professional University, Phagwara, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

Signature of Supervisor

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LIST OF ABBREVIATIONS

AODV	**Ad-Hoc on Demand Distance Vector Routing Protocol**
DSDV	**Destination Sequenced Distance Vector Routing Protocol**
DSRC	**Dedicated Short Range Communication**
GPS	**Global Positioning System**
LAN	**Local Area Network**
MAC	**Media Access Control**
MAN	**Metropolitan Area Network**
OBU	**On-Board Unit**
OFDM	**Orthogonal Frequency Division Multiplexing**
PKI	**Public Key Infrastructure**
RSU	**Road Side Unit**
WAN	**Wide Area Network**
WAVE	**Wireless Access in vehicular Environment**
WAN	**Wide Area Network**
WAVE	**Wireless Access in vehicular Environment**
VANET	**Vehicular Ad-Hoc Network**
V2V	**Vehicle to Vehicle**
V2I	**Vehicle to Infrastructure**
RF	**Radio Frequency**
ITS	**Intelligent Transportation System**

ISP	**Internet Service Provider**
IP	**Internet Protocol**
WSN	**Wireless Sensor Network**
PDR	**Packet Delivery Ratio**
CBR	**Constant Bit Ratio**

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The network is a set of nodes which are connected by a media link. A node often mentioned as a device that is capable enough to send and receive data from other nodes in the network such as a printer, computer, etc. Devices are connected through the links known as communication channels. Computer Network also known to be a data network is a telecommunication channel via which data is being shared. Computer Network is not like a system is having one control unit and other appear to be as slaves. It is known to be a distributed system [36]. A network should be able to meet criteria, such as:

- **Performance**
- **Reliability**
- **Security**

Performance:

Various ways to measure performance can be how much efficient the software is, how many users are there, how much the hardware is capable. There are ways to measure the performance, such as transit time which is defined as a time that a message takes to travel from one node to other and response time which is characterized as the elapsed time amongst response and inquiry.

Reliable:

How frequently the network failure is taking place. More the number of failures are, less is the reliability of a network.

Security:

Protecting the data from unauthorized access [36] [37].The network can be classified as:

1) **Wired**
2) **Wireless**

1.2 Wired Networks

"Wired" itself represents a physical medium that consists of cables. Wired network is being useful to carry out various forms of electrical signals from source to destination. Cables being used in a wired network can be twisted pair, fiber optic or copper wire [38]. We can take an example of LAN. In this network, ethernet cards are connected through ethernet cables. We can make use of switches and routers in order to increase the coverage area of the network.

1.3 Wireless Networks

"Wireless" represents a medium that is made up of electromagnetic waves or the infrared waves. Wireless devices will be having sensors or antenna for communication. This network doesn't make use of wires for communication of data or voice; it makes use of radio frequency waves. Wireless devices are such as TV remote, laptops equipped with WLAN card, etc [39]. For comparison of wired and wireless network refer Table 1.1.

Specifications	Wired Network	Wireless Network
Installation	Moderately difficult	Easier in nature, but beware interference
Cost	Less costly	More costly
Reliable	High	Reasonably high
Performance	Very good	Good
Security	Reasonably good	Reasonably good
Mobility	Limited	Outstanding

Table 1.1: Comparison of wired and wireless Network [38]

Wireless Network can be classified as (refer Figure 1.1):

- **By the network formation and architecture**
- **By communication coverage area**

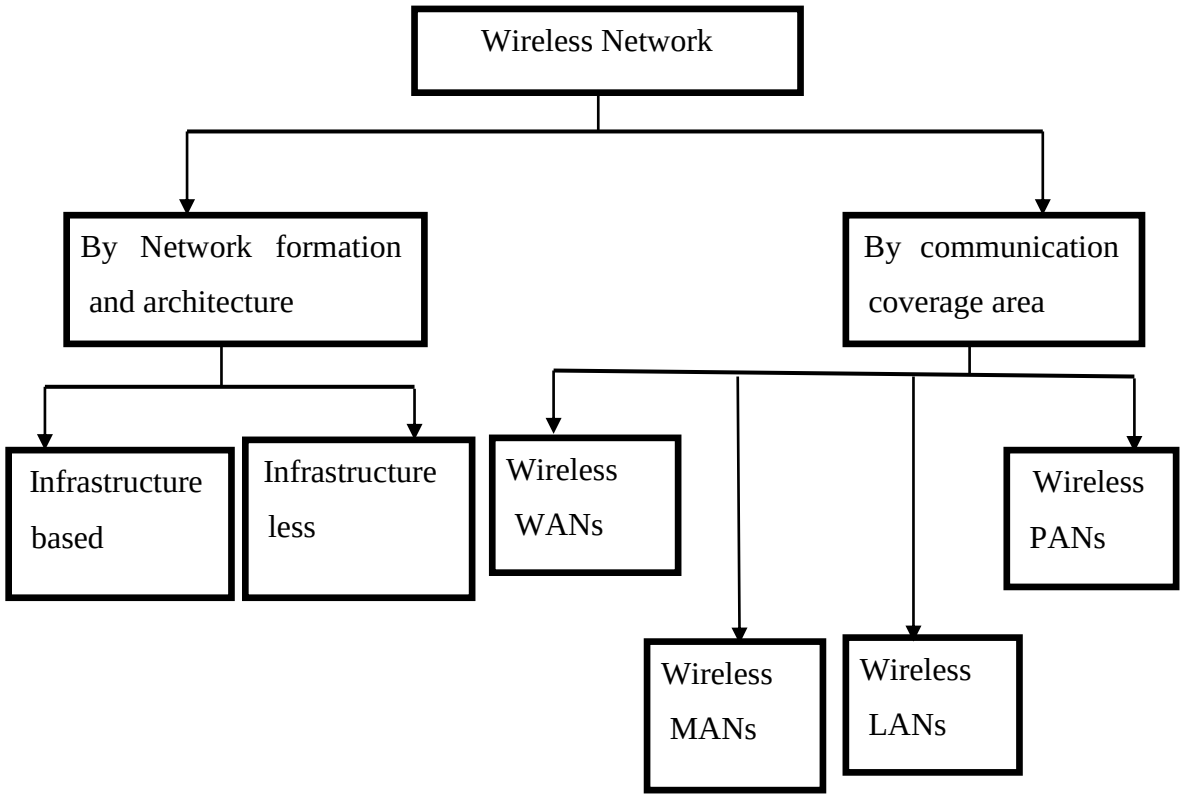


Figure 1.1: Wireless Network Types [40]

Wireless communication is being preferred by companies that can either be a small scale or large scale company or by homes just to get rid of heavy wiring installations and they are setting up there communication via a wireless medium.

By Network Formation and Architecture

- **Infrastructure based networks-** Defined as a network in which devices are being connected to the access points that are present. The communication among the devices is through access points. It can further be divided into single and multi-hop networks for which the examples are WiFi and the wireless sensor networks [40].

- **Infrastructure less networks-** In this there is no access point which means devices communicate directly. This network is also known as the ad-hoc network. Further divided on the basis of single and multi-hop that can be Bluetooth and mobile ad-hoc networks. The choice of which network we are going to select is entirely on the basis of our requirement [43].

By Communication Coverage Area

- **Wireless WANs–** These networks are covering a large area that is cities or countries. Communication is being maintained through satellites or antennas. These networks are 2G based. The network is being administered by ISP.

- **Wireless MANs** – This network is referred as a network in which communication is being carried out among locations such as different buildings in a city.

- **Wireless LANs** – This network is referred to the communication that is being carried out in particular area such as within the university campus and the range of this network is up to 100m.

- **Wireless PANs**– The technologies related to this defined category of a network are Bluetooth and Infrared (IR) communication. This allows the connection among personal devices that are within 30m of range [40].

1.4 Network Topologies

The network topology is defined as the way various elements such as nodes, links arranged. The topology may be depicted as physical or logical one. Physical topology is defined as way various network components are placed, including the location of devices and cable installation, whereas logical topology defines how data flow in the network [41].Various topologies are as below (refer Figure 1.2):

Point to Point Topology

This is one of the simplest form of topology having a dedicated link in between the two

end points. This is one of the simplest form of topology having a dedicated link in between the two endpoints. A point to point kind of circuit can be established with the circuit or packet switching and the same circuit can be dropped when it is not useful.

Bus Topology

In LAN where this topology is being used, each and every node is having a connection with a single cable with the help of connectors. Here central cable is known as the backbone of a network. A signal originated from source travel to all the machines connected out there till it finds its intended destination. If address gets matched, data is being accepted otherwise it gets rejected. It involves less cost for implementation as it consists of single cable. Due to this single cable, this topology involves drawback of single point failure. Further it consist of linear and distributed bus.

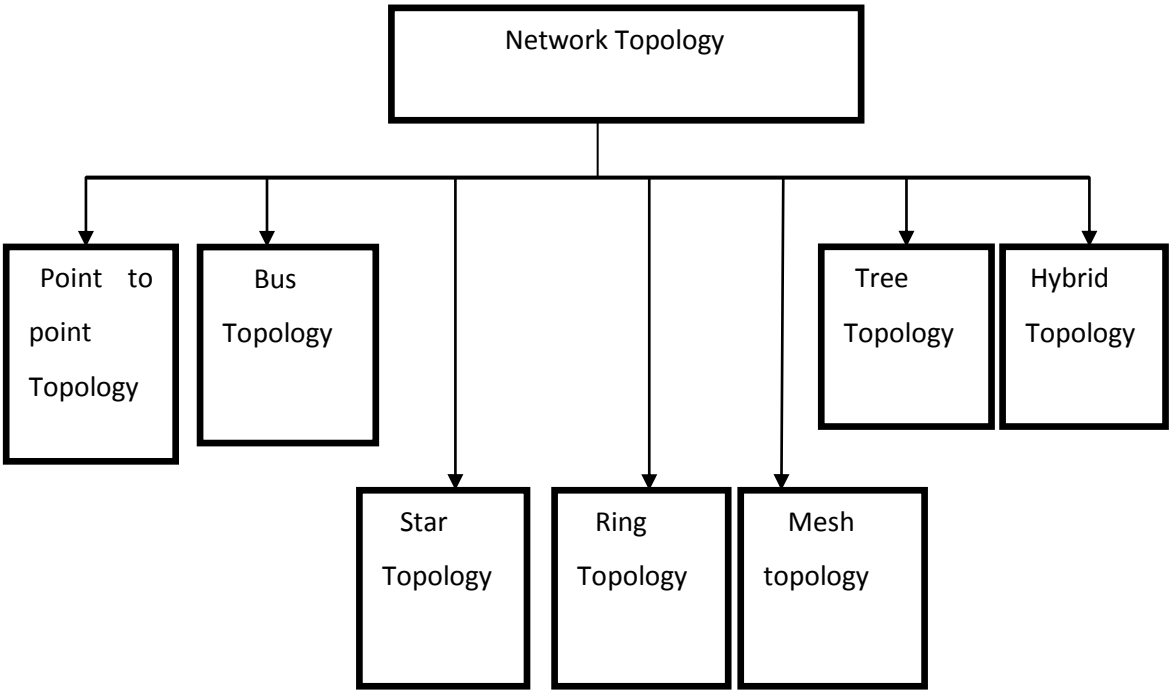


Figure 1.2: Various Network Topologies [41]

Star Topology

In LAN with this topology, each node is connected with a point to point communication to a central hub. All the traffic passes through this central hub and the hub is

acting as a signal repeater. This topology is an easy one to design and implement. This topology has an advantage in simple addition of additional nodes and disadvantage of single point failure. It further involves extended and distributed star [41][44].

Ring Topology

In this topology data travel in a single direction. When data originates from source node, it passes through each intermediate node till it gets its intended destination. To keep the single strength strong, intermediate nodes repeat the data. This topology involves an advantage that is performance is better as compared to bus topology when the network load is increased. There is no requirement of the server to control workstations connectivity.

Mesh Topology

This topology has introduced routes. Messages being sent over this network can take any of the possible routes from source to intended destination. A mesh network can either be full and partial in nature.

Tree Topology

This topology involves a structure in which elements are arranged in a manner that appears to be branches of a tree [41]. This topology forms a hierarchy of parent-child. This topology is known to be as a star bus topology.

Hybrid Topology

This topology is defined as a combination of two or more topologies. As tree network is the combination of star and bus network.

1.5 Introduction to VANET

VANET is an innovation which has been taken in huge consideration because of fast change in topology and frequent separations make it tough to outline a productive steering convention for directing data among hubs, called vehicle to vehicle correspondence and vehicle to street side framework. It is self-sufficient and self-sorting out remote arrange for

communication, where hubs in VANET include themselves as servers and additionally as clients for trading and conveying data [4]. Vehicles can participate with each other to scatter short recordings of hazardous circumstances to advise drivers and save them both in the case of the city and on the highway. The growing demand for wireless devices and correspondence lead to self-curing and self-organized network without having any centralized management. This is known to be Ad hoc Network that is minimizing both motor vehicle collision, congestion in case of traffic, which seem to be a critical problem across the world.

Vehicular Ad hoc Network is based on a principle of Mobile Ad hoc Networks. This is a spontaneous process of data exchange from one node to another node. Vehicular networks come with the new promising field in wireless technology which is used to deploy a vehicle to vehicle communication and vehicle to street side framework communication between nodes. It provides a communication path between vehicles and road side equipments\units. It is used in safety and non-safety application [9]. When RSU receive a message from any node first it authenticate the message, then it sends to the other nodes. The autonomous server is responsible for the security purpose between the vehicles and RSU. VANET is based on the wireless fundamental concept that is classified into different networks such as Wireless Sensor Networks (WSN), Wireless Mesh Networks (WMS) and Mobile Ad Hoc Networks (MANET). VANET is a subset of MANET having different characteristics like mobility in nodes, self-organizing, frequently data exchange.

1.5.1 Applications of VANET

To deploy VANETs, applications play an important role that is categorized in two classifications:

- **Safety Related Application**:

Users expands the security on the road and additionally classifieds in the subsequent method:
Collision Avoidance: Some of examination state, 60% mishaps can be rid of if drivers get cautioning a large portion of a moment before the crash. On the off chance that a driver gest a notice alert on time, the crash will not be there [1]**.**

Cooperative Driving: Drivers are getting alerts for activity alike notices like varying velocity alerts. These signs can participate in continuous and safe driving.

Traffic Optimisation: Maximized with the use of transferring signals like jam, accidents, etc. to the vehicles.

- **User Based Application**:

Supplies the customer infotainment. These are classified in the following ways:

Peer to peer application: They are functional to facilities like distributing songs, movies, etc. between the motor vehicles in the system.

Global Network Connectivity: User required to interrelate the network for all the time.

Other services: utilized in other user on the basis of application alike payment examine to gather the toll assessment, to position the petroleum station, eating place, etc.

VANET is a division of Mobile Ad hoc Network. Individual node meets with rest of the nodes specifically on the multi-hop. Vehicular ad hoc network delivers secure and non secure armed forces to the drivers. Vehicular ad hoc network composed small range radios installed in vehicles, Road Side Units and middle establishment which is account able intended for individuality registration and organization [2]. However, a difficult task for vehicular ad hoc network to protect from the exploited behavior, safety structural design have to be cautiously intended particularly when it is all over the world employed. The safety of Vehicular Ad hoc Network is most serious problems due to transferable among hubs.

1.5.2 Characteristics of VANET

Vehicular Ad hoc Network has novel qualities that make VANET not the same as that of MANET. VANET characteristics can be summarized as:

High dynamic topology: The topology changes in light of hubs moving at high velocity. Assume two hubs are having the velocity of 20m/sec and range which is radio range among them is 160 m. At that point connection between two hubs will be there for 160/20= 8 sec.

Frequent disconnections in the network: Due to profoundly dynamic topology, continuous detachment is there between two vehicles when they are trading data. This detachment happens mostly in the sparse system [4].

Portability: It relies on upon moving environment, street type, the velocity of vehicles, driving conduct of drivers, etc.

Battery consumption and capacity limit: In cutting edge vehicles battery consumption and capacity are boundless. Subsequently, it has enough figuring power that is inaccessible in case of Mobile Ad hoc Network. It is useful for communication in an effective way and settling on steering choices [4] [1].

Correspondence environment: Environment for communication between hubs is distinctive in case of sparse and dense systems. In the case of dense system building, trees and different items act as impediments, but in the sparse system like the highway, these things are not there. So the directing methodologies of the sparse and dense system will be quite different.

Collaboration with on board sensors: Present position and the movement of hubs can undoubtedly be detected by locally available sensors like GPS gadget. Which is helping in case of effective correspondence [44].

Node distribution pattern: Node distribution pattern is non-homogenous along the road segment such as traffic control and available speed limits.

1.5.3 Advantages of VANET

Following are the advantages in case of Vehicular Ad hoc Network:

- Safety Of Public
- Managing the traffic
- Coordinating and Assisting traffic
- Information Support system for travelers
- Measurement and reduction of air pollutants

1.5.4 Disadvantages of VANET

Following are disadvantages in case of Vehicular Ad hoc Network:

- Route discovery flooding on initial phase
- Bandwidth wastage
- Delay
- Increase in system congestion
- External source for target location
- Bad performance in case of large distance among source and destination

1.5.5 Challenges in VANET

Network Management: Because of high versatility, the topology of system and condition of channel change quickly, difficult to set and keep it as quickly as the topology changed.

Congestion and collision Control: System which is unbounded in nature measure additionally builds up a test. A load of traffic is less in the rural area and on a night in even in urban ranges. Due to which, partitions in network frequently occur while in day slot load is very high and the collision occurs due to congestion in the network [1].

Environmental Impact: VANETs make use the electromagnetic waves, may get affected due to the environment while communication.

Security: Security of road safety messages being provided by VANETs should be there as they are life critical.

MAC Design: VANET makes use of shared media while communicating hence MAC design is the main problem.

Social and Economic Issues: It's difficult to convince anyone to build a system that will convey traffic signal information as there are chances that consumers are not going to accept the type of monitoring [5] [9].

1.6 Intelligent Transportation System

VANET is also known as ITS (Intelligent Transportation System). In vehicular ad hoc network, every node is a vehicle that communicates with each other or a nearby vehicle and road side units.

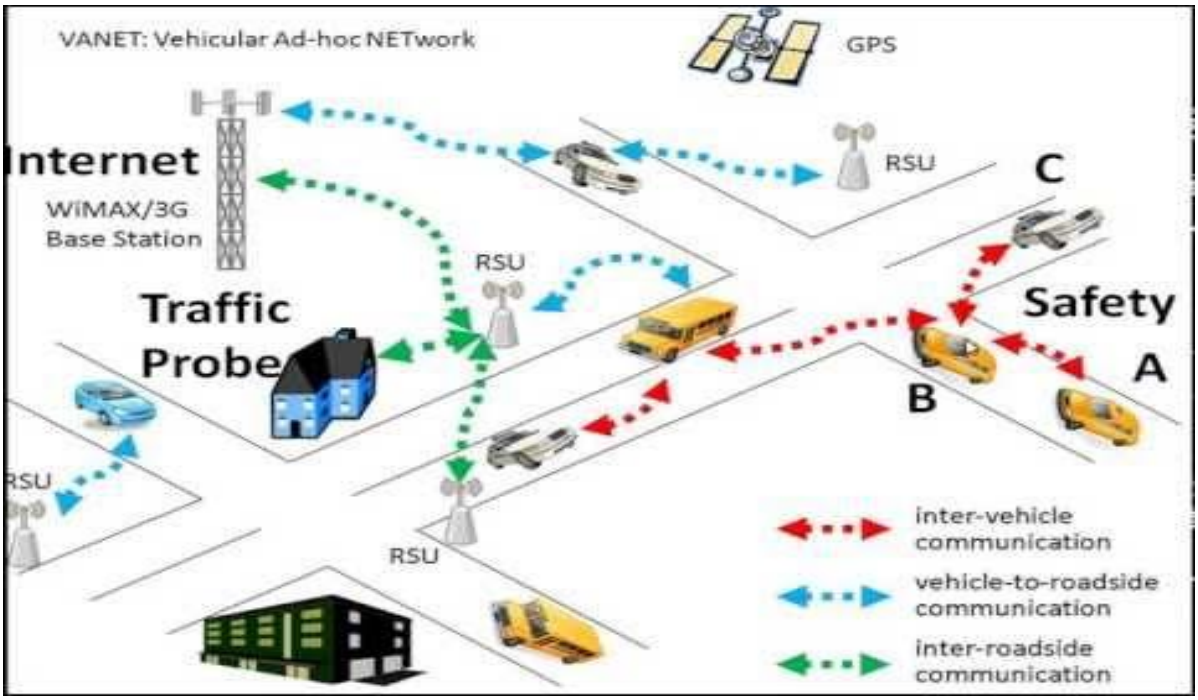


Figure 1.3: Vehicular Ad-hoc Network [2]

When communication between vehicles occur it is called vehicle to vehicle communications and when vehicle communicate with equipment\units on road side then it is known as V2I (vehicle to infrastructure) communications (Figure 1.3).ITS improve the road safety, communication and efficiency. V2V is used as a automobile technology which is design to enable automobile communication. The communication between vehicles is through WiFi networks or Bluetooth. Public key infrastructure is the current security system that is used in V2V communication. V2V communication is suited for short range communications. V2V communication is fast and reliable, provides more safety [2]. V2V does not need any road side units. One problem occurs in V2V is vehicle shadowing that means vehicles small in size being shadowed by vehicles large in size thus preventing it to communicate with the road side units. In V2I communication vehicle communicates with

road side equipment that provides information such as safety warnings or traffic information. The main goal of vehicular communication is to avoid the collision and provide safety. V2I provide a larger range networks. Roadside infrastructure involves additional installation cost. V2I used infrastructure with is pre-existing in nature such as wireless access point. Lack of infrastructure in VANET has come up with an extra sum of tasks for vehicles, where each vehicle being in the network, manages the control over correspondence along with its communication requirements.

VANET infrastructure involve three broad domains:

1) Mobile Domain
2) Infrastructure Domain
3) Generic Domain

Mobile Domain

This kind of domain involves two kinds of devices i.e. vehicle and mobile devices. Vehicle devices include all the devices that are running on road and hence forming the network. Illustration of vehicle devices is cars, buses, etc. Whereas mobile devices have devices that are portable in nature and helping in the communication among mobile devices such as the navigation equipment, etc.

Infrastructure Domain

This kind of domain involves roadside and the central infrastructure as its parts. Roadside infrastructure involves signals that are present on road side such as various sign boards, traffic light signals, toll plaza signals whereas central infrastructure involves centers of traffic and vehicle management [46].

Generic Domain

This kind of domain is explaining the way in which different vehicles are communicating with each other or with RSUs. Vehicles are equipped with Onboard units (OBUs) for communication among vehicles and RSUs. Vehicles should be equipped with GPS i.e. Global Positioning System for navigation purpose.

1.7 Communication Architecture

The communication architecture involve three kinds of communication (refer Figure 1.4):

1) **Inter-vehicle communication**
2) **Vehicle to roadside communication**
3) **Routing based communication**

Inter-Vehicle communication

This kind of communication makes use of multicast or broadcast to forward the traffic. In the case of ITS, vehicles take into consideration the forward traffic not the traffic behind them [46]. So the traffic is being routed in single direction i.e. from the vehicles to the vehicles behind them. In case of V2V communication, two kinds of messages are being transmitted-

1) **Naïve broadcast**
2) **Intelligent broadcast**

In the case of **naïve broadcast**, message updates are periodic in nature and are being sent at a regular interval of time. Whenever the vehicular node receives the message, it checks whether the message has been received from the vehicles traveling behind or not. If the message has been received from behind it will reject it otherwise forward it to the vehicles behind. In spite of being a good method for forwarding the messages, it is generating lot more messages which are leading to collisions in the network.

In the case of **Intelligent broadcast**, it is trying hard to avoid congestion by eliminating the broadcast message problem. It uses the concept whenever the message is being received from the vehicle behind; it leads to broadcast by assuming the fact that at least one vehicle traveling behind has received the message. By discarding that received message, it ceases broadcast [43].

Vehicle to Roadside communication

It is representing a broadcast of a single hop in which RSU is sending a broadcast to

all the vehicles which are lying within its range. High bandwidth is required by RSU for communication because it is keeping track of speed and the traffic [1]. Whenever any vehicle is exceeding its speed limit alert is being generated to lower down its speed.

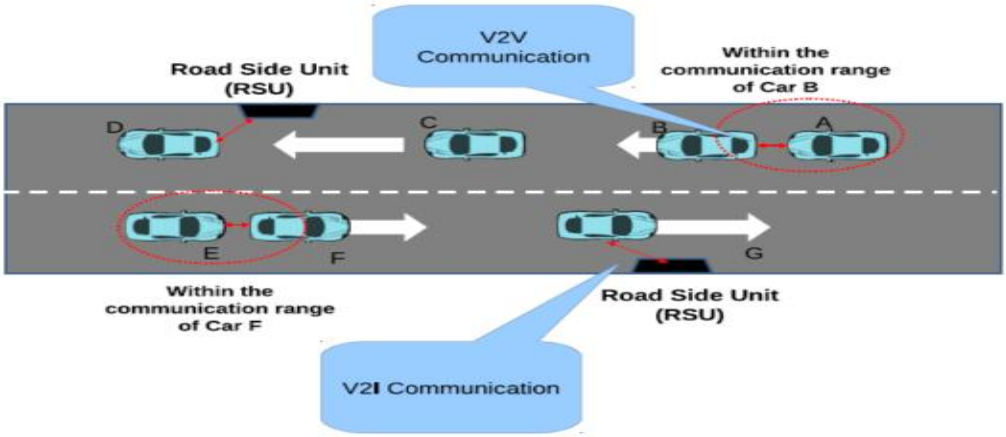


Figure 1.4: Communication types in VANET [1]

Routing based communication

It is defined as a unicast message that is traveling through multiple hops until it is being received by its intended destination. Whenever vehicle receives a request for particular kind of information, it is responding back in the multi-hop unicast message.

1.8 Standards in VANET

Standards are aiming to simplify the work of building the product, help in cost reduction and enables the users to compare it with the competitors. With the help of standards, many problems can be solved and services get enhanced. It provides the efficient and convenient way of launching the product in the market. There is a list of standards which are related to VANET and are ranging from routing, various services, enhancing the security and protocols for interoperability.

WAVE/DSRC

WAVE in VANET provides us with very accurate and to the date information related to surroundings, which is further helping in the global positioning of vehicles (Figure 1.5).

DSRC is defined as Dedicated Short Range Communication which is providing short range communication among vehicles and road side units. The main aim of DSRC is to provide high range of data transfer and ensuring low latency while the time data is being transmitted. All the nodes communicate with each using radio signal which is short, DSRC 5.9 GHz, for the range of 1 KM [5]. DSRC was capable enough for providing connectivity among vehicles which are moving out there but was failed to address the issues related to speeds of vehicles, environment for driving and pattern for traffic. Overhead in the huge amount has made the communication difficult among the nodes.

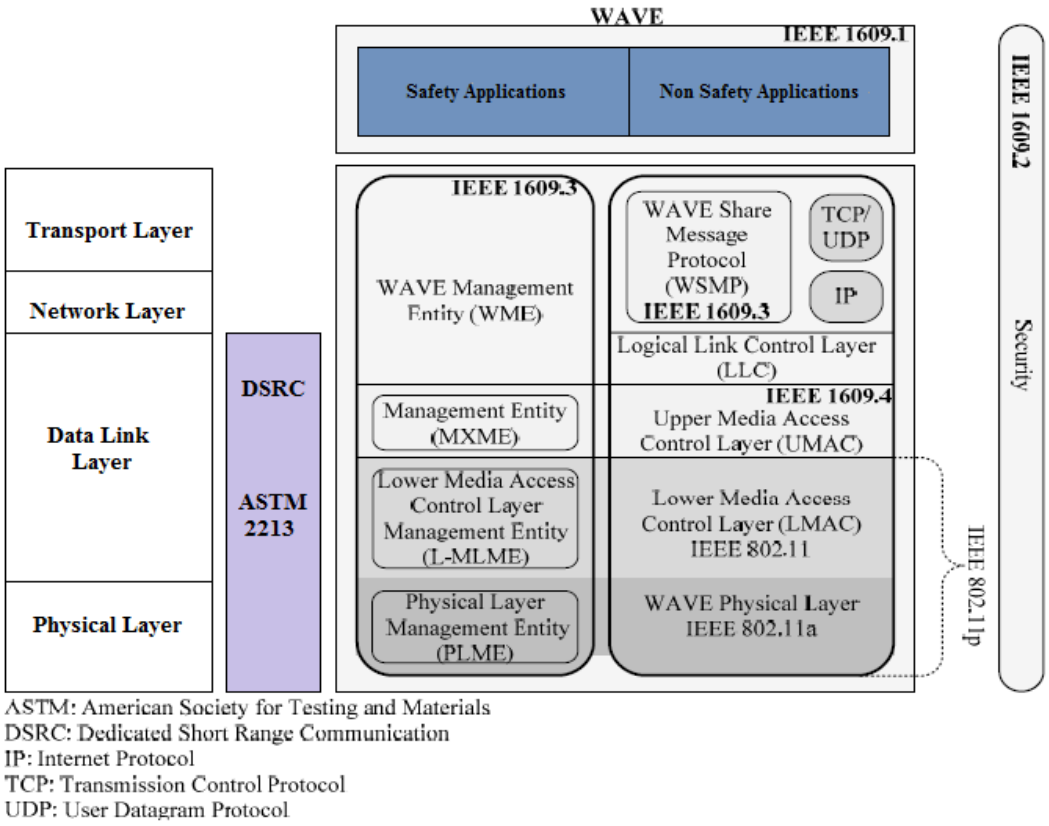


Figure 1.5: WAVE/DSRC [5]

IEEE 802.11a standard has been migrated to IEEE 802.11p standard and has renamed the DSRC as the WAVE. The WAVE scope is being limited to the layers i.e. physical and Mac layer whereas the DSRC is being handled by the upper layers of IEEE standard.WAVE is defining the two types of services which are Roadside Units (RSUs) and the Onboard Unit (OBU). The summary of IEEE standards is provided in Table 1.2.

IEEE Standard	Description
IEEE Standard 1609	Defines the VANET architecture, model for communication, mechanisms for security and wireless communication physical access in VANET. Defines the necessary components of VANET like RSU, OBU and WAVE Standard for communication.
IEEE Standard 1609.1-2006	Provides interoperability Explains the main components of WAVE architecture
IEEE Standard 1609.2-2006	Security attributes for WAVE and VANET applications are defined which protect the system from various attacks like spoofing, replay and eavesdropping
IEEE Standard 1609.3-2007	Specifies routing protocols for secure communication between source and destination. Defines multiple upper/lower layers in WAVE networking services, introduced IP for WAVE applications which simply denied WAVE Short Message Protocol
IEEE Standard 1609.4-2006	Contains information regarding the enhancement of media access control layer so as to support WAVE
IEEE Standard 802.16e	Along with interoperability it adds an additional functionally of multi vendor broadband wireless access.|

Table 1.2: IEEE Standards in VANET [43]

1.9 VANET Routing

Topology-based Routing Protocols

These protocols are making use of the routing tables so that they can store information based on the packet moving from the source to the intended destination. Based on the network architecture these are further divided (refer Figure 1.6) into:

- **Proactive Routing Protocols**
- **Reactive Routing Protocols**

Proactive Routing Protocols

Theses protocols are also known as table driven protocols which are allowing every node in the network to maintain the information to the intended destination; next node

information is being maintained that is in the path from the source towards the destination. Whenever any change in the topology of the network occurs, tables are being updated as a result of which overhead cost incurs [1]. These protocols are providing the actual data for the availability of the network. To make a choice for which route has to be chosen shortest path algorithms are being used. Destination Sequenced Distance Vector (DSDV) is an example of Proactive Routing protocols.

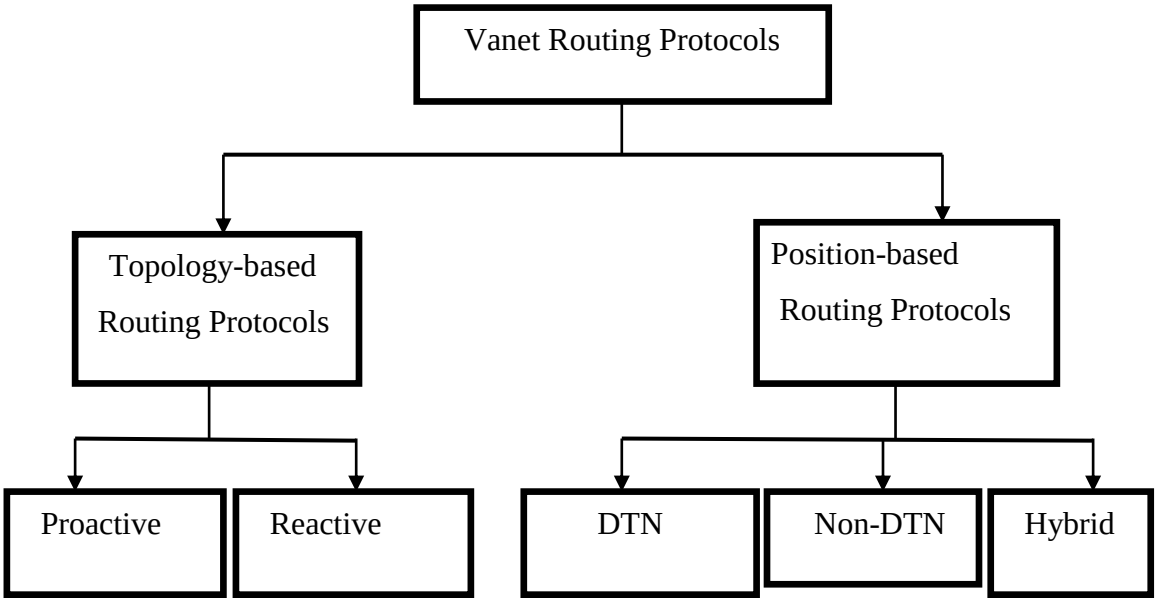


Figure 1.6: Routing Protocols [1]

Reactive Routing Protocols

These are also known as On-demand routing protocols. This is due to the reason that whenever there occurs the requirement for the route from source to destination, discovery for the route begins. This leads to the reduction of traffic in the network and saves the bandwidth. These are highly suitable for large size ad-hoc networks which are highly mobile in nature and have frequent changes in topology. Ad-hoc On-Demand Distance Vector (AODV) protocol is an example of reactive protocols.

Position-based routing protocols

These are dependent on the position of data during the routing process. The source node is making use of packet location instead of the address of network while sending the

data to the destination. Each and every node is deciding its position and also making the decision on neighboring nodes with the help of GPS [45]. While sending the data source node is saving the location of the intended destination, no route discovery, route maintenance is required. Position-based protocols are:

- **Delay Tolerant Network**

These protocols are using the concept of store and carry forward through the network where nodes are helping each other to forward the packets. In the case of DTN we are not able to ensure that there will not be any disconnectivity in the network, so packets are cached for some duration of time with other nodes on the route.

- **Non-Delay Tolerant Network**

These are the type of position based routing that is not taking into consideration the problem of disconnectivity with the assumption that a large number of nodes are exist there to continue with successful communication [43].

- **Hybrid protocols**

This is a Position based routing that is reducing the overhead and is not maintaining the tables since they are making use of neighboring nodes location and destination node.

Topology-Based Routing Protocols	Reactive Routing Protocols (On-Demand)	Proactive Routing Protocols (Table-Driven)
Advantages	As these are beaconless, they are saving the bandwidth. To update the routing tables, On-demand flooding of the network takes place.	Process for route discovery is not required. Latency for real-time applications is low.
Disadvantages	Disturbance in the communication of nodes occurs due to high flooding in the network. High latency for route determination.	Part of bandwidth that is available is being used by the paths that are not being used.

Table 1.3: Reactive and Proactive Routing Protocols [43]

VANET Routing Protocols	Topology-Based Routing Protocols	Position-Based Routing Protocols
Methodology	Using the shortest path algorithms. Packet forwarding is by the link information in routing table.	Position determining service is used. Vehicles position is required to forward the packets.
Strength	Route discovery is required. Beaconless Suitable for unicast, multicast and broadcast.	Route discovery and maintenance routes is not required, Beaconing. Support for high mobile environment.
Limitations	More overhead. Involve route discovery and delay constraint maintenance.	Least overhead. Services for position finding. Deadlock may occur in the location server.
Remarks	Proposed for MANETs. Suitable for small networks.	Suitable for large networks such as VANETS.

Table 1.4: Topology and Position Based Routing Protocols [43]

1.10 VANET Security

The security in case of VANET is one of the important and the crucial issue. The systems that are being used for communication must be having any algorithm among them so that they can detect the malicious activity as well as the non-legitimate user in the network [8]. There exist some classifications whenever we are addressing the security issues. Some classifications of attackers are:

1) **Insider Versus Outsider**
2) **Malicious Versus Rational**
3) **Active Versus Passive**

Security attributes are authentication, integrity, confidentiality, availability, non-repudiation.

CHAPTER 2

LITERATURE REVIEW

Jie Luo et al. (2010) "A mobile infrastructure based VANET routing protocol in the urban environment," This paper first dissect the novel components of urban VANET that hubs have diverse sorts, and move alike bunches because of the impact of activity lights. Along these lines, the idea of utilizing transports as the versatile foundation to enhance the system availability is proposed. We likewise build up a novel steering convention named Mobile Infrastructure Based VANET Steering convention. This convention made complete utilization of the transports, making it a key segment in course opting and bundle sending. It is a location based steering convention. MIBR attains the highest data delivery ratio. MIBR protocol improves the network connectivity by escalating the transmission range [1].

Kevin C. Lee, Mario Gerla (2010) "Opportunistic vehicular routing," In opportunistic system there is no predefined administer for picking the following hub to goal (as it is the situation in ordinary plans, for example OLSR, DSR or even Geo-Routing). Rather, a middle of the road hub in transit acts in an unrehearsed manner and takes a choice that is construct exclusively in light of current conditions. A prevalent case of opportunistic steering is the "delay tolerant" sending to "data mules" when an immediate way to goal does not exist. Conventional steering for this situation would simply "drop" the packet. With opportunistic steering, a node follows the available information and it seeks the best neighbor to carry the information to the destination [2].

Mohammad Jalil Piran et al. (2011) "Vehicular Ad Hoc and Sensor Networks; Principles and Challenges," In this paper, they have explained main fundamentals and challenges of VASNET. The proposed approach VASNET is specifically for highway traffic. VASNET is a self-manageable Ad Hoc and sensor network consist of a large number of sensor nodes. In VASNET there are two sorts of sensor nodes, some are implant on the vehicles-vehicular nodes and others are established in fixed distances excepting the highway road, known as Road Side Sensor nodes. The vehicular nodes are used to sense the velocity of the vehicle for illustration. Authors have some Base Stations which may be stationary or mobile. VASNET

supplies capabilities for wireless communication among vehicular nodes and stationary nodes, to enlarge security and contentment for vehicles on the highway roads [3].

Bijan Paul et al. (2011) "VANET Routing Protocols: Pros and Cons," This paper presents the advantages and disadvantages of Vehicular Ad hoc Network steering conventions for inter-vehicle correspondence. The current directing conventions for VANET are not productive to meet each activity situations. In this way plan of a productive steering convention has taken huge consideration. In this way, it is exceptionally required to recognize advantages and disadvantages of directing conventions that can be utilized for future changes of any new steering convention. Because of quick changes in topology and visit separation makes it tough to plan a productive directing convention for the steering information among vehicles known as a vehicle to vehicle correspondence and vehicle to street side framework [4].

Mohammad Al-Rabayah (2012) "A new scalable hybrid routing protocol for VANETs," This paper describes new kind of hybrid location based steering convention has been proposed that is especially intended to address the issue. This new convention consolidates components of the reactive steering with location based on the geographic directing in a way that effectively utilizes all area data accessible. The convention is intended to effortlessly exit to the reactive steering as the area data degrades. We show through examination and simulation that our convention is versatile and has ideal overhead, even within sight of high area blunders. Their convention gives an improved but realistic area empowered arrangement that can be conveyed in all VANET situations [5].

Farahnaz Naeimipoor et al. (2012) "Performance evaluation of video dissemination protocols over Vehicular Networks," This work considers the infrastructure less situation of Vehicular Ad hoc Networks. The spread of video substance over VANETs is to a great degree testing essentially because of the system's dynamic topology and stringent prerequisites of video streaming. This paper concentrates the primary methodologies pointed towards a compelling and proficient result for video dispersal over Vehicular Ad hoc Networks. Work depicts in detail the procedure of video scattering over VANETs and presents an exhaustive assessment of existing arrangements [6].

Cristiano Rezende et al. (2012) "VIRTUS: A resilient location-aware video unicast scheme for vehicular networks," Video streaming abilities in Vehicular systems are urgent to the advancement of profitable administrations. Nonetheless, VANET is a challenging domain to this sort of correspondence because of the scattering and development of vehicles. This work, introduce an achievable answer for this issue. The VIdeo Reactive Tracking-based UnicaSt convention is an accepting based arrangement that uses vehicles present and future area for a choice strategy of handing-off hubs. It satisfies video streaming prerequisites without bringing about into an over the top no of transmissions [7].

Sabih ur Rehman et al. (2013) "Vehicular Ad Hoc Networks (VANETs) - An Overview and Challenges," The author presents the cutting edge of Vehicular Ad hoc Network and suggests similar problems. System design, signal modeling and the propagation structure mobility modeling steering convention and network security are explained in details. Main outcomes of the paper are a well-organised and steady Vehicular Ad hoc Network is one which persuade factors such as QoS, minimum latency, low BER and high PDR [8].

Shouzhi Xu et al. (2013) "QoS evaluation of VANET routing protocols," The principle objective of paper to examine the fundamental quality criteria in steering conventions with a coordinated Vehicular Ad hoc test bed. Topology-based directing conventions are inspected. To consider Quality of service execution of various conventions, assessing models of edge misfortune proportion, PSNR and network likelihood are represented. Three normal directing conventions: Destination source distance vector, Ad hoc on demand and GPSR are chosen to affirm the Quality of service as indicated by the insights consequence of video transmission over VANET testbed. The utility of service execution is broke down under a few states of various separation of directing information transmission and vehicles arriving rate. Test comes about demonstrate that Pro-dynamic convention is not appropriate for high mobility Vehicular networks, and Position-based hybrid convention is more reasonable for video transmission over Vehicular networks than Re-dynamic convention [9].

Mingjun Xiao et al. (2014) "Community-aware opportunistic routing in mobile social networks," Mobile Interpersonal Organizations are a sort of postpone tolerant system that comprises of loads of versatile hubs with the social attributes. As of late, numerous social-mindful calculations have been proposed to address steering issues in MSNs. Nonetheless,

these calculations have a tendency to forward messages to the hubs with locally ideal social qualities, and consequently can't accomplish the ideal execution. This paper, propose a conveyed ideal Community-Aware Opportunistic Routing algorithm. Principle commitments are that it has proposed a community model of home-aware, where it turn an MSN into a system that alone incorporates group homes. CAOR can compute the minimum expected conveyance postponements of hubs through the turn around Dijkstra algorithm and achieve the ideal astute steering execution. In spite the number of groups is far not exactly the quantity of hubs in size, the computational charges and support charges of contact data are enormously reduced. Optimal route performance is the biggest advantage of the CAOR algorithm [10].

Xuebin Ma et al. (2014) "An overlapping community detection algorithm for opportunistic networks," In this paper community structure are designed to understand networks, which can likewise profit productive steering conventions and QoS plans to outline. For an Opportunistic Network which comprises of various types of versatile hubs, its topology changes after some time. Accordingly, the community detection turns out to be more troublesome than static circumstances. Besides the covering group identification is a more mind boggling issue. This paper dissects the time changing topology of Opportunistic Networks and the covering group structures of the human. Community detection algorithm applied to social science, complex networks and graph theory. The algorithm is highly reliable and flexible in nature for overlapping community detection in case of the opportunistic networks [11].

Xinming Zhang et al. (2015) "A Street-centric Opportunistic Routing Protocol Based on Link Correlation for Urban VANETs," In this paper link model has been constructed with a Wiener procedure so as to analyze the availability of link that is taking into consideration the states which are stable as well as unstable as per conduct of vehicles. It presents a keen idea known as the Link correlation that talks about the impact of various connection mix in system arrangement to transmit a parcel with lower asset utilization and high goodput. In view of above idea opportunistic metric for routing, the normal transmission charges over a path which contains multiple hops (ETCoP) executed with the link model that guides for selecting relaying hub in case of intra streets. Metric can likewise help in following road

determination at a crossing point. Simulation demonstrates that this system beats traditional conventions in context of ratio of data delivery, normal delay, and system yield [12].

K. W. Wong Gary et al. (2015) "Performance Evaluation of Social Relation Opportunistic Routing in Dynamic Social Networks," This paper social relation opportunistic steering algorithm is used for mobile social networks and defines the social relation and profiles among the hubs. SROR algorithm is used to resolve the routing issues by searching and forwarding the packet to the node. Social computing has adapted to solve the networking protocol design such as routing and scheduling. In this paper, aim is to provide the more accurate and extensive performance evaluation results with the quality of service metrics. These approaches are much capable than the traditional opportunistic steering protocols; social properties provide more stable over the unstable dynamic characteristics. Social characteristics of nodes, the routing protocol, can efficiently predict and deal with the dynamics of networks [13].

Juan Luo et al. (2015) "Opportunistic routing algorithm for relay node selection in wireless sensor networks," Wireless Sensor Networks having a wide range of applications in areas such as monitoring of traffic, care in medical terms, the robotic examination. In this paper, main concentration is on minimizing vitality utilization and expanding system lifetime for information transfer in one-dimensional (1-D) line arrange. Broad recreations and genuine testbed come about demonstrate that the proposed arrangement ENS_OR can essentially enhance the system execution on vitality sparing and remote availability in the examination with other existing WSN steering plans [14].

Mingjun Xiao et al. (2015) "Deadline-sensitive opportunistic utility-based routing in cyclic mobile social networks," This paper, brings out utility-based directing into cyclic MSNs, has proposed a deadline touchy utility-based steering model. A cyclic Mobile Social Network is another sort of postpone tolerant system, in which the mobile clients occasionally move around, and get in touch with each other through their conveyed short-remove specialized gadgets. This paper introduces a deadline sensitive utility model into MSN routing. Under this model, proposed a single-copy routing algorithm DOUR (deadline sensitive opportunistic utility based routing model), and a multi-copy routing algorithm m-DOUR can

achieve a maximum utility for each message delivery. Both provide a good balance between the advantages, delay, and cost for every message conveyance [15].

Mario De Felice et al. (2015) "A distributed beaconless routing protocol for real-time video dissemination in multimedia VANETs," This paper introduces an application system that can handle multi-hop, multi-way, and element situations, the Distributed Beaconless Dissemination, that improves the scattering of live video streams on media interstate Vehicular Ad hoc Network. DBD utilizes a backbone based way to deal with make and maintain constant and quality routes through video delivery in opportunistic Vehicle to Vehicle situations. It additionally enhances the execution of the IEEE 802.11p MAC layer, by providing a solution to the Spurious For-warding (SF) issue, while expanding the data delivery proportion and decreasing the sending delay. Performance assessment demonstrate the advantages of Distributed Beaconless Dissemination contrasted with existing work for sending recordings over Vehicular Ad hoc Network, where the primary target and subjective QoE results are being measured [16].

Neha Garg, Puneet Rani (2015) "An improved AODV routing protocol for VANET (Vehicular Ad hoc Network)," This paper has enhanced the evaluation of Ad-hoc on Demand Distance Vector steering convention by using few parameters such as time outs in case of active routes and interval of hello to opt the best way for steering and is comparing the proposed AODV evaluation with Normal AODV in context of varying evaluation metrics i.e. average goodput, average delay and average system load. Simulation shows that proposed AODV steering convention has better performance in comparison to normal AODV [17].

Shehu Jabaka Muhammad et al. (2015) "Network Coding for Reliable Safety Message Communication in Vehicular Ad-Hoc Networks : A Review," This paper audits a portion of the applications of system coding for dependable reliable message correspondence in VANETs, grouping them in view of the transmission introduction and revealing the increase acknowledged when the technique is utilized. A summary table introducing the relative investigation of the conventions is given. At present, data dispersal in the practical communication networks is accomplished by steering. Be that as it may, organize coding can be considered as the cheerful speculation of steering that can possibly arrange evolving

circumstances. Regardless of the presence of various reviews on the applicability of system coding to broadcasting interchanges for MANET [18].

Xin Ming Zhang et al. (2015) "A Street-centric Routing Protocol Based on Micro Topology in Vehicular Ad hoc Networks," This paper describes the concept known as micro-topology (MT), which is consisting of nodes and the links among the nodes along side the street as the basic component for the routing the paths and the entire topology of network. The first analysis is being done on the end side performance of routing considering as the basis for the routing decision. Then street-centric protocol for routing which is based on the micro topology has been proposed. The results of simulation show that the proposed protocol is achieving the higher delivery rate of data and the min end to end delay in comparison to the GPSR and GyTAR [19].

Chander Prabha et al. (2016) "Optimising social information by game theory and ant colony method to enhance routing protocol in opportunistic networks," The proposed convention is analyzed completely by means of examination and reproduction keeping in mind the end goal to survey their execution in correlation with other social based steering conventions in opportunistic network under different parameters settings. The information misfortune and detachment of nodes are visit in opportunistic system. The social data assumes an essential part in lessening the information misfortune since it relies on upon the network of hubs. The proper determination of next jump in view of social data is basic for enhancing the execution of directing in opportunistic systems. Frequent disconnection issue is avoided by enhancing the social data with ACO technique which relies on upon the topology of opportunistic network [20].

Elnaz Limouchi, Imad Mahgoub (2016) "Intelligent Hybrid Adaptive Broadcast for VANET," This paper describes the intelligent hybrid adaptive broadcast (IHAB) scheme that is combining the strength of fuzzy logic-based broadcast and bandwidth efficient fuzzy logic-assisted broadcast. FLB is offering the high level reach where as BEFLAB is much more bandwidth efficient in nature. In order of designing a broadcast scheme which is efficient in case of bandwidth with higher ability of reach, a vehicle which is receiver is finding out neighbors which are common with the neighbors which are transmitting and treating it as the potential transmit density (PDT). If potential density for transmission is exceeding the

threshold the receiving node is going to use BEFLAB to make a decision whether to rebroadcast or not, in other case FLB is being used. As per the simulation results, IHAB has higher reach level and the efficient bandwidth [21].

Wanting Zhu et al. (2016) "A Collision Avoidance Mechanism for Emergency Message Broadcast in Urban VANET," This paper describes RBEM/CBEM mechanism of handshake for the enhancement of the broadcast protocol, which is for the broadcast of emergency messages in case of urban environment. The emergency messages reliability can be improved by the reduction in case of packet delivery failure which is due to the collisions. A process for the broadcast of emergency messages has been designed through the urban roads by taking into account the characteristics of the road and the requirements of scalability. Simulation has been conducted just to have the confirmation of feasibility and the effectiveness of proposed approach [22].

Sahil Chhabra, Rajesh Kumar (2016) "Efficient Routing in Vehicular Ad-hoc Networks Using Firefly Optimization," In this paper, they have described that VANET is providing the networking environment for ITS in which nodes are having high speed and their topology is changing on the frequent basis. Due to which communication among nodes and the route discovery in the network is a tiresome task. This paper has described an approach to improve the performance of routing in terms of time to transmit and the better connectivity. The proposed algorithm is applying the concept of firefly optimization algorithm on the vehicular ad-hoc network that is enhancing the routing performance by transmitting the packets in an efficient way from source to destination [23].

Hui Wang et al. (2016) "Firefly Algorithm with Neighborhood Attraction," This paper describes a new technique for optimization known as Firefly Algorithm which is on the basis of swarm intelligence. This algorithm is simulating the social behavior i.e. attraction associated among the fireflies where less bright firefly is moving towards the bright one. In the case of FA, each firefly can be attracted by the other fireflies which are brighter in nature which is going to result in a large number of attractions and high time for computation. To overcome these problems neighborhood attraction (NaFA) has been proposed in which each firefly is being selected by other fireflies which are brighter in nature selected from the

predefined neighborhood. Results have depicted that this proposed method is going to improve the accuracy and is reducing the time complexity [24].

Chun-Chih Lo, Yau-Hwang Kuo (2016) "Traffic-aware routing protocol with cooperative coverage-oriented information collection method for VANET," This paper describes a protocol that is taking into consideration the real time scenario of traffic for the formation of a path for delivery of data. Three mechanisms have been designed to achieve the goal which are a collection of the information related to cooperative traffic, light weighted real-time scoring for roads and adaptive route constructing. Weights are being assigned as per the overall view of conditions for traffic and the segments which are providing efficient routes for data delivery are used to construct a path for routing. Results depict high performance of network in terms of packet delivery, delay and overhead in communication [25].

Tareq Emad Ali et al. (2016) "Review and Performance Comparison of VANET Protocols: AODV, DSR, OLSR, DYMO, DSDV & ZRP," This paper is providing the brief study of ad-hoc protocols for routing that are being used in a Vehicular ad-hoc network. The vehicular network is providing communication among the vehicles that are moving on roads. The protocols that are being used for communication are being affected by the high speed of vehicles which is leading to the path breaks. The main motive of a vehicular network is the assembly of data system in vehicles which are moving on the roads. In this paper routing protocols has been compared on the basis of a delivery ratio of packets, delay, throughput [26].

Ruchi Mehra et al. (2016) "Efficient Clustering based OLSR Routing Protocol for VANET," This paper describes a proposed routing protocol which is based on clustering. The algorithm that has been proposed is the algorithm of distributed clustering along with the OLSR protocol for routing which is providing high throughput, good results in terms of delay and overhead. New clustering technique is being used which is making use of a position of a vehicle and the information related to velocity for the formation of clusters with the lower relative mobility in between in heads of clusters and their members. The proposed algorithm's performance is being validated against the AODV, DYMO and OLSR routing protocol in the terms of delay, throughput and is providing the better performance [27].

Awos Kh. Ali et al. (2016) "Evaluating VANET Routing in Urban Environments," This paper describes depth evaluation of MANET routing protocols, AODV, OLSR and GPSR in the case of VANET with a setup of an urban environment. Performance is being compared in terms of packet drop, the delay involved and the ratio of delivery. The results show OLSR has been able to achieve short drop burst length and higher delivery ratio in comparison to AODV. GPSR shows much stable delivery ratio in medium and the high load of the network [28].

Mehdi Tavakoli Garrosi (2016) "Enhanced Intersection-based Perimeter Geo-routing in the Urban Vehicular Ad-hoc Networks," This paper describes Enhanced Intersection-based Perimeter Geo-routing for the urban vehicular networks. This is employing the new forwarding perimeter based on the intersection just to avoid the wrong estimation of streets. EIPG is inheriting the greedy forwarding feature of GpsrJ+. The simulation results show that EIPG is improved as compared to GpsrJ+ in the terms of delivery of packets, delay and the overhead. EIPG requires the information of direct neighbor just to avoid the overhead by the extra information [29].

William Angeles et al. (2016) "The Impact of Propagation Models in the Performance of Ad Hoc Routing Protocols for Urban VANET," This paper is comparing the performance impact of ad-hoc protocols for routing such as AODV, DSR, OLSR, DYMO under the different models of propagation. Different propagation models are such as free space, two ray ground, nakagami, log normal. The metrics that have been evaluated are the delivery ratio of packets, delay in case of end to end delivery. This work is concerned towards the contribution of real time scenario for vehicles in case of urban environment [30].

Amrita Chakraborty, Arpan Kumar Kar (2017) "Swarm Intelligence: A Review of Algorithms," This paper describes the study of insect and animal based algorithms. This is the analysis of way in which these algorithms operate. The specified areas for these protocols have been introduced after the analysis of inspiration. Specific areas where these algorithms can be applicable have been highlighted. Swarm intelligence is an integral part of the artificial intelligence. This study is providing the basic concept of the technical aspects and the future scope of algorithms [31].

Hussein Chour et al. (2017) "VANET aided D2D Discovery: Delay Analysis and Performance," This paper describes the effective reduction in the consumption of resources in LTE-A network by proposing the D2D scheme which is working for the users. The scheme that has been proposed is capable of offloading a part of traffic of D2D and processing that which is involving the drivers and passengers. This proposed scheme is making use of information from road side units about the vehicular users in their coverage areas. The results depict the how effective is the proposed scheme and are showing that low latency can be achieved [32].

V. Kanimozhi et al. (2017) "A survey on Multi-Constrained Optimal Path Selection Schemes and Authentication Schemes for VANET," This paper is examining the various schemes for authentication and the optimal selection of path on the basis of certain criteria such as Quality of service. Vehicular network are intending to get safety for drivers, avoiding the collisions and offering the optimization for traffic. There exist several issues prior to the authentication process [33].

Clayson Celes et al. (2017) "Improving VANET Simulation with Calibrated Vehicular Mobility Traces," This paper describes the solution to fill out the gaps which are leading to more fine-grained traces which is further leading to more trustworthy results. They have proposed and have evaluated the results of data basis solution by using the algorithms of clustering. Results represent that gaps are inducing the topologies of a network by differing them from reality, decreasing the quality of results [34].

Xinxin He et al. (2017) "Transmission Capacity Analysis for Linear VANET under Physical Model," In this capacity of transmission for VANETs is being analyzed on the basis of 1D line model and the carrier sense multiple access with collision avoidance protocol. On the base of proposed model, we are analyzing the attempt to transmit probability of each and ever road segment and the max intensity of transmitters that are active. Then, the physical model is being employed to derive the upper bound for the transmission capacity, which is being defined as the average of spatial density of transmissions which are successful [35].

CHAPTER 3
PRESENT WORK

3.1 Problem Formulation

In order to have a clear cut scenario of proposed work related to enhancement of routing in vehicular Ad-hoc network, first of I am formulating description of the base paper that I am referring for my M.Tech dissertation work.

3.1.1 Previous work

Xinming Zhang, Xulei Cao, et al. (2015) "A Street-centric Opportunistic Routing Protocol Based on Link Correlation for Urban VANETs," has tried to formulate solution for the two challenging issues being faced in case of urban vehicular networks. The two challenging issues are:

- Selecting an optimal relaying node in case of an intra-street
- Selection of street at the intersection.

This paper has formulated link model with the wiener procedure so as to make analysis on the availability of link that is taking into considerations the stable and unstable states of vehicles as per the vehicle conduct. It is presenting a keen idea which is known as link correlation that talks about the impact of various connection mix in the system arrangement to transmit a parcel with the lower asset utilization and the high throughput. In view of the idea of opportunistic routing, the normal transmission charges over a path which contains multiple hops (ETCoP) executed with the link model that guides for selecting the relaying hub in case of intra streets. This metric can likewise help in following the road determination at a crossing point. Street-Centric Protocol based on the expected transmission cost works as follows:

a) Vi is the ith vehicle which is maintaining the expected transmission cost in case of failed transmission of vehicle and aggregation quality of all links from itself to the destination, which is towards the two intersections of street through which packet is being delivered.

b) Calculation of expected transmission cost of vehicle Vi in the street through which packets are being delivered.
c) If the destination vehicle is the part of current street then forward it under the expected transmission cost gradient.
d) Else if the vehicle arrives at the intersection part of the current street than Calculate the expected transmission cost from source to destination end of the adjacent streets. Current street through which transmission will take place will be the street with the minimum expected transmission cost.
e) Else if destination vehicle = = Vi then destination vehicle has received the packet successfully from the source vehicle.

The simulation results are demonstrating that SRPE is beating the traditional convention in the context of data delivery ratio, end to end delay and the yield of system.

3.2 Objectives of the study

As my dissertation work is focused on VANET, packet drop is main problem. The main reason for packet drop is due to the high mobility among the nodes. Main challenges are selection of an relaying node which is optimal in nature in case of an intra-street and selection of street at the intersection in case of urban environment. Therefore improving the VANET routing decision in the context of packet drop with the help of firefly optimization. The objectives of my study are:

1) Selection of an optimized relay nodes on the basis of coverage area.
2) Implementation of link state routing and optimization of the proposed approach with the help of firefly algorithm.
3) Evaluation of parameters such as network yield, overhead, delay from end to end, delivery of packet ratio.
4) Comparison of the proposed work with the existing approach.

3.3 Proposed Work

We proposed a system in which the two challenges being faced in case of urban environment are being solved. The challenges are the selection of an optimal relaying node

in an intra-street and the selection of street at the intersection. We proposed a system(Figure 3.1) in which relay nodes are being selected on the basis of coverage area. Link state routing has been implemented for routing and optimization of the proposed approach is with the firefly algorithm. The parameters such as network yield, overhead, end to end delay, packet delivery ratio are being evaluated.

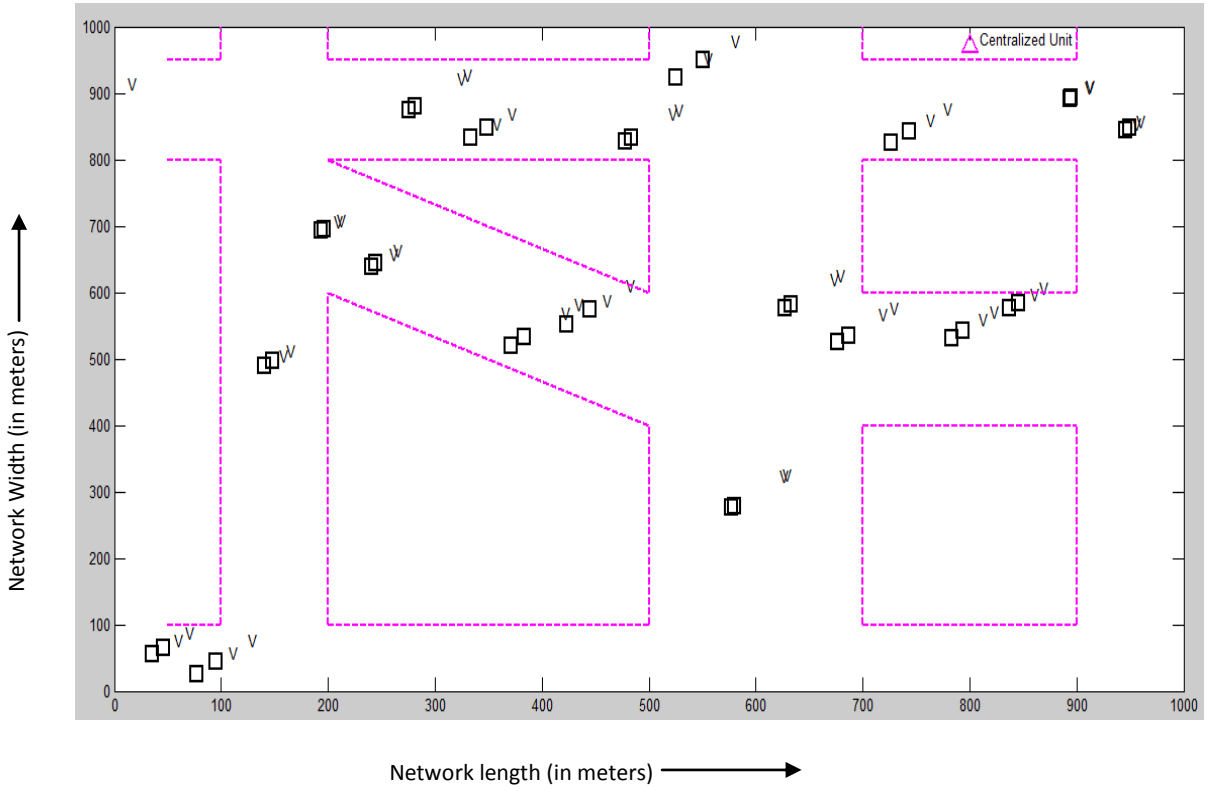


Figure 3.1: Proposed Work architecture

The simulation parameters that have been taken into consideration for the design of architecture (refer Table 3.1).

Simulation Parameter	Value
Simulator	MATLAB2013
Simulation Area	1000m*1000m
Number of Nodes	20
Traffic Type	CBR
Simulation Time	300s

Table 3.1: Simulation Parameters

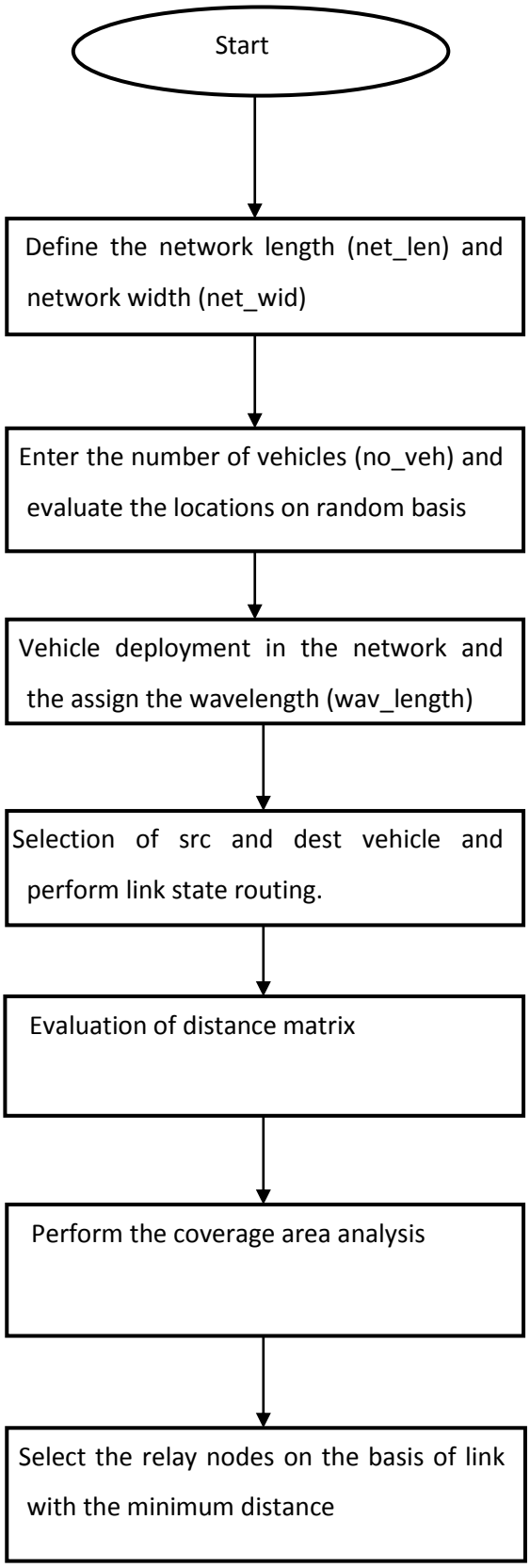
3.4 Assumptions

The following underlying assumptions have been made to evaluate the efficiency of proposed approach for urban environment. This approach has been designed for routing in case of urban scenario. If the routing overhead increases, then we have to go for optimization. The randomness of vehicle has to be reduced, ie less is the randomness of vehicle, more stable is the state of vehicle, then the packet drop will be reduced.

1) Each vehicle has been equipped with a device known as GPS and a digital map of streets in onboard navigation system.
2) Vehicles along the street having intersections can have the details related to the vehicles which are in neighbor with in range of communication.
3) Each vehicle is executing the distributed algorithm to have details that will be required for the estimation of end to end cost for transmission across the streets.
4) The information can be collected through the beacons which are iterative in nature for the topologies.

3.5 Research Methodology

Packet drop is main problem in case of VANET. The main reason for packet drop is due to the high mobility among the nodes. Main challenges are selection of an relaying node which is optimal in nature in case of an intra-street and selection of street at the intersection in case of urban environment. Therefore improving the VANET routing decision in the context of packet drop with the help of firefly optimization. In case routing overhead increases, it is being optimized. After performing the optimization, parameters are being evaluated to have the comparison among the results of proposed approach and the existing approach. Simulation results are showing that the proposed approach is better in terms of the ratio of packet delivery, delay involved in terms of end to end delivery, yield of the network, and the routing overhead. For the steps involved in the proposed approach refer Figure 3.2.


Start
Define the network length (net_len) and network width (net_wid)
Enter the number of vehicles (no_veh) and evaluate the locations on random basis
Vehicle deployment in the network and the assign the wavelength (wav_length)
Selection of src and dest vehicle and perform link state routing.
Evaluation of distance matrix
Perform the coverage area analysis
Select the relay nodes on the basis of link with the minimum distance

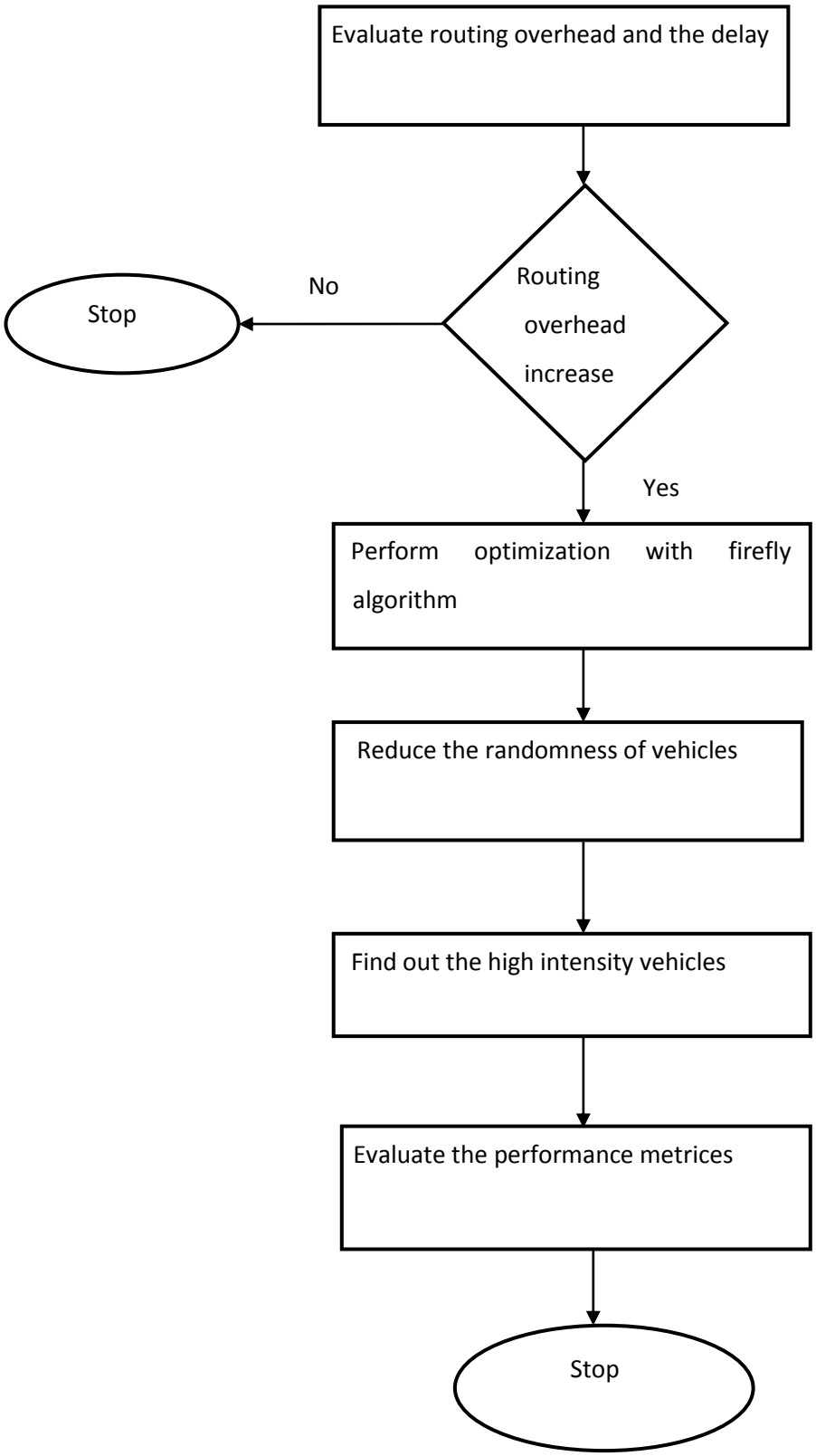


Figure 3.2: Research Methodology for proposed approach

3.6 Code Snippets

As the research is focused on data transmission in urban environment, therefore following code snippets are being provided.

```
dist_veh=sqrt((dest_xcord-src_xcord)^2+(dest_ycord-src_ycord)^2);

if dist_veh<0
    dist_veh=-dist_veh;
end
clear coverage_set
if dist_veh==0
    msgbox('Data will be transferred directly');
else
    covnumber=1;
   for i=1:no_veh
       format long g
       for j=2:no_veh
     dist_cov=sqrt((xloc(i)-xloc(j))^2+(yloc(i)-yloc(j))^2);

     if dist_cov<0
        dist_cov=-dist_cov;
     end
     cov_area(i,1)=veh_id(i);
     if dist_cov<=500 && dist_cov>0    | veh_vel(j)<mean(veh_vel)
         cov_area(i,j)=veh_id(j);
         d_veh(i,j)=dist_cov;
         time_veh(i,j)=100*rand;
     end
       end
   end
```

Figure 3.3: To find out the coverage area

```
for i=1:r
   dist_route(i)=sum(d_veh(i,:));
end
[min_dist id_veh]=sort(dist_route,'descend');
rel_node=cov_area(id_veh(1),:);

% rel_node=cov_area(comm_veh(1),1);
rel_node(find(rel_node==0))=[];
total_rt=[comm_veh(1) rel_node  dest];

rel_node(find(rel_node==0))=[];
msgbox(['Optimized Link Route Vehicluar Nodes: ',num2str(rel_node)]);
```

Figure 3.4: To find out Optimized link route

```
% Ranking the fireflies by their light intensity
[Lightn,Index]=sort(val);
xn=xn(Index); yn=yn(Index);
xo=xn;   yo=yn;    Lighto=Lightn;

[xn,yn]=ffa_move(xn,yn,Lightn,xo,yo,Lighto,alpha,gamma,range);      % Move all fireflies to the better locations
alpha=newalpha(alpha,delta);
end
response_opt=yo';
response_opt=sort(response_opt,'ascend');

% The initial locations of population fireflies
function [xn,yn,Lightn]=init_ffa(population,range)
xrange=range(2)-range(1);
yrange=range(4)-range(3);
xn=rand(1,population)*xrange+range(1);
yn=rand(1,population)*yrange+range(3);
Lightn=zeros(size(yn));
```

Figure 3.5: Firefly algoritm working

```
% Reduce the randomness during iterations
function alpha=newalpha(alpha,delta)
alpha=alpha*delta;


% Make sure the fireflies are within the range
function [xn,yn]=findrange(xn,yn,range)
for i=1:length(yn),
    if xn(i)<=range(1), xn(i)=range(1); end
    if xn(i)>=range(2), xn(i)=range(2); end
    if yn(i)<=range(3), yn(i)=range(3); end
    if yn(i)>=range(4), yn(i)=range(4); end
end
```

Figure 3.6: Optimization through firefly algorithm

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Implementation

The current simulation has been carried out using the MATLAB2013. MATLAB stands for matrix laboratory. For the technical computation, MATLAB is a high level language that is integrating the computation, visualization, and the programming in an environment which is easy to be used. In this environment problems and solutions are in the form of mathematical notation. The basic data element in case of MATLAB is an array that is no need of dimensioning. Uses include:

- Development of algorithm
- Simulation, Data analysis
- Application development which is also including Graphical User Interface building

The main parts of MATLAB system:

1) **MATLAB language**:

This is composed of high-level matrix and the array language that includes the control flow statements, data structures, object-oriented programming features etc. It allows us to programme in both on the small and large programme basis.

2) **MATLAB working environment**:

This consists of set of tools and the facilities that you are working with as MATLAB user or the programmer. It is having the facilities for the variable management in workspace ana the data import and export facility.

3) Gaphics Handling:

This is known as the graphics system for MATLAB. It is including commands of high-level for the two and three dimensional visualizations of data, processing of images, graphics for the presentation. It also includes commands of low level that provide with the

facility of customization of graphics appearance as well as to build up the graphic user interface on complete basis.

4) **MATLAB mathematical function library:**

This consists of vast range of computational algorithms that are ranging from basic functions to the complex ones such as ranging from sum, sine, cosine etc. to matrix inverse, fast fourier transforms.

5) MATLAB Application Program Interface (API):

This is known as a library that is allowing us to write programs in C and Fortran that are interacting with the MATLAB. It is having the facilities of routine calling from MATLAB, for reading and writing of MAT-files.

In this, I have designed a proposed approach to solve the challenges being faced in case of urban environment which are relay node selection in an intra-street and selection of streets at the intersection. I have deployed the VANET nodes on the network of defined length and width. For simulation parameters refer Table 4.1.

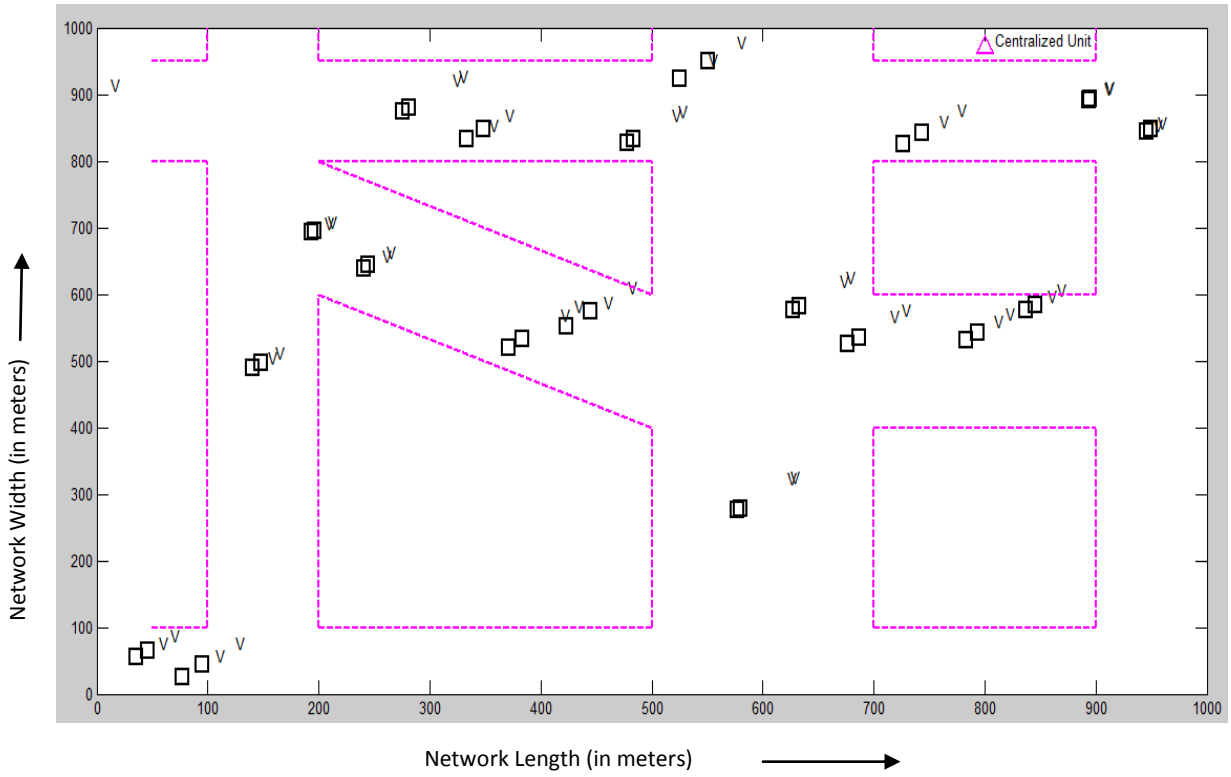


Figure 4.1: Proposed architecture

Then relay nodes are being selected on the basis of minimum distance, link state routing is being performed, and in case of overhead increase optimization with firefly algorithm is being done. Figure 4.1 shows a structure of streets with intersections and the two-way streets are being deployed in rectangular area of dimensions 1000*1000. The initial locations for the vehicles has been stored in the map known for a city and the movement for the nodes has been bounded in streets. Each vehicle in the environment is moving with the help with a speed which is randomnly ranging from minimum 30km/h to maximum 60km/h in the streets. Nodes are in the state which is stable in nature in case of intra streets, when the vehicles are changing their speeds at the intersection vehicles are in the state which is unstable. Constant bit rate is being used to generate the data traffic in case of network, and each CBR data are delivered in between the vehicles which are selected on the random basis.

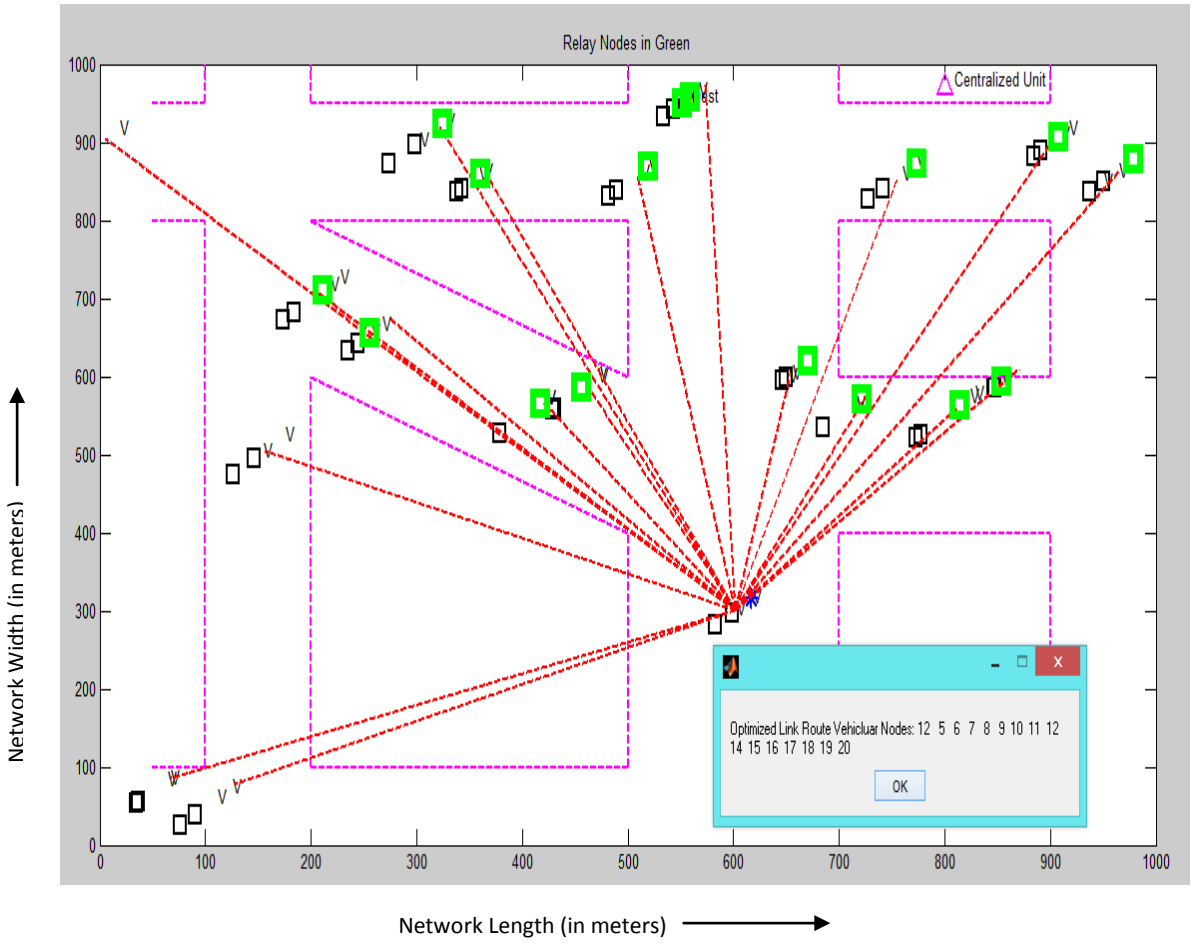


Figure 4.2: Selection of relay nodes

Here after deployment of nodes in the environment, wavelength is being assigned after that selection of the optimal relay nodes is being done. In the Figure 4.2 green color nodes are representing the relay nodes. These relay nodes are forming the Optimized Link Route for the transmission. For the simulation parameters for Figure 4.1 and Figure 4.2 refer to Table 4.1

Simulation Parameter	Value
Simulator	MATLAB2013
Simulation Area	1000m*1000m
Number of Nodes	20
Simulation Time	300 s
Channel Data Rate	2 Mbps
Traffic Type	CBR
Packet Size	512 bytes
Minimum speed	30 km/h
Maximum speed	60 km/h
Queue Length	500 packets
Traffic Flow	Free flow of traffic

Table 4.1: Simulation Parameters

The following performance parameters have been evaluated for the simulation results:

1) **Network yield**: It is representing forward reliability and the throughput of network. It is defined as the ratio calculated for the sum of amount of packets received at the intended destination node to the sum of data being delivered by all vehicular nodes through the time assigned for the simulation.

2) **Routing Overhead**: It is defined as the ratio calculated for the sum amount of the control packets to the sum amount of packets that have been successfully reached at the intended end node. Here size of control packets is to be considered instead of the number.

3) **Delay calculation from end to end**: This is defined as the average delay in case of transfer of data from the source node to the destination node. It is including the time taken by the packets over the vehicles for transmission which is also taking into consideration the partitions of the network.

4) **Ratio of Packet Delivery:** This is defined as ratio calculated for all packets that have been received successfully at the end node to the sum of packets originated from the source node.

All these performance parameters have been evaluated just to make the comparison among the proposed approach and the existing one.

4.2 Simulation Results

For evaluating the efficiency of the proposed system for the efficient routing in urban environment, analysis of the proposed and the existing one has been carried out. The analysis has been done in order to route the packets more efficiently. Observations are being made by taking into consideration and comparing various performance parameters.

4.2.1 Evaluation of ratio of packet delivery:

Figure 4.3 and Figure 4.4 illustrates the packet delivery ratio for the no of vehicles with the speeds in random manner having the range from 30km/h to maximum of 60km/h. On comparing the ratio of packet delivery for the vehicles without and with optimization there is increase in packet delivery ratio. This is due to rise in the vehicle number, there is improvement in the network connectivity, which is reducing chances of encountering the network partition.

Parameters	Value
Simulator	MATLAB2013
Xlabel	No. of vehicles
Ylabel	Packet Delivery
Optimization algorithm	Firefly Algorithm

Table 4.2 : Packet delivery evaluation parameters

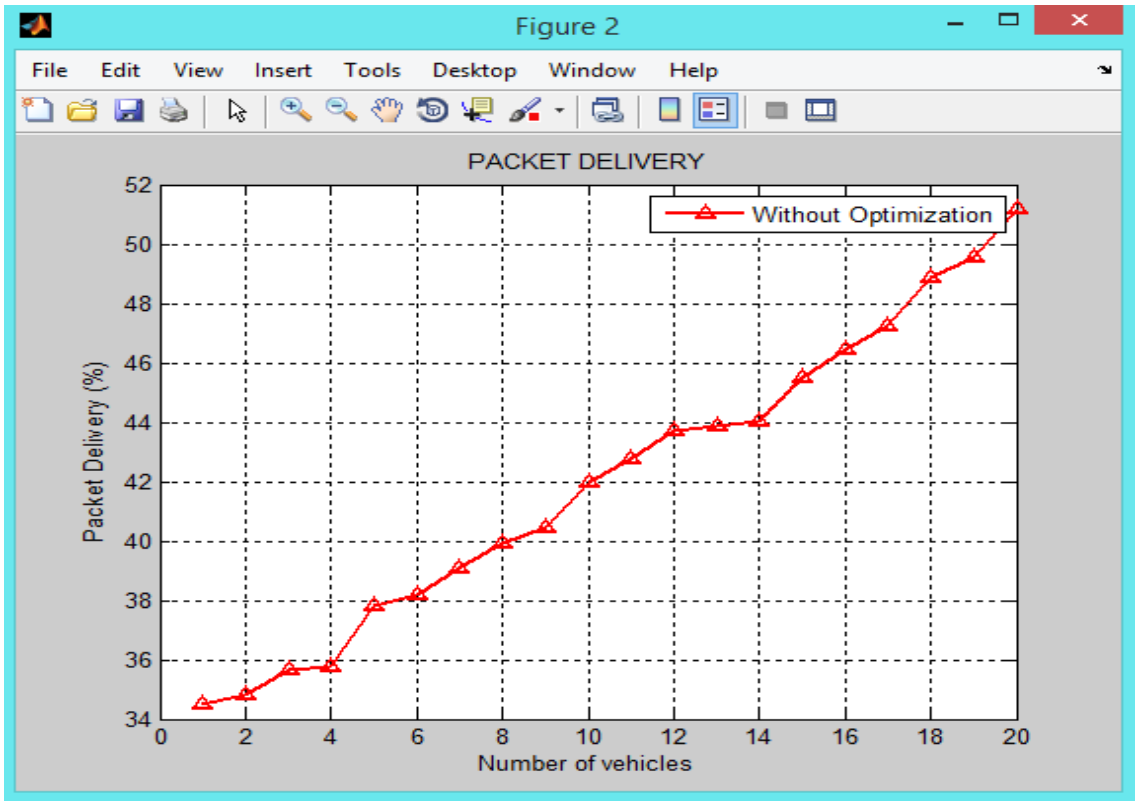


Figure 4.3: Packet delivery ratio without optimization

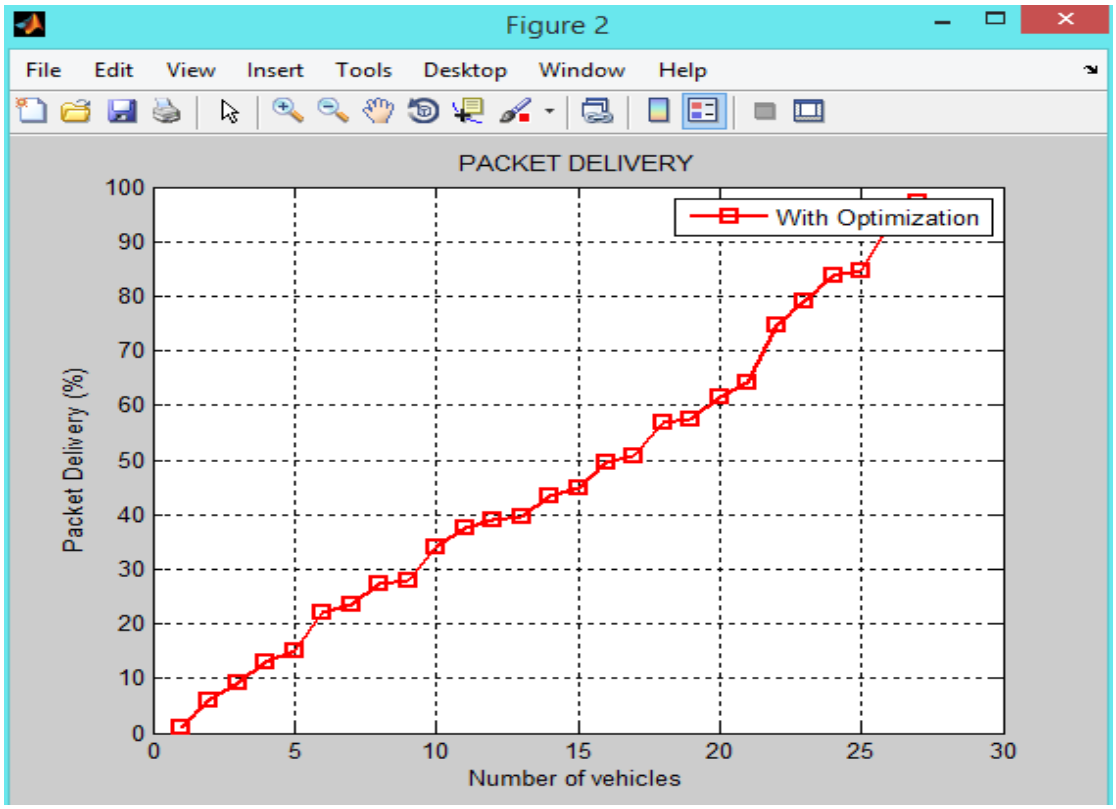


Figure 4.4: Packet delivery ratio with optimization using firefly algorithm

When the network density is sparse, vehicles are scattered, connectivity of the network becomes bottleneck, which is restricting the improvement in case of performance of routing. As the vehicle number increase there is increase in the network connectivity. There is increase in packet delivery ratio in both the existing and the proposed approach but with the proposed approach there is variation which is due to the optimization, which is managing the increase in routing overhead.

4.2.2 Evaluation of End to End Delay:

Figure 4.5 and Figure 4.6 illustrates the delay calculation from end to end for vehicle numbers with the speeds randomnly ranging from minimum of 30km/h to maximum of 60km/h. On comparing the delay for the nodes without optimization and with optimization there is decrease in end to end delay with the increase in number of vehicles. Here, optimization has been done with the firefly algorithm.

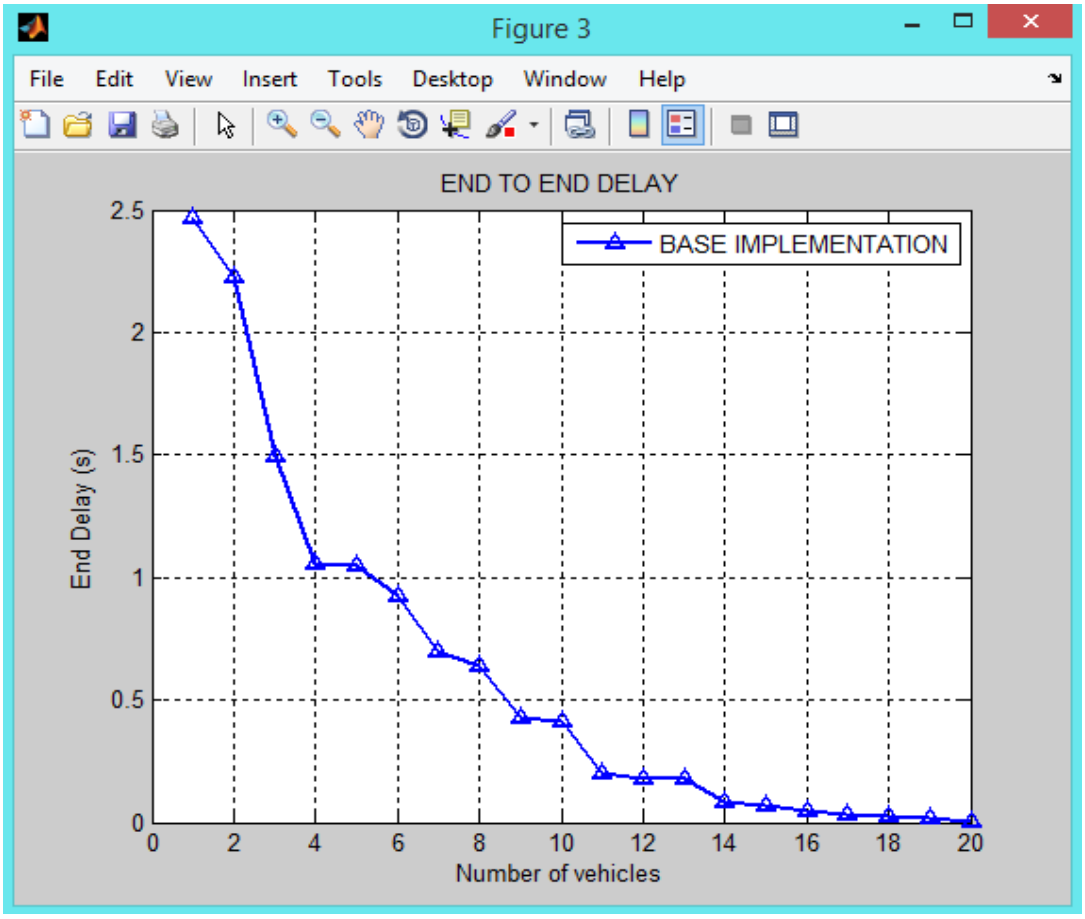


Figure 4.5: End to end delay evaluation without optimization

Parameters	Value
Simulator	MATLAB2013
Xlabel	No. of vehicles
Ylabel	End delay
Optimization algorithm	Firefly Algorithm

Table 4.3: End to end delay evaluation parameters

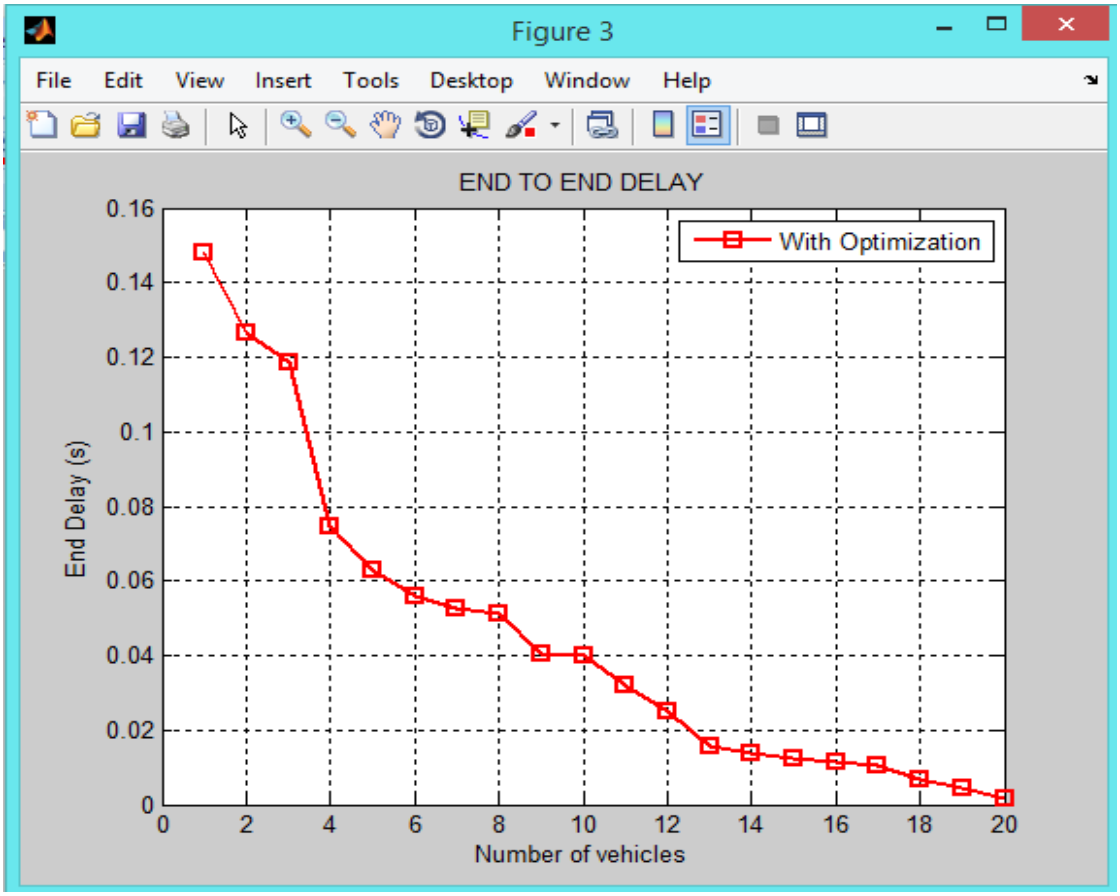


Figure 4.6: End to end delay evaluation with optimization using firefly algorithm

When the network density is sparse, vehicles are scattered, connectivity of the network becomes bottleneck, which is restricting the improvement in case routing performance. If the intersection has been encountered by the packet, it has to wait till the time an appropriate neighbor has been found residing in the communication range, which is increasing the delay. As vehicle number increases, there is increase in the network

connectivity which is leading to the decrease in end to end delay. Proposed approach takes into consideration the network resources consumption and the adjacent streets performance in case of intersections, which is ensuring the efficient transmission of packets and reducing the chances of encountering the partitions in the network.

4.2.3 Evaluation of Network yield:

Figure 4.7 and Figure 4.8 illustrates the yield of network for the vehicles moving with the random speeds ranging from the minimum 30km/h to maximum 60km/h. Network yield is reflecting the efficiency of network, taking into consideration the routing performance of delivery of packet ratio and the throughput value of the network. As the network density increases, yield of network levels off.

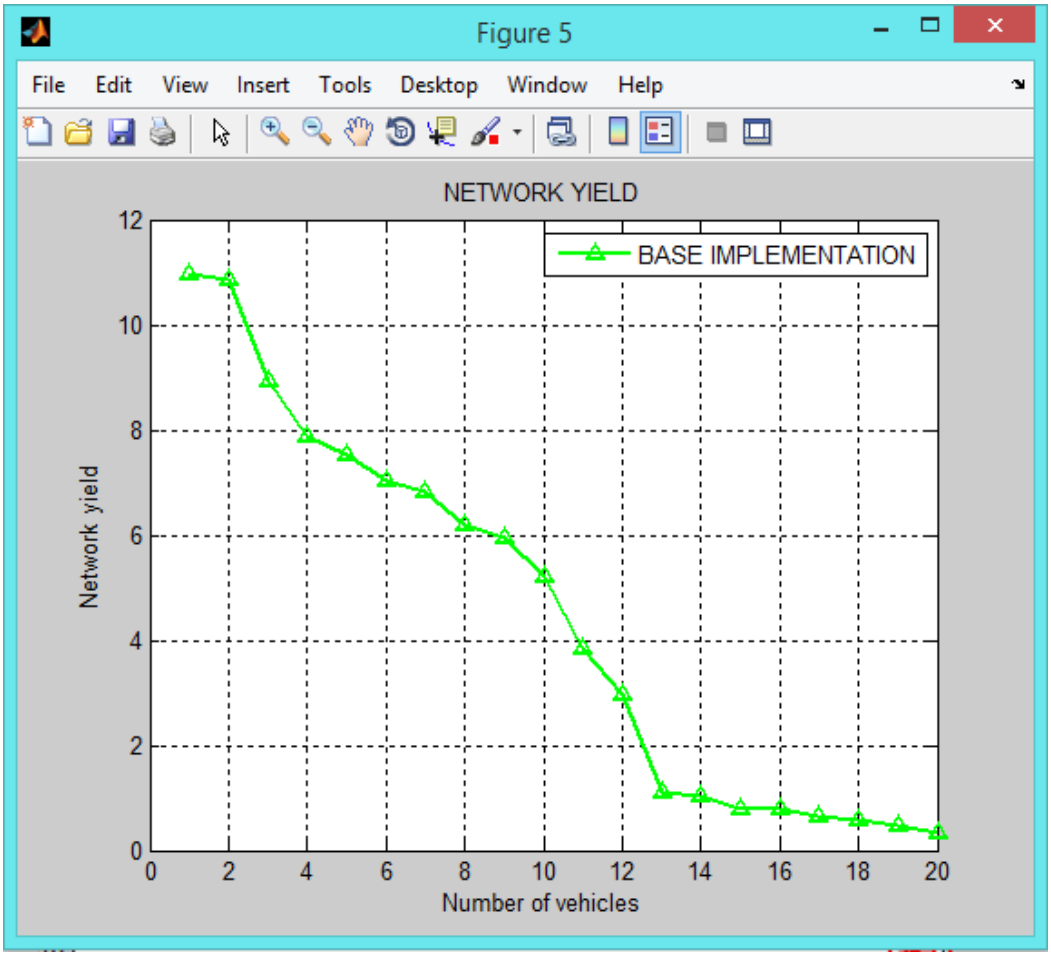


Figure 4.7: Network yield evaluation without optimization

Parameters	Value
Simulator	MATLAB2013
Xlabel	No. of vehicles
Ylabel	Network yield
Optimization algorithm	Firefly Algorithm

Table 4.4: network yield evaluation parameters

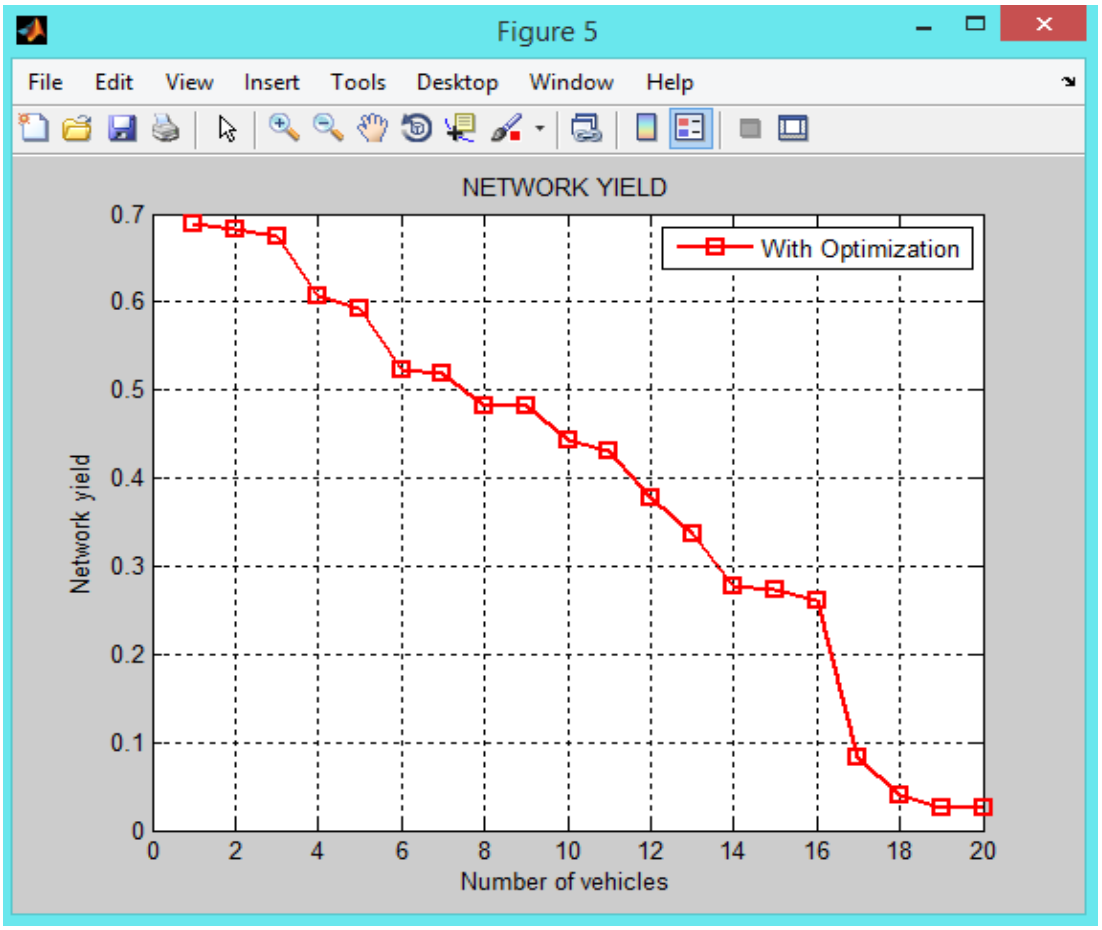


Figure 4.8: Network yield evaluation with optimization using firefly algorithm

Factors which are balancing the yield of network are:

1) Increase in the density of network is improving network connectivity, that is further reducing chances of the network partition and which is further increasing the network yield.

2) Increase in the network density, average hop count for end to end paths for routing also increases, which is further decreasing the network yield.

Our proposed approach is taking into consideration the network resources consumption, and forward quality of multiple hops, which is providing the high network yield.

4.2.4 Evaluation of the Routing overhead:

Figure 4.9 and Figure 4.10 illustrates the overhead for the vehicles moving at the random speeds ranging from minimum of 30km/h to maximum of 60km/h. Approach is utilizing the periodic beacons to have the information so that the decisions for routing can be made. The acceptable amount of overhead is important in the design of the routing protocol.

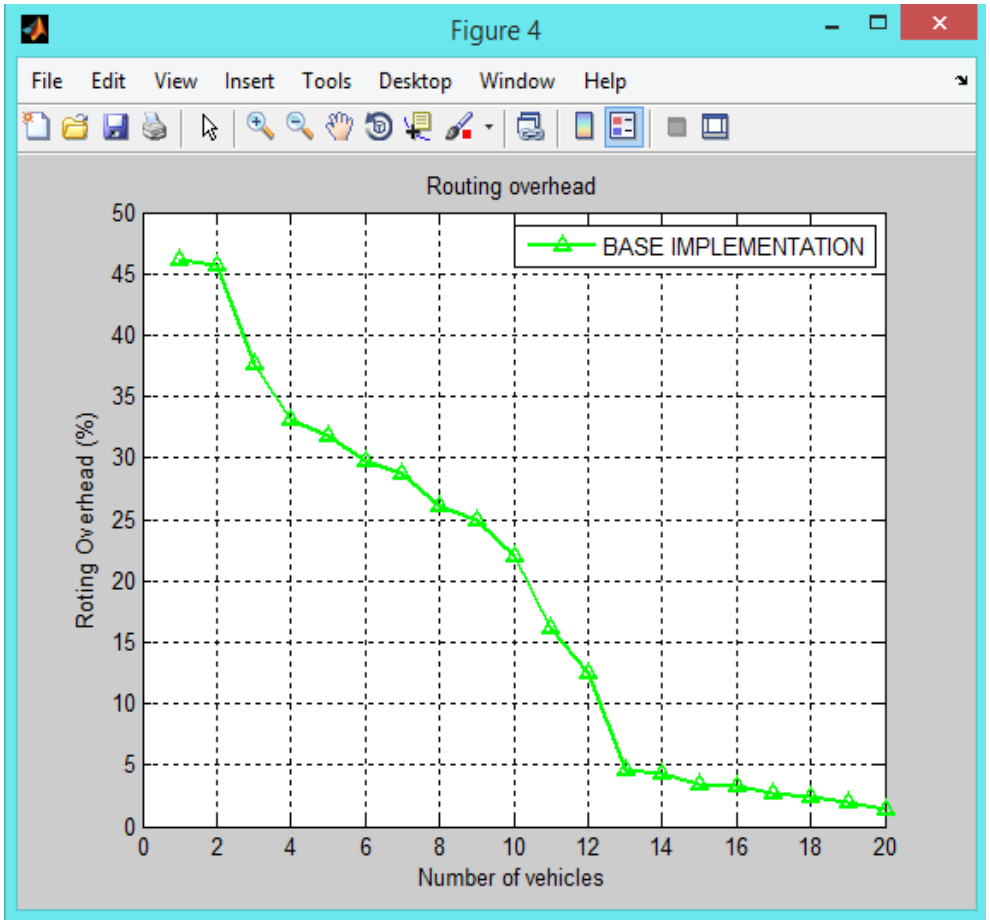


Figure 4.9: Routing overhead without optimization

Parameters	Value
Simulator	MATLAB2013
Xlabel	No. of vehicles
Ylabel	Routing overhead
Optimization algorithm	Firefly Algorithm

Table 4.5: Routing overhead evaluation parameters

The normal amount of routing overhead is dependent on factors such as the amount of the control packets in total and the delivery ratio of the packets.

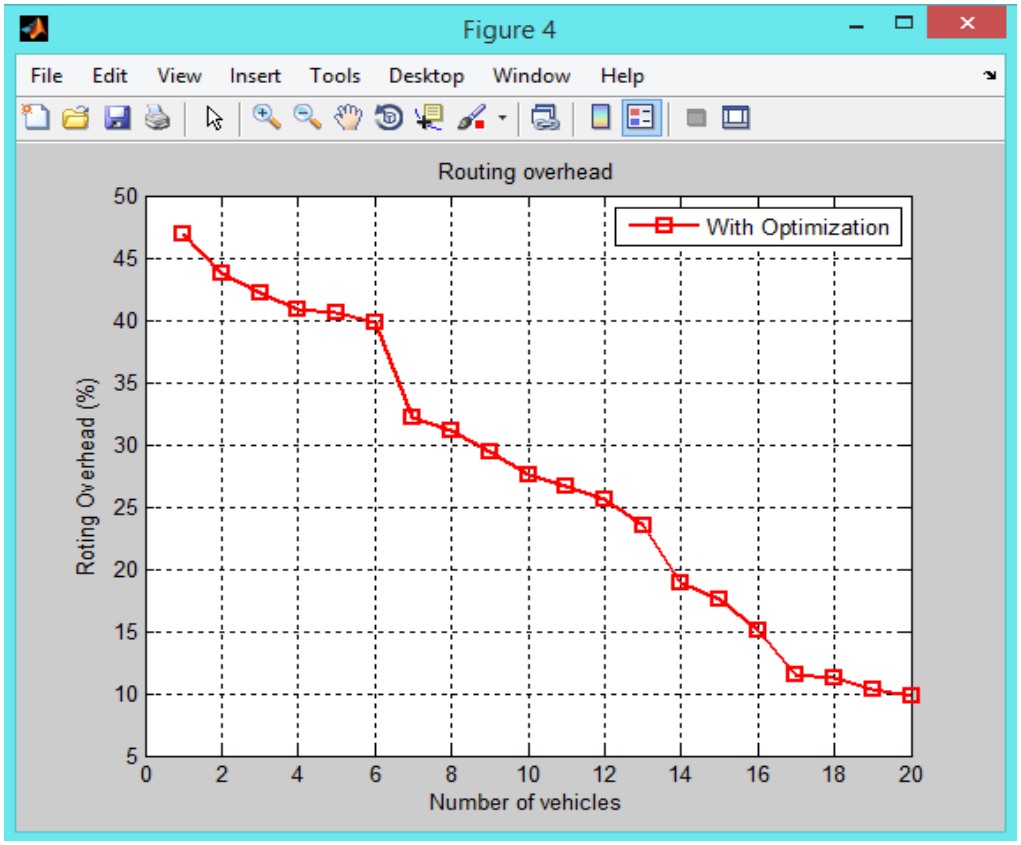


Figure 4.10: Routing overhead evaluation using firefly optimization

There is increase in the routing overhead of both the approaches at some point. Although our proposed approach is increasing the amount of control packets, the dynamic routing decisions for forwarding the packets at the intersection increases the ratio of packet delivery.

CHAPTER 5
CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

We have proposed a system to achieve the maximum reliability for forwarding the data packets in intra-streets and the selection of street in case of intersection. In order to adapt to the urban scenario, we have proposed the system that is selecting the relaying nodes on the basis of minimum distance, and then the link state routing is being performed, after that if routing overhead exceeds then we are opting for the optimization using the firefly algorithm. The results of simulation show that the our proposed approach is better than the existing street-centric opportunistic routing. Results have shown that proposed approach is better in terms of ratio of packet delivery, delay for end to end delivery, yield of network, and the routing overhead.

5.2 Future Work

Though we have tried to introduce a system for enhancing the routing in case of urban environment, but still the work is due. In the current scenario we have only focused on the routing. As the future work we can also incorporate the more factors such as direction and the information related to the history of vehicular traffic. We can also consider the security aspects as security is the main threat. Detecting the malicious vehicle and blocking them from interaction in the system which is further increasing the reliability.

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APPENDIX

GLOSSARY OF TERMS

A

Ad-hoc

Authentication

Avaliability

C

Confidentiality

Cluster head

D

Dedicated Short Range Communication

I

Integrity

N

Network

Node

P

Proactive Protocol

R

Reactive Protocol

V

Vehicular Ad hoc Network