Design and Implementation of Ad-hoc Routing Protocols Applying NS2 Simulator

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Abstract

One of the most promising network that has emerged from the technology world is the mobile ad-hoc network or MANET. It is a type of multi-hop network. Wireless by nature, MANETs do not have a specific network infrastructure. It is a collection of wireless mobile devices that communicate with each other without the help of any third party backbone like a base-station or a router. In MANETs, nodes change locations with time, configure themselves and get the information transmitted from source to destination without the help of any router or base station. Hence, for efficient data transmission, it is critical to understand the type of routing thatis being used by these networks. Since they have no specific routers to handle these tasks, it can be a monumental task for the nodes to efficiently determine a path to forward and route their packets when they are at constant motion. This research makes a comprehensive performance analysis of the various mobile ad-hoc routing protocols. Significant work is done in this area for more than a decade and researchers around the world have come up with a wide range of results. In this research, the results from previous work are taken into account for comparison and a wide analysis is made to carveout the most efficient routing algorithm under various mobility scenarios. All the major proactive and reactive routing protocols viz. Destination sequenced distance vector (DSDV), Optimized Link State Routing (OLSR), Dynamic Source Routing (DSR) and Ad-hoc On-demand Distance Vector (AODV) protocols are compared in three different phases - mobility, speed and network load. Simulation results show that dynamic source routing protocol (DSR) performs the best in small networks while ad-hoc on demand distance vector (AODV) routing protocol performs the best in medium and large networks. Although OLSR fails to cope with the level of AODV, it can be a superior protocol having demonstrated comparable performance to AODV and its proactive natureof routing packet.

Declaration

We do hereby declare that the research works presented in this project entitled, "Design and Implementation of Ad-hoc Routing Protocols Applying NS2 Simulator" are the results of our own works. We further declare that the paper has been written by us and no part of this paper has been submitted elsewhere for the requirements of any degree, award or diploma or any other purpose except for publications. The materials that are obtained from other sources are duly acknowledged in this paper.

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Certification

“We certify that the work in this document has not been previously submitted for a degree, neither has it been submitted as part of a requirement for a degree except fully acknowledged within this text.”

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Acronyms and Abbreviations

ABR	Available Bit Rate
AODV	Ad hoc On demand Distance Vector
CBR	Constant Bit Rate
DSDV	Destination Sequence Distance Vector
DSR	Dynamic Source Routing
MANET	Mobile Ad hoc NETwork
NRL	Normalized Routing Load
OLSR	Optimized Link State Routing
PDF	Packet Delivery Fraction
PDR	Packet Delivery Ratio
RERR	Route ERRor
RREP	Route REPly
RREQ	Route REQest
TCL	Tool Command Language
VBR	Variable Bit Rate
WRP	Wireless Routing Protocol
ZRP	Zone Routing Protocol

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CHAPTER ONE
INTRODUCTION

1.1Motivations of the Study

According to previous years has seen rapid growth in wireless networks, largely due to the increasing prevalence of wireless devices like mobile phones and laptops. These devices make it easier to connect with each other through wireless communication. A network with multi-hops is a kind of infrastructure network where information is transmitted from a source to a node of destination through several wireless nodes. These nodes are self-arranging in a simple and changing manner, enabling smooth interconnection within a predetermined range. A wireless network that transmits data over a single hop is also known as a network of single-hop. Very popular networks that is known as single-hop is Bluetooth Piconet, which makes it simple for two nodes within range of each other to swap data. [1]

MANETs are one kind of network that is known as multi-hop. Independent, self-created mobile nodes that can travel anywhere they choose and connect when they are in communication range make up mobile ad hoc networks. These unique capabilities have attracted many researchers to this field. MANETs are utilized in many different applications, including as public safety response, emergency first response, military applications, and vehicle communications. [9]

A network that is known as ad hoc which is made up of a group of movable nodes that instantly build a network without a predetermined structure. Each node in a network like this can freely join or leave the network and functions as both the server and a router at the same time. The nodes of ad hoc network decide how to route among themselves when utilize the ad hoc protocol for routing.

The mobile network comes in two different types:

- **An infrastructure-based network**
- **Infrastructure-less or Mobile Ad-hoc network.**

An infrastructure-based network build of cable and a permanent port connection. Wireless connection in infrastructure mode creates a link between wireless and wired networks using Ethernet. Central WLAN client access points are additionally offered by infrastructure-based wireless. The wired infrastructure includes LAN, WAN, and MAN, among other components. [2]

Ad hoc networking depends on a centralized control system or isn't based on a fixed connection. This kind of network makes use of RF (radio frequency) frequencies and connectors for communication without demanding the building of a permanent infrastructure. The network consists of groups of devices known as nodes equipped with wireless transceivers. Transceivers can be used to create a network of communication at any period in time or place where one is building one. Cell phone devices can connect multiple times, enabling communication without the need for a physical wired infrastructure. Because it requires infrastructure, the use of wireless ad-hoc systems has made it easier to communicate across networks without having to pay for the costs of constructing an infrastructure for communication or making the required installations. [8]

Within a Network of Mobile Ad Hoc, mobile nodes share wireless channels without relying on established communication infrastructure or central control. MANET is really neat because nodes can move around unpredictably without any set paths. Plus, the nodes can be both routers and servers within the similar time. When a node behaves as a router, it usually finds and maintains routes to several other nodes in the network. Especially when it comes to wireless networks, MANET has made an important contribution to the communication of the field. Because wireless networks are so popular, several applications have been developed that consider many aspects of the network performance, including security, simplicity of installation, dependability, low prices, consumption of bandwidth rate, and power usage rate per node. [9]

Nearby are various forms of mobile ad-hoc networks, including mobile networks that are multi-hop. Its name indicates that it is a sort of wireless network that employs many hops rather than the many single hops that standard wireless networks require for connecting a base station and mobile phone clients. A problem that multi-hop mobile networks overcome has been resolved depends on single-hop cellular networks. According to the results, multi-hop networks perform better overall and regarding throughput than single-hop networks. If two mobile stations in a multi-hop network are mutually reachable, they can establish a direct connection, in contrast to single-hop cellular networks. For multi-hop networks, this is a crucial component. This type of network works well whenever an ongoing structure is absent. [2]

Due to its evolving nature, ad hoc-based wireless networks enable network communication even when the network nodes are in motion. MANET is one kind of an ad hoc-based wireless networks. Because MANETs automatically configure themselves, a node can develop communication among a collection of wireless nodes (such as mobile phones, laptops, portable devices, etc.). route discovery is the process by which a network of peer-to-peer devices known as MANET initiates a connection among both origin and destination nodes. Node mobility is changing due to its inherent characteristics, which causes connections between nodes to break or disappear. Nodes can act as a router to forward packets at the point of sending after receiving them at the end that receives them. Nodes are broadcast to neighbors to let them know they are present within communication range. In other words, every communication node first listens before learning about a neighboring node. [3]

The use of switches, routers, mobile nodes, and various auxiliary techniques and instruments set MANET activities apart from other types of network activity. Frequent topological modifications, power constraints, and mismatched connectivity provide the biggest challenges for wireless networks. According to the network design, MANET can be distributed into three types of routing methods: reactive routing procedures such as DSR, AODV etc., proactive routing procedures such as OLSR, DSDV, etc.), and hybrid such as WARP, ZRP, etc., which is a combination of the two previous types. When both hosts communicate, routing protocols are essential to the packet interchange process. The two primary categories of routing protocols are RRP and PRP. The Proactive routing method is a modified version of the Internet's Links State technique. Tables of routes contain changes for the node in the network along with information, and the proactive routing approach helps to maintain them. Each network node upgrades the system to maintain integrity because the structure of the network keeps changing. The reactive routing method is a table-driven protocol that is a modified version of the Internet's Links States Distance Vector technique. There are two routing operations that make up the reactive routing algorithm are route discovery and maintenance. The route discovering method includes two components, a route query and a route reply, which vary based on the protocol. [4]

Every node in a MANET has independent mobility. Routing is the main issue because of the MANET's topology frequent alterations. Problems were found in a multi-hop communication method due to power.

In this work, NS-2 and other performance indicators are used to evaluate and examines how well MANET routing protocols work. The purpose of the study is to establish the optimal efficiency stage for reactive routing methods such as AODV and DSR along with proactive routing method such as OLSR and DSDV. [7]

1.2 Advantages of the MANET

MANETs have several benefits to offer. They are capable of spreading to a wide range, enhancing the system's overall coverage. Unlike single-hop systems, that have limited distances between the initial source and the recipient nodes. Transmission power and energy are typically lower because the transmission is done over small links. They make it possible to use the wireless medium more effectively and at higher speeds, which increases throughput. Additionally, MANETs prevent the need for extensive cable infrastructure and enable cost-effective transmission. [8]

1.3 Statement of Problem

It has a significant advantage to operate a network connection or packet transmission via network cables or through connection points that are installed. Mobile Ad hoc Networks, noted for their infrastructure-free connectivity, have helped to reduce network costs. [1]

Routing is a way of establishing a route of communication between the source and the final destination. networks that are ad hoc offer significant difficulties to protocol design due to their unpr edictable node movement, changing topological structure, limited capacity, decreasing number of pat hs, node battery capacity, and other factors. [2]

Among various difficulties related to damaged network links changing the topology of the network, asymmetric links, interference, and routing overhead provide a significant routing problem in networks of mobile Ad hoc. [6]

The route between a source towards a destination, traditional systems of routing offer one or more paths. Protocol methods have a number of drawbacks, with energy consumption being one of the most significant ones. [5]

Several analyses and studies have been made on this subject in order to offer a better protocol performance for routing. Because of the uncertain nature of topology, it is still being study. The routing issue, for which this study aims to evaluate and examine routing protocol. We offer NS2 toward simulate four procedures of routing: DSDV, DSR, OLSR and AODV, using various quantities of nodes. [3]

1.4 Goals and Objectives of the Project

The project purposes to estimate the particular protocols' ability for routing whenever simulated as a real scenario on an internet connection. This study has the following objectives:

- MANET protocols are produced and analyses for various types of networks.
- The protocols used for MANET routing are emulated in a network scenario that consists of a medium-sized, large-sized, and small network.
- examine the chosen route protocols.
- The parameters that follow are used to evaluate protocol performance: total throughput, packet dropped and power delivery ratio. [1]

1.5 The opportunities for study

The protocols for routing are classified as reactive or proactive. This paper examines four routing protocols: two reactive, AODV and DSR, as well as two proactive, OLSR and DSDV. This study examines the behaviors of reactive and proactive routing algorithms within a simulation of a network, in addition to the effects of different elements and their corresponding responses. This paper examines the design of algorithms, including protocol evaluation, in addition to the properties and responses of the routing procedures of the network's infrastructure. [2]

1.6 Importance of the Study

Over the last few decades, the need for ad hoc networks that are mobile has grown significantly. Because wireless networks that are ad hoc offer infrastructure-free, they are suitable for usage in situations where establishing central connecting points isn't necessary or depended on. In compare to wired network infrastructure, which is limited in the areas it may service and in the ways that attacks, natural disasters, floods, and other events may affect network communication. Research has found that MANET can get over the limitations of wired networks. The results of this study will give the optimal routing protocol for MANET operation in any situation. Therefore, the suggested protocol will decrease packet loss with respect to of node and improve packet delivery throughput when used in any kind of network scenario. [1]

1.7 Report Structure

There are five chapters in this report, and everyone has several parts.

Chapter One: provides a basic overview of the MANET term and its use of the routing protocol. It also highlights the study's issue statement, study goal, objectives for the study, its scope, importance, and limitations.

Chapter Two: A study of related research, a summary of routing protocols, a classification for protocols of routing within MANET, and an overview of the protocols used for routing is being evaluated for this paper.

Chapter Three: Explains the tools used to evaluate routing protocol performance based on performance measures, the simulation environment, and the research methods used in the study.

Chapter Four: Displays and explains the performance parameters of Average Throughput, packet delivery ratio and packet drop because of a variety of nodes.

Chapter Five: An overview of the results are provided, which includes a conclusion and suggestions for an opportunity next research.

CHAPTER TWO
REVIEW OF THE LITERATURE

This chapter explains the history of MANET, its related activities by various researchers and their explained method for MANET. It also provides a description of routing in an ad hoc network, describes and examines routing classification, and understanding of each routing protocol.

2.1 Background

MANET, a dynamic technology, offers a wide range of suitable activities and is ideal for use during crises and natural disasters due to its rapid setup and minimal configuration. With Wi-Fi becoming more prevalent and being integrated into portable devices, MANET is a crucial tool for technological advancement.

Numerous researchers have studied MANET routing protocols' performance, focusing on parameters like throughput, end-to-end delay, and packet delivery ratio in recent years. The NS2 network simulator has been used extensively in detailed studies on MANETs, examining various network situations and approaches. The paper aims to determine the performance of proactive and reactive routing protocols in NS2, AODV, DSR, and DSDV, comparing their performance using demands like throughput, average end-to-end delay, power delivery ratio, and average energy usage. The development of an achievable routing protocol for MANET remains an open topic. [1]

2.2 Related Work

The paper assesses the effectiveness of Manet's proactive and reactive routing protocols, utilizing NS3. The study uses real-time simulations with NS3 at 20, 40, and 60 nodes. The results show that Optimized Link State Routing (OLSR) performs better for small networks with 20 nodes or fewer, Ad hoc On-demand Multipath Distance Vector (AOMDV) works better for medium networks with 40 or more nodes, and Destination Sequence Distance Vector (DSDV) performs better for larger networks with over 60 nodes. The cumulative performance of both small and larger networks indicates that OLSR performs better, providing valuable insights for network design.

The study by Bhattacharyya et al. (2011) highlights the security risks associated with mobile ADHOC networks due to the lack of a centralized authority. The authors categorize current attacks into data and control traffic attacks, and discuss suggested countermeasures. The study also provides crucial details for network architecture, highlighting the need for centralized authority to oversee node management.[5]

Adeyemi et al. (2019) studied DSR, DSDV, and AODV using AWK and the NS2 network simulator. They found that increasing nodes leads to higher average throughput, PDR, and Jitter. AODV is more effective in networks with over 35 nodes, while DSR is suitable for smaller networks as both reactive methods outperform DSDV, the proactive protocol.[7]

The study by Lei D, Wang T, and Li J. (2015) evaluated the performance of routing protocols AODV, DSDV, DSR, and AOMDV using the NS2 network simulator. Results showed that dynamic network topology changes reduced the efficiency of these protocols. DSDV was found unsuitable for fixed network designs. Packet Delivery Ratio showed greater performance, and PDR showed 95% flexibility after network modification. The average end-to-end delay of AODV was found to be smaller compared to DSR, but DSR had fewer load than DSDV. AOMDV, a multi-path routing protocol, had a smaller average E2E delay but needed improvements in functions like upgrading and maintaining alternative paths and broadcasting packets simultaneously.[3]

Ali and Nand (2016) used the QualNet 5.0.2 network simulator to simulate AODV and DSR routing protocols, focusing on various node mobility scenarios. They applied wormhole attacks to the simulation, analyzing their performance in and out of the attack. The results showed that throughput for both protocols decreased with increased node speed, regardless of the wormhole attack. In the absence of an attack, node average end-to-end delay increased. Wormhole attack on DSR led to an unexpected increase in node speed. DSR outperformed AODV, offering different data delivery routes.[2]

The study by Sakshi and Neha G. (2017) examined the impact of packet size and node number on network communication dependability. They used Network Simulator 3 to evaluate the performance of DSDV, AODV, and OLSR in terms of packet delivery ratio, throughput, and total energy usage. The results showed that AODV performed best with minimal traffic, DSDV in medium traffic, and OLSR in heavy traffic. Despite similar performance, OLSR outperformed DSDV in high traffic situations.[6]

Rahman & Abbas' 2016 study evaluated the effectiveness of various routing protocols using the Random Propagation Group Model (RPGM) model, focusing on speed and node density. Results showed that the effectiveness of these protocols changes with density and network performance varies depending on the network situation. More mobile nodes result in higher PDR, improving communication efficiency. Speed has a cost, and AODV performs better for large networks and greater speed over DSR. DSDV, an end-to-end delay protocol, performs lower for delivered packets but generates significant routing costs.[1]

The study reveals that while most scholars have studied MANET extensively, they have not addressed the issues of determining reactive and proactive routing methods using performance criteria like throughput, end-to-end delay, PDR, and energy consumption, and using a different simulation methodology than when simulated using NS2.

2.3 Overview of Routing in Mobile Ad hoc Network

A mobile ad hoc network is a network of wireless nodes that exchange information for communication. Routing is the chosen path for transmitting data between nodes, and the protocols used are called routing protocols. A routing protocol's primary goal is to construct an accurate and efficient route between two nodes. Routing has been used in various network technologies, including electronic data, the internet, and telephone. This research focuses on routing in mobile ad hoc networks, as without an established protocol, physical cable network connections are impossible. Nodes on the move search for a path to link multiple nodes to exchange data packets. A protocol is a set of guidelines that improves communication between devices. [8]

2.3.1 Characteristics of MANET Routing Protocol:

To prevent issues with routing in MANET, it is recommended that routing protocols possess the following characteristics:

- It should be widely distributed.
- The statement requires localization.
- Due to the mobility of nodes, it should be adaptable to frequent changes in topology.
- The object must be free of impermeable routes.
- The speed of route convergence is crucial.
- The network should require each node to store information about the stable local topology.
- The service should be of high-quality.

2.3.2 Broadcasting Methods in MANETs

Broadcasting techniques improve MANET routing operations. Additionally, there are hierarchical and distributed broadcasting techniques, which can be further divided into different transmission mechanisms. The most common types of distributed network broadcast techniques are:

- **Neighbor Knowledge Mechanism:** The DSDV routing protocol utilizes a "Hello" type packet to ensure nodes have direct knowledge about their neighborhood topology, allowing them to decide whether to rebroadcast a packet based on neighbor information.
- **Simple Flooding:** The method of sending a packet to every node in the transmission range after it's obtained for the first time wastes bandwidth and node resources, which is implemented by AODV and DSR.
- **Probability-based Mechanism:** Nodes utilize a probability-based technique to determine if rebroadcasting relies on probability, or if it's a dependent event linked to the possibility of reaching new neighbors.
- **Area-based Mechanism:** The transmitting node's information determines if a transmission covers a significant portion of the coverage region. [8]

2.4 Routing Protocols Taxonomy in MANETs

The changing environment of a node in a Multi-Agent Network (MANET) impacts packet routing, making it a challenging task. Routing primarily directs packets over subnetworks to their destination, but it has limitations due to the need for more nodes with fewer resources. To function effectively, routing protocols must have features such as security, unidirectional link support, demand-based operation, distributed operation, loop freedom, and proactive operation.

Protocols are rules that manage device communication across a network, and data packet movements are defined by routing from their source to their destination. However, continuous modification of network routes is another significant issue with MANETs. Routing methods that protect network communication in structured networks are found to be inappropriate for MANET operation, leading to the development of unique routing protocols for improved network routing. MANETs can be categorized into reactive (on-demand) and proactive (table-driven) routing protocols. (Ref) The routing categories used throughout in this paper are displayed in Figure 2.1.

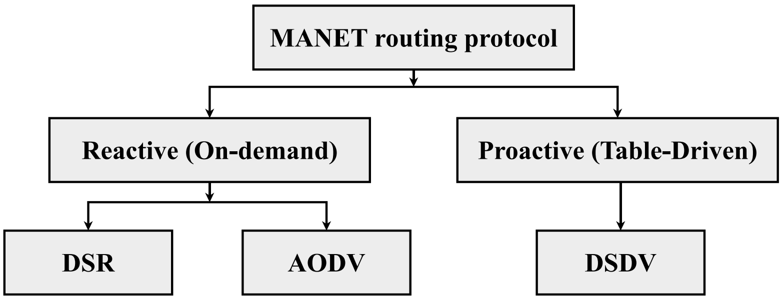

Figure 2.1: Routing Protocol Taxonomy in MANET

2.5 Proactive Routing Protocol

Table-driven routing protocols, an altered version of the Bell-Man Ford formula, use the link-state routing method to regularly flood the network with information about nearby nodes. Each mobile node has a distinct routing table that lists all possible routes to all possible destination nodes. Node changes in the network topology cause each node to send a broadcast message to the entire network. This protocol ensures that routes are readily available for use, but it also incurs additional overhead costs due to the need for up-to-date information. [6] This may affect network throughput, but it provides actual information about network availability. Below is the Proactive Protocols –

Destination Sequenced Distance Vector (DSDV) protocol:

The proactive algorithm ensures Quality of Service (QoS) and real-time communication through early route access, backup path assistance, and monitoring. However, it struggles with large networks due to large routing table entries, route overhead flooding, high bandwidth requirements due to link loss updates, and high storage requirements. Proactive protocols are also considered poor due to their high mobility rate or large number of nodes. [1]

2.5.1 Destination Sequence Distance Vector (DSDV)

- DSDV is a hop-by-hop vector routing technique that necessitates regular broadcasting of routing updates by each node.
- DSDV pro-active routing protocol ensures that every network node has a working route to every destination.
- The Bellman-Ford routing technique has been modified to inform this table-driven algorithm. The protocol is able to prevent routing loops from forming due to this method. [1]

Every node in the DSDV maintains a routing table including route information. The following details are included in each table:

- ID of destination node
- Details of next hop
- Metric
- Sequence number

In DSDV, two distinct kinds of update packets are used to distribute updates to routing tables:

- **Full dump**: The full dump update approach in nodes increases network overhead by sending the entire routing table to its neighbors.
- **Incremental:** The incremental update strategy, which sends only the latest updates to entries, is most effective in significant, stable networks to minimize traffic. [1]

2.5.1.1 Table Maintenance in DSDV:

The following lists the procedures used to keep a routing table up to date at each node:

1. Every node updates its database after receiving from other nodes the route data with the most recent serial number.
2. To find the quickest route to every destination, the node examines its routing database.
3. Based on the information about the shortest way, every node creates a new routing table with the most recent route information to get to the destination as close as possible.
4. Its neighbors will receive a broadcast of the updated routing table.
5. The nearby nodes change their routing table in response to these instructions. [2]

2.5.1.2 Maintaining Metric Field:

Ad-hoc wireless networks feature dynamically moving nodes, who broadcast routing table update packets to their neighbors when topology changes.

The procedure for updating metric field is as follows:

1. There is one metric at the beginning of the routing table update packet.

2. The neighbor nodes that receive this packet will rebroadcast the update packet to their neighbors after incrementing this metric by one.

3. Until a copy of the update message is sent to every node in the network, this process will be repeated.

4. The update packet with the lowest metric value will be taken into consideration to guarantee the shortest path when a node gets several packets. We won't pay attention to other packets.

Significance of sequence number:

- Node increments sequence number when transmitting routing table update packet, obtaining the most recent route packet by using this method.
- A node updates its routing packet in the table when it receives an update packet from a neighboring node with a sequence number equal to or greater than the previous packet.

2.5.1.3 Advantage of DSDV

- DSDV's routing tables need regular updates, consuming battery power and bandwidth when the network isn't in use.
- DSDV is not suitable for dynamic or large-scale networks due to the need for a new sequence number each time the network's topology changes before re-converges.
- Suitable for small networks
- DSDV guarantees for loop free path.
- Use less memory.
- The ad-hoc network always provides a route to every other node.
- High delivery rate.

2.5.1.4 Problems of DSDV

- The DSDV protocol mechanism involves every node sending its routing table to its neighbors regularly. As the network grows, each node sends more messages to update the routing table, preventing packets from reaching their destination nodes and preventing the network from converging.
- Regular broadcast of update packets causes overhead, leading to traffic congestion and delayed delivery of precise information.
- The DSDV protocol's usefulness and performance may decrease as the network grows, making it beneficial for smaller networks.
- In DSDV, occupancy to links grows as node count rises.

2.6 Reactive routing protocols

On-demand routing protocols, also known as route discovery, are a method where a route is discovered only when needed, involving the flooding of request packets throughout the mobile network, and consisting of two main phases: route discovery and maintenance.

2.6.1 Dynamic Source Routing(DSR)

DSR is a wireless ad-hoc network routing protocol that includes the entire path to the destination in the packet header, ideal for small to medium-sized networks with restricted mobility and fewer broadcasts.

A node checks its cache for an RREQ message, comparing its unique identifier to confirm if it has already received it. If it's a fresh message, it's broadcasted to its neighbors. If it's not new, it's rejected. This process repeats until the message reaches the destination node or a node with a new route.

The destination node sends a Route Reply (RREP) message after receiving the RREQ message, updating intermediate nodes along the path. The RREP message provides the complete path to the source node, appending it to the packet header.

When a node moves or malfunctions on a route, a Route Error (RERR) message is sent to the source node. The source node removes the invalid node and broadcasts a new RREQ message to find a new route, containing the unreachable node's address.

Routing protocol of DSR is that offers reduced overhead, increased flexibility, and multiple routes to the same destination, but has drawbacks like bigger packet header size and higher risk of routing loops.

In the figure, the request travels through two paths to reach destination S7. The incoming packet's route records determine the path to be selected and replies to the source node via the reverse path. The optimal route with the fewest hops is saved at each hop. The route record status at each hop from the source node to the destination is displayed in this example. The route used in this case is S1-S2-S4-S5-S7. [3]

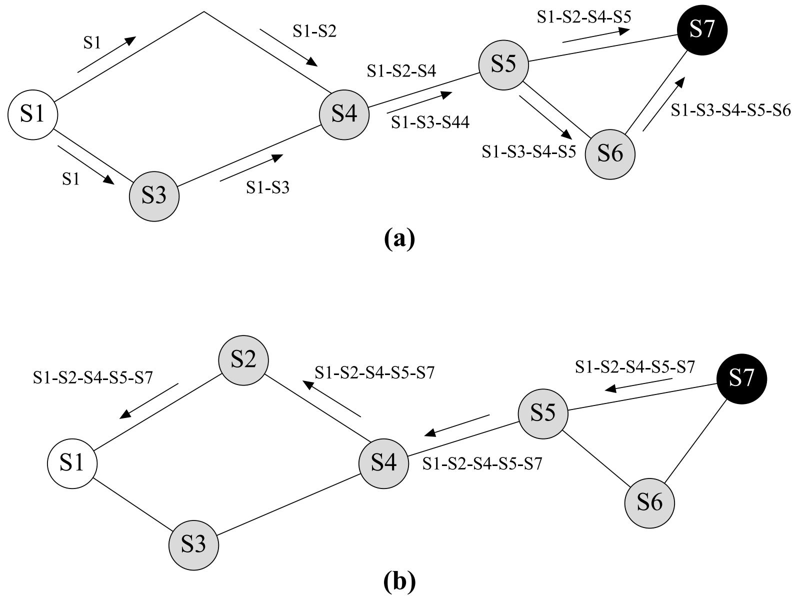

Figure 2.2 :(a) Route discovery (b) Using route record send the route reply

Route Discovery

- It determines the path between a source and a destination node.
- A source node checks its route cache to verify if a destination route exists before transmitting a message to a destination node.
- The source node sends a Route Request Message to all nodes within its transmission range and initiates Route Discovery if no route exists to the destination.
- Request of routing message contains the destination address, source address, and unique identification number.
- Upon receiving a Route Request Message, nodes check if they have a route to the destination and if not, they rebroadcast the message to their departing nodes after adding their address.
- Upon reaching the destination node, a message sends a Route Reply Message back to the source node, containing the source route record list gathered during the forwarding of the Route Request message.
- The final destination sends a Route Reply using MAC protocols like IEEE 802.11, which necessitate a bidirectional link.
- The origin node stores the returned route in its cache upon receiving the Route Reply message, ensuring all messages fated to the similar destination utilize this route.

Route maintenance

- Ad hoc networks' dynamic nature and frequent topological changes cause frequently broken routes stored in route cache, necessitating the importance of route upkeep.
- A node must verify that the next-hop node can be reached after forwarding a message.
- The node will retransmit the packet if it doesn't receive confirmation from the next hop within a specific timeframe, and if the connection to the subsequent hop is broken, it will send a Route Error message to the source node.
- To verify this DRS employs three acknowledgment methodologies such as -
    - **Link-layer acknowledgment** - Given by MAC layer protocol for example IEEE 802.11.
    - **Passive acknowledgment** - The node receives a message from the next-hop node, confirming the route's reachability.
    - **Network-layer acknowledgment** - Node verifies the route's reachability by hearing the next-hop node forwarding the message.

2.6.1.1 Advantages of DSR

- Routes, which are maintained only between communication nodes, have a lower maintenance overhead.
- Additionally, route cache lowers clumsy during route discovery.
- A individual route discovery generates multiple routes as intermediary nodes retrieve responses from their regional caches.

2.6.1.2 Disadvantages of DSR

- The duration of a route rises the packet header size because of origin routing.
- Enormous routing requests might potentially reach every node within the network.
- Possible clashes between route requests transmitted by nearby nodes
- Before sending RREQ, random delays are inserted.
- More contention as a result of nodes using their local cache to reply, which causes an excessive number of route replies to come back.
- Route Reply can occasionally result in a Storm issue.
- Increased overhead will result from stale caches.

2.6.2 Ad-hoc On-Demand Distance Vector (AODV)

AODV is a wireless ad-hoc network routing protocol that allows nodes to create routes on the fly for packets to their intended destination, reducing routing costs and improving efficiency in large networks with frequent architecture changes, especially in mobility-sensitive networks.

In order to deliver a packet, an AODV node notifies its neighbours using a Route Request (RREQ) message. The message includes a unique identity, the address of the destination node, and the address of the originating node. Upon receiving the message, the node verifies if it has previously received it by comparing the unique identification. If it's a fresh message, it's stored in the cache.

The destination node sends a Route Reply (RREP) message in response to receiving the RREQ message, which is sent to either the destination node or a node with a new route. The full path to the source node is provided by the RREP message, and intermediate nodes update their caches with the updated path. Using the predefined route, the source node transmits packets to the destination node.

By building a sequence of hops between nodes and having each one keep a routing table with the next hop to every destination, AODV is able to maintain a route. Other nodes receive a hello message when a node fails or moves, and they update the tables appropriately.

In order to handle routing problems, AODV employs the Route Error (RERR) message. A node notifies its neighbours via an RERR message when it finds a broken connection or another node on an established route. The neighbours update their routing databases and, if necessary, start a fresh route discovery process. [8]

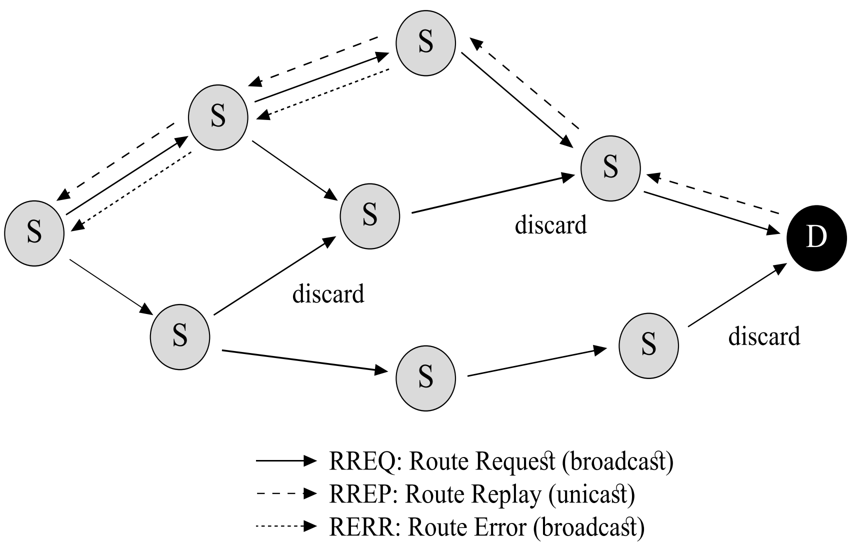

Figure 2.3: AODV Routing Protocols

Reduced routing overhead, support for both unicast and multicast traffic, and quick route building are all provided by AODV. However, it has drawbacks like higher control message costs and increased routing loops. Despite these, it is a suitable routing protocol for large, mobile networks requiring high performance. [2]

2.6.2.1 Working procedure of AODV routing protocol:

- Reactive MANET routing protocols like AODV maintain in-demand routes within the network. To reach destinations, they keep track of the next hop in a routing table. The packets time out if no packets are transmitted. Re-transferring data frames may take longer due to the limited information about neighboring nodes. [8]

2.6.2.2 Types of routing in AODV:

- It is composed of the following three kinds of routing messages.
- **RREQ: Route Request –**

  A node sends a multicast message called RREQ to initiate route discovery when unsure of its destination. Neighboring nodes forward the message to their neighbors, keeping track of its origin before it reaches the destination node.
- **RREP: Route Reply –**

  The destination node sends an RREP along the path the RREQ took to return to the source, creating forward routes at intermediate nodes. Nodes can enter a known route by sending an RREP if the intermediary node is aware of the path. As soon as the RREP arrives at the source, communication between the source and destination starts.
- **REER: Route Error –**

  AODV is a reactive protocol that uses a RERR message to manage routes. It detects link interruptions, preventing messages from being sent. Other nodes recast the message, and the unreachable destination is displayed. Those receiving messages deactivate the route. This approach requires fewer messages than a proactive approach.

2.6.2.3 Advantages of AODV

- AODV's adaptability to dynamic networks allows it to swiftly respond to topological changes that impact active routes.
- Even for nodes that are continually moving, AODV can support both unicast and multicast packet transfers.

- AODV provides a faster setup time for connections and can accurately identify the most recent route to the intended destination.
- AODV does not add any additional cost to data packets as it does not employ source routing.
- The AODV protocol is a flat routing protocol that manages the routing process without the need for a central administration system.
- AODV is a self-starting, loop-free system capable of accommodating a large number of mobile nodes.

2.6.2.4 Disadvantages of AODV

- A link break generates numerous control packets, leading to increased congestion on the active route.
- AODV requires a lot of computing power.
- A significant portion of the bandwidth is used by AODV.
- Building the routing table with AODV takes a lengthy time.
- The possibility of a legitimate path ending is plausible, but determining a fair expiration point remains a challenge.
- Various performance measures start to decrease as the network expands in size.

2.7 Proactive vs Reactive protocol

- The average end-to-end delay in Reactive Protocols is variable, while it remains constant in Proactive Protocols for an Ad hoc network.
- Reactive Protocols offer a more efficient method for delivering packet data compared to Proactive Protocols.
- Proactive protocols function much slower than Reactive protocols.
- Reactive protocols exhibit greater adaptability and efficacy across diverse topographies in comparison to Proactive protocols.
- Compared to Proactive Protocols, Reactive Protocols are more versatile and efficient across different topographies.
- Compared to proactive protocols, reactive protocols send packet data more quickly.

2.8 TCP and its performance in MANET

TCP (Transmission Control Protocol) is a connection-oriented protocol used to transmit data between computers via the Internet. It manages the tracking of discrete data units (packets) for effective Internet routing, while IP handles data delivery. TCP ensures that packets are reassembled into the entire message at the other end when split into packets controlled by IP. It was designed for reliable communication in computer networks and can detect packet losses as an indication of network traffic, adjusting its behavior accordingly. [3]

Routing algorithms were developed to manage traffic flow and improve network efficiency, addressing traffic delays and congestion. However, as wireless networks evolved, they struggled to provide optimal performance. These algorithms were initially proactive, deciding on actions after a situation. Reactive routing protocols are needed in wireless scenarios, requiring immediate changes in routing tables due to congestion or packet loss. In multi-hop networks, nodes must identify the path to transmit data without intermediary routers, affecting network performance and TCP performance. The effectiveness of the routing protocol significantly impacts network performance. [4]

Researchers have proposed various methods to enhance TCP performance in multi-hop wireless networks. TCP congestion control strategies primarily focus on buffer overflows as the primary cause of loss. However, in ad-hoc networks, link contention caused by unidentified terminal issues is not suitable. [7]

2.9 Comparison Between DSDV, AODV and DSR

Priority of Algorithms	DSDV	AODV	DSR
Reactive	No	Yes	Yes
With particular nodes, the average packet delay	Lower	Modest	Higher
throughput with selfish nodes	Best	Better than DSR	Worst
End-to-end delay	Shortest	Modest	Highest
Energy consumption	Low	Modest	Highest

Table 2.1: Comparison Between DSDV, AODV and DSR

CHAPTER THREE
METHODOLOGY AND PROPOSED MODEL

This chapter describes and clarifies the study's methodology. The simulation techniques and metrics utilized in the efficiency evaluation of MANET proactive and reactive routing protocols are reviewed. The chapter's contents include the performance parameters evaluated along with the simulation setup.[3]

3.1 Proposed Work

In terms of simulation tools, various scholars and researchers in network research have employed NS2, NS3, OPNET, and QualNet, among others. NS2 has been selected as the tool for this project. Under network, the routing protocols to set up and test are DSDV, DSR, and AODV.

3.2 Experimentation Procedure

3.2.1 Experiment Network

- Mobile Ad hoc Wireless Network (MANET)

3.2.2 Experimental Protocols

- Ad-hoc On-Demand Distance Vector (AODV)
- Dynamic Source Routing (DSR)
- Destination Sequence Distance Vector (DSDV)
- Optimized Link State Routing Protocol (OLSR)

3.2.3 Experimental Metric

- Packet loss
- Packet delivery ratio (PDR)
- Speed
- Average throughput

3.2.4 Experimental Environment

- Ubuntu 20.04.6 LTS (windows subsystem for Linux)
- Network Simulator 2(NS2)
- C++/TCL
- AWT script

3.3 Software Environment

The technique of learning by doing is called simulation. One kind of simulation that is used to mimic networks, such as MANETs, VANETs, etc., is called network simulation (NS). For both wired and wireless networks, it offers routing and multicast protocol simulation**.** This study has made use of NS 2.35. Since it is open source software, we can get it for free online. we can install NS 2.35 on top of either Linux or Windows. The OS that has been utilized is Ubuntu 20.04.06 LTS On Ubuntu, NS 2.35 has been installed, and simulations have been run.[6]

The simulation tool utilised in this article was Network Simulator 2 (NS2) software. NS, sometimes referred to as NS2, is a programme that may be used under the terms of the GNU General Public Licence version 2. Written in C++ and Otcl/Tcl, it is a discrete event-driven simulator that is object-oriented.Routing algorithms, router queue management mechanisms like Drop Tail, RED, and CBQ, traffic source behaviour like FTP, Telnet, Web, CBR, and VBR, and network protocols like TCP and UDP may all be implemented using NS-2. In ns2, Otcl is used for setup and C++ is utilised for full protocol implementation. The Otcl interpreter has access to the built C++ objects, allowing for control of the pre-made C++ objects at the OTcl level.The genuine systems—such as space and flight simulations—which are sophisticated, expensive, or dangerous are not accessible.The design options, such as various system configurations, were also promptly assessed.The complex functions for which closed-form formulas or numerical techniques not available are also evaluated.[7]

Install NS-2 using this command: sudo apt-get install ns2

3.3.1 Advantages of Ns2 simulation

- Sometimes, Ns2 simulation is less expensive.
- Occasionally, it detects errors (in the design) in a sophisticated way.
- Generality: it provides greater generality than analytical and numerical approaches.
- Detail: It is also possible to mimic system details at any level.

3.3.2 Features of NS2

1. It is a networking research discrete event simulator.
2. It has strong support for simulating several protocols, including DSR, TCP, FTP, UDP, and https.
3. Both wired and wireless networks are simulated.
4. It is mostly built on Unix.
5. Speaks TCL when writing scripts.
6. Otcl: Object oriented support
7. Tclcl: C++ and otcl linkage

3.4 NS2 Programming Architecture

The two main languages of NS2 are Object-oriented Tool Command Language (OTcl) and C++. While the C++ describes the simulation objects' underlying mechanism (i.e., backend), the OTcl sets up simulation by assembling, setting, and scheduling discrete events. The C++

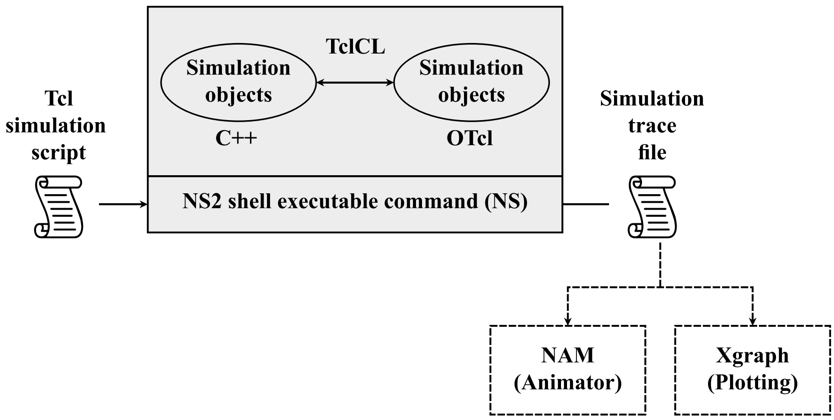

Figure 3.1: Software architecture of NS2

and the OTcl are linked together using TclCL. In the Ns2 simulation, the network topology, load, and output files are defined in Tcl script. Internally, C++ classes based on the tcl scripts are instantiated. [8]

3.5 NS2 Tools

The following tools allow to set up the network infrastructure, perform the simulation, and analyze the results of the NS2 simulation software:

3.5.1 NAM

NAM is the short form of Network Animator. One of the animation tools based on TCL/TK is the NAM. The application for viewing both actual packet traces and network simulation traces. We may carry out tasks like packet level animation, topology creation, and several data inspection tools by utilizing this nam tool. The file extension.nam is used to hold nam trace files. Additionally, we use the term "exec nam" to run the nam trace file. NAM reads the trace file after it is formed, establishes topology, opens a window, performs any necessary layout, and pauses when the trace file has its first packet. Using the connection, queue, packet, agent, and monitor building elements, NAM is a tool that offers control over multiple elements of animation via its user interface. [1]

3.5.2 Trace File

The trace information is encoded in ASCII codes produced at the conclusion of the experiment. To get the output, NS2 employs two major strategies: pre-defined bulk output methods and tracing. The contents of generic predetermined bulk output methods are parsed to retrieve valuable information. Changes are not necessary while using the pre-defined bulk output technique. However, to parse and filter appropriate information, programs must be written. PCAP or NS_LLOG output messages are typically collected when simulations are running, and are individually processed by scripts that help in message parsing using grep, sed, or awk, decrease and restructure data to make it more manageable. In addition to the bulk output technique, NS3 offers Tracing, which has a number of benefits. By tracking only, the things of interest, one can minimize the quantity of data that needs to be managed initially. If sed, AWK, Perl, or Python scripts are used to manage the format, this way can also maintain control and prevent post-processing. [5]

3.5.3 TCL Program in NS2

One of the main languages used to implement Ns2 is TCL [Tool Command Language]. TCL is also a scripting programming language. More precisely, OTCL [Object oriented extension of TCL] and C++ are used to implement NS2. The internal mechanics are programmed in C++, while the configuration is done in OTCL. Ns2 package is completely open source and comes with the name ns-allinone-2.35 (2.35 is version). [1]

3.5.4 OTCL

"TCL Simulation script" is an OTCL file that is used as a configuration file in NS2. It also includes details on the things we want to replicate, including creating nodes, topologies, and links, among other things. A TCL file is also an input configuration file for C++ file. To run the TCL file, use the command

ns filename.tcl

Here the ns is also an executable program obtained by compiling the entire NS2 code using "make" utility and the **.**tcl file is an input configuration file of executable ns file. Let's now review some fundamental TCL commands and run a little TCL programme in NS2 so that students may gain a thorough understanding of the language. [2]

3.5.5 C++

When working with packets or modifying pre-existing NS2 modules, C++ is used. It's possible that this choice deters the majority of novices from using NS2. A C++ programme can be developed in three ways, in theory. The first style, called "Basic C++," is the most straightforward and simply includes fundamental C++ instructions. This method lacks flexibility since it requires the entire programme to be compiled, which takes a significant amount of time, if system settings change. The system parameters are used as input arguments in the second coding method, known as "C++ coding with input arguments. We don't need to recompile the complete programme when the system settings change because we can only modify the input arguments. The last coding technique, "C++ coding with configuration files," stores all system settings in a configuration file, which is then read by the C++ code. [4]

3.6 AWK Script for NS2

The computer language AWK is intended for handling text-based data in streams or files. Alfred Aho, Peter Weinberger, and Brian Kernighan are the creators of AWK, and their family names are the source of the name. Awk has powerful regular expressions, TCP/IP networking access, user-defined functions, and multiple input streams. AWK works well for processing and searching patterns. The script searches one or more files for patterns that match, and if they do, it executes commands. Awk is very strong working with tabular data. Processing rows of data, executing commands based on conditions and relevant actions. It allows us to look at tabular data, analyses columns, set up actions based on conditions. It allows us to refer to each cell by the column number in a row. [6]

3.7 Proposed Model of Project

A model has been offered that uses some of the key parameters that the articles discussed in the previous part did not explore. To evaluate the performance of mobile ad-hoc protocols for routing, the study is separated into the following stages: mobility, network load, and also speed. Ad-hoc routing algorithms are determined by three primary performance parameters such as: throughput, packet delivery ratio, and the number of packets loss.

In both the initial and subsequent stages, [9] uses simulation to ensure the protocols' accuracy. Yet, OLSR is included to compare its performance with different protocols. The initial stage considers mobility while maintaining the total amount of nodes with CBR sources consistent. The next stage focuses on the highest speed as the major variable, with performance characteristics shown against speed. The final stage focuses on network size to figure out that ad-hoc routing techniques operate under varied network loads. For purposes of ensuring reliability, CBR sources are typically one-third of the total amount of nodes. This model analyzes the routing protocol's performance in various kinds of network sizes, such as medium-sized, large-sized, and small networks.

Pause time is regarded as a key parameter for study because maximal mobility variation is a critical feature in movement nodes [10]. A detailed packet evaluation, which provides the total quantity of packets sent out, received, fell, and also forwarded, is examined to verify the performance of mobile ad-hoc routing methods according to traffic situations.

The situations with three distinct network sizes are shown in the illustrations below. We've figured out that a network with fewer than 36 nodes represents small, 36–54 nodes represents medium, and a network with 72–90 nodes represents a large network. [8]

Scenario of Small Size Network

As seen in Figure 3.2, scenario of small network often has fewer nodes in the network. Figure 3.1 shows 18 nodes that are randomly traveling in various directions. The data is transported from the point of origin to the destination based on the wireless communication range shown by the rings surrounding the nodes**. [9]**

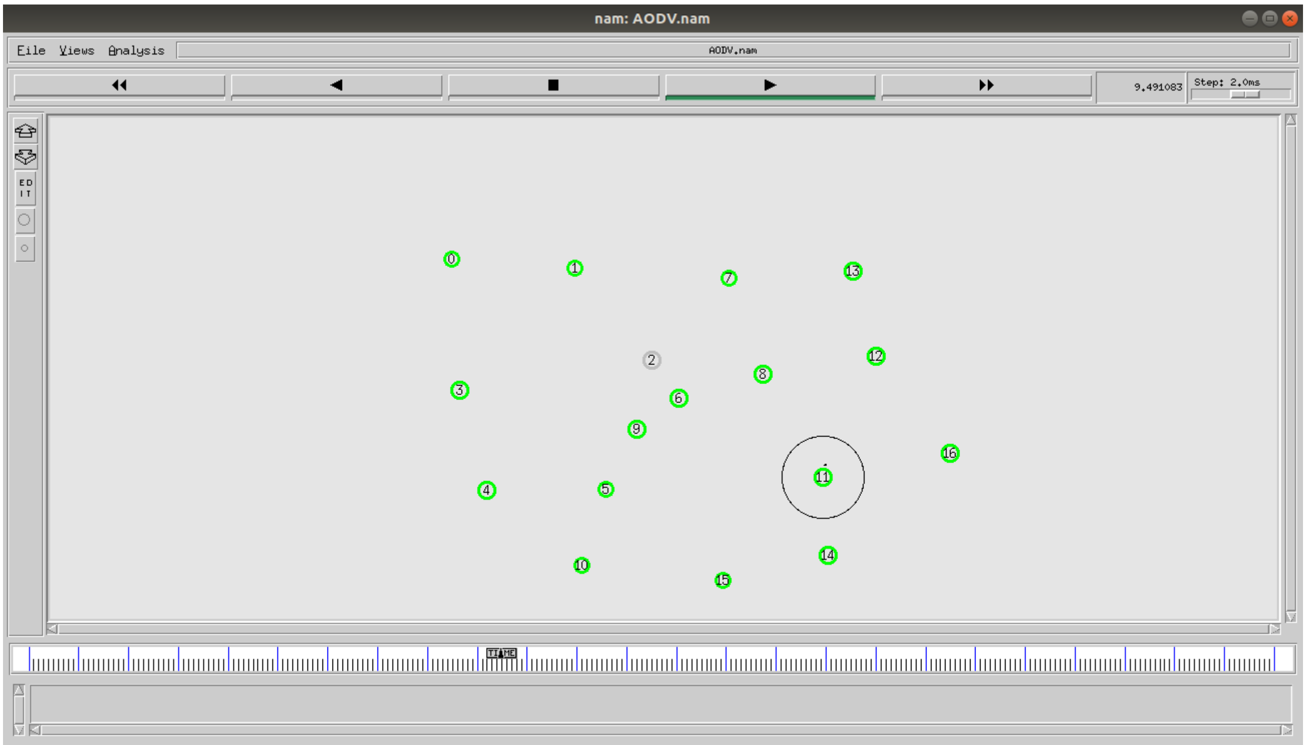

Figure 3.2 (a): Scenario of Small Network

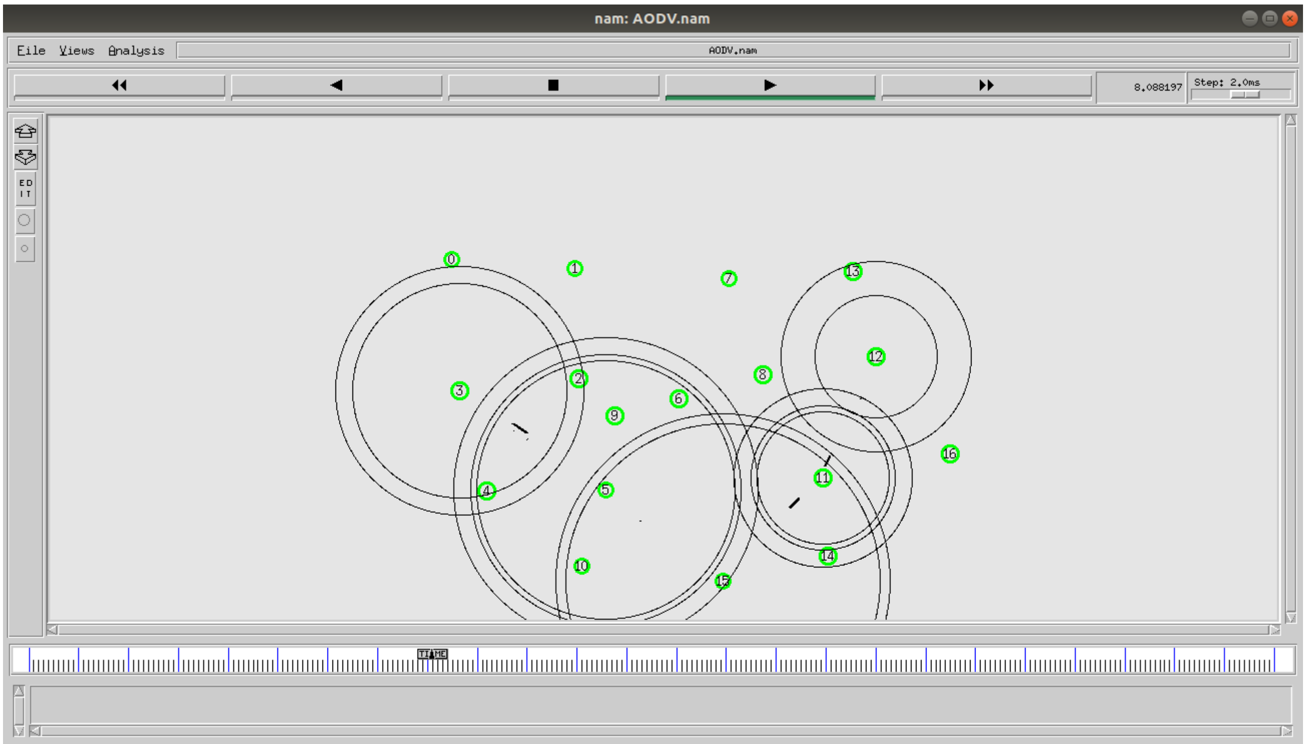

Figure 3.3 (b): Scenario of Small Network

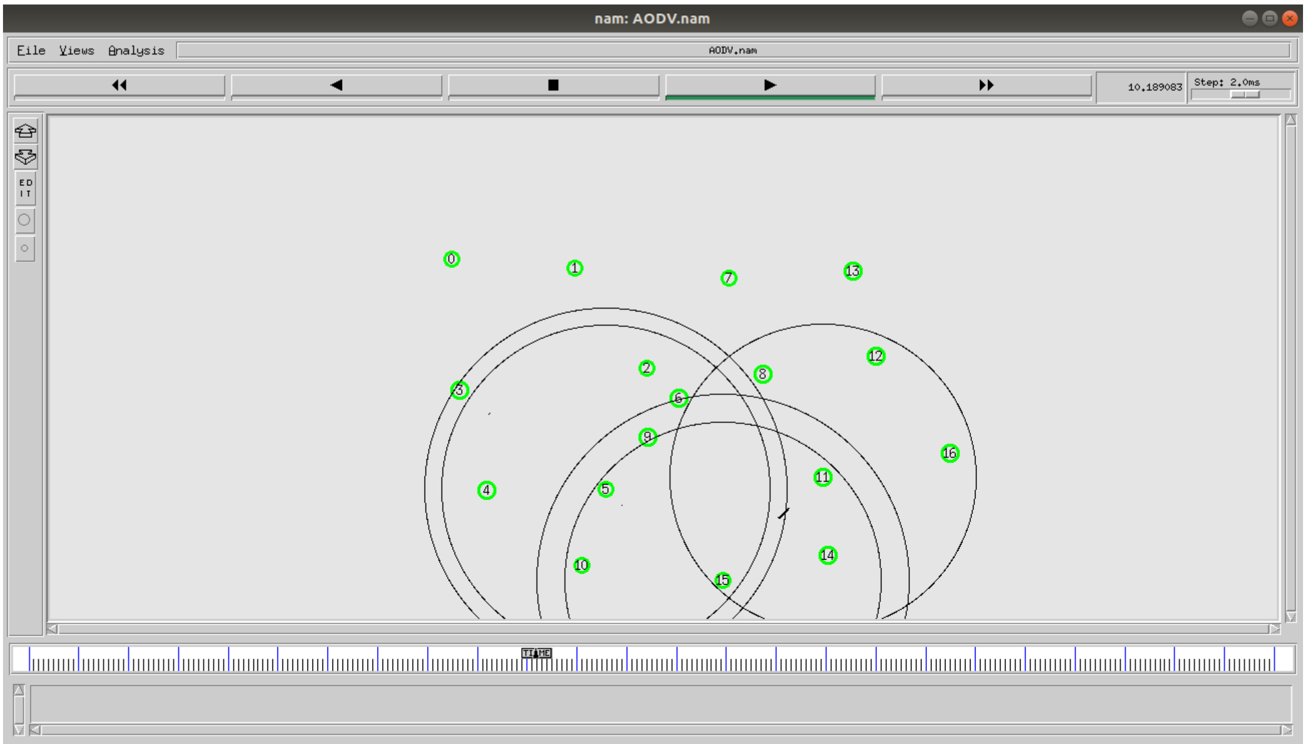

Figure 3.4 (c): Scenario of Small Network

A medium size network with 54 nodes. Larger networks require multiple routing protocols to adapt to changing network conditions. A big network setup consisting of 72 nodes. In such massive networks, it is challenging to reach 100% delivery of packets ratio. This is confirmed in the next portions of the study. [9]

3.8 Performance Parameters

Routing protocols are evaluated using a range of performance measures. The packet delivery ratio, packet loss, and average throughput, are the three primary performance metrics taken consider in this paper. When traffic conditions vary, the network's stability is determined by its average throughput. The percentage of delivered packets under various traffic situations on the network is known as the packet delivery fraction (PDF). To determine whether the amount of packets received is more impacted by dropped or forwarded packets, the number of packets dropped is taken into consideration. [8]

3.8.1 Packet Delivery Ratio (PDR):

PDR is calculated as the proportion of packets obtained through the final destination to packets originated at the source. An equation is used to calculate the packet delivery ratio and that is highlighted in the following.[8]

Packet Delivery Ratio = ∑ total amount of packet receive / ∑ total amount of packet send ×100%

3.8.2 Packet Loss Rate(PLR)

Packets are small information units that are transferred across a network from one source to another. Packet loss happens when the network packet is unsuccessful to reach its intended destination, causing data loss. An equation is used to calculate the packet loss rate and that is highlighted in the following.

PLR= (total number of TP-total number of RP)/total number of TP×100%

Here, TP represent transmitted Packets and RP represent Received Packets. [8]

3.8.3 Average Throughput

Throughput is the amount of packets that are received successfully in a certain period and is measured in bits per second (bits/sec) or kilobits per second (kbps). Another way to calculate it bits delivered per second**.**

An equation is used to calculate the average throughput and that is highlighted in the following:

S = Total amount of delivered Packet *size of Packet * 8/Overall simulation-time

Throughput=TBR / (TLPR – TFPR) × 8

Here, TBR represent Total Bytes Received, TLPR represent Time Last Packet Received, TFPR represents Time First Packet Received. [8]

3.8.4 Pause Time

The pause time is the parameter that matters most. The model's mobility rate is essentially determined by pause time; as stop time grows, the mobility rate falls. The length of time that each moving node takes before beginning to transmit packets is known as the pause time. As the nodes are not always sending packets, when the stop time is high, the nodes have a high wait time and low mobility. A low pause time results in a low wait time for the nodes, which increases mobility. This indicates that there is no wait time between packets sent by the nodes. [9]

CHAPTER FOUR
SIMULATION, RESULTS AND DISCUSSION

4.1 Simulation setup

The environment for simulation is configured in such a way that allows for the investigation of four main protocols with different parameter values. The simulations are categorized into three stages: mobility, network load and also speed. The initial and next stages keep the total amount of nodes constant while determining the average throughput, packet delivery fraction, and packet loss from which to repeat the outcomes. The third stage determines similar parameters while varying the number of nodes.

60 nodes in each of the two simulated scenarios form an ad hoc network and travel across a 500 meter by 500 meter horizontal area for 300 seconds. Using actual packet trace data, network simulations are visualized using the NAM animation tool. In both of these simulation settings, a constant 10 CBR sources are used. The network's scalability is assessed in the third simulation scenario based on changes in the load on the network. We use the total amount of nodes as variable and also compare each of the following routing protocols: AODV, DSR, DSDV, and OLSR. [9]

For every run, the simulator gives two types of inputs: an interconnection pattern file that configures random traffic based on the type of traffic connection (in our case, CBR) and a movement file that describes the movement of each node. The NS movement file contains all of the node movements at different times and rates. Setdest is the command that generated this file. The connection pattern file determines whether a TCP or CBR traffic connection exists along with the nodes. Additionally, it gives an approximation of the total amount of sources and connections that the nodes established throughout that simulation time. This file was created using the cbrgen software. To provide suitable and easy-to-understand comparisons, processes are replicated with exact loads and conditions in the environment.

The simulation parameters that were used and the outcomes that were produced are described fully in the following three parts. Availability decisions are reached after analyzing the graphs to determine which protocol in an ad hoc network is most appropriate for a given set of parameters. [9]

4.2 Analysis of performance with different mobility

Parameters	Value
Time for Simulation	300 seconds
Size of Environment	1500 x 1500
Size of Packet	1024 bytes
Type of Traffic	CBR
Rate of per Packet	5 packets per second
Model of Mobility	Model of Random Way-point
CBR sources	15
Maximal Average Speed	50 meter per second
Pause Time	0,75,150,225,300
Name of Protocol	AODV, DSR, DSDV, OLSR
Amount of nodes	90

Table 4.1: Phase 1 of the simulation setup

Table 4.1 displays simulation settings from the initial research period. The overall number of nodes in the simulation above stays unchanged at 50, but the pause length and node movement are altered. Figure 4.1 illustrates how, during the simulation, the supplementary protocol OLSR outperforms than its neighbour, DSDV. In this situation, OLSR performs very well than DSDV and is approximately as higher as the reactive processes, DSR and AODV. This may be found that while mobility is higher, i.e., when pause time is 0, DSDV is lacking in considerably higher throughput; nevertheless, whenever mobility decreases, DSDV performance increases. This is because finding routes with greater mobility is challenging due to DSDV's proactive nature. [8]

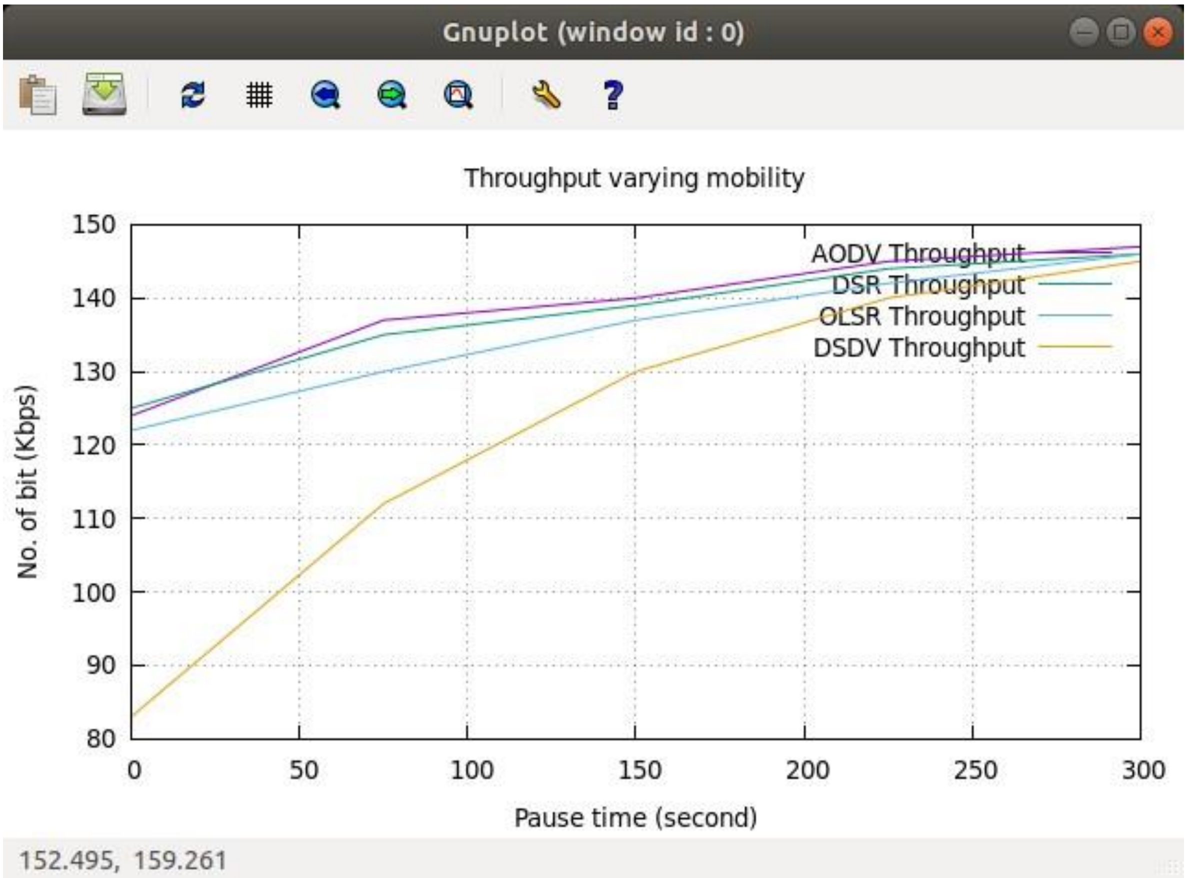

Figure 4.1: plot ting of Throughput with varying mobility

After that, packet delivery percentage is investigated over adjusting mobility. Apart from DSDV, every protocols achieve higher packet delivery ratio performance. Figure 4.2 illustrates how the performance of DSDV lost to as lower as 60% when mobility increases. In terms of packet delivery fraction, which is somewhat lower than tat of AODV and DSR, OLSR performs better than DSDV.[4]

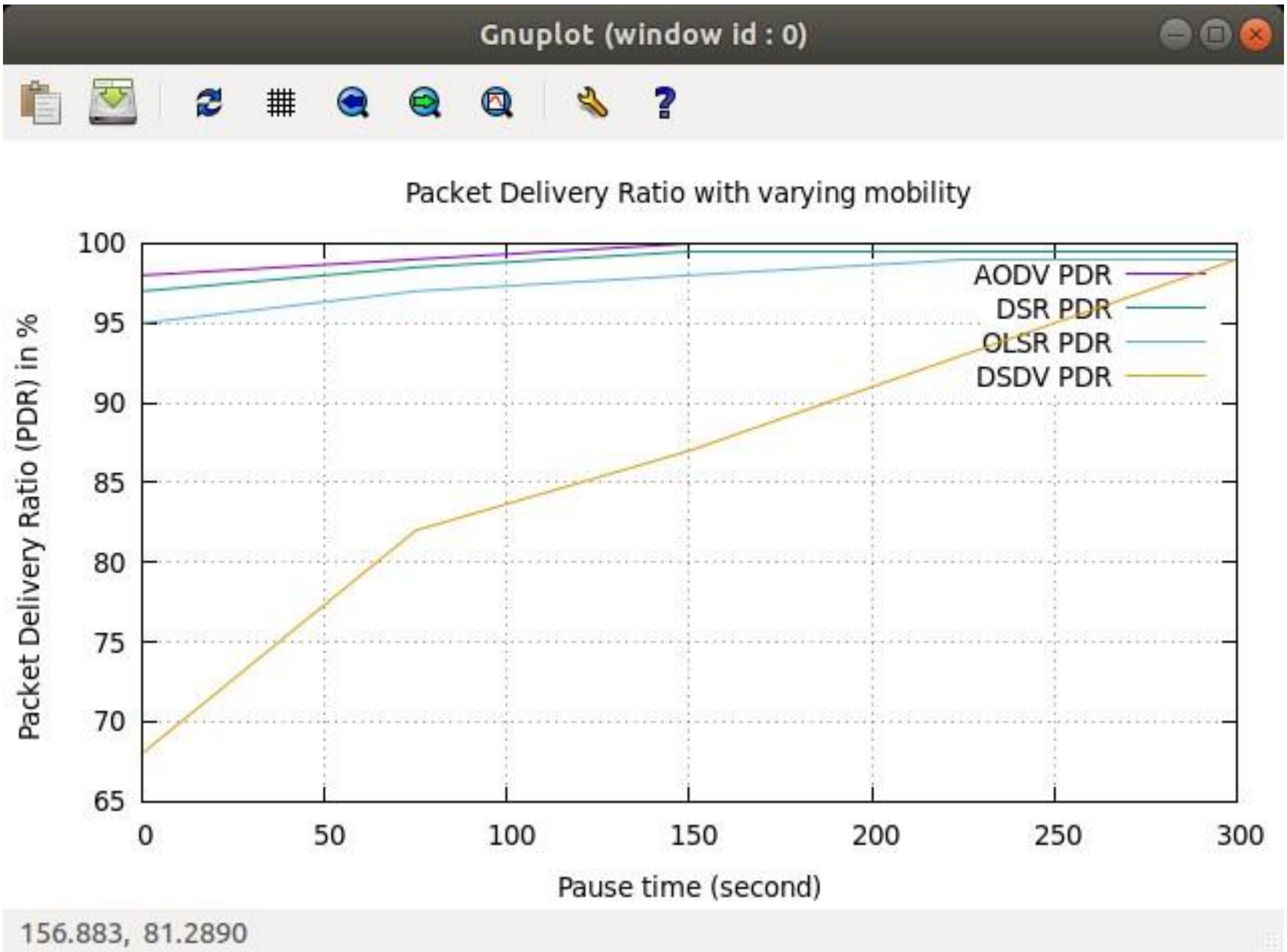

Figure 4.2: Plot of the Packet Delivery Ratio with Different Mobility

Figure 4.3 depicts that quantity of packets discarded as mobility that are modified. AODV performs better than all four protocols, losing only 116 packets when moving at its fastest speed. DSR and OLSR yield comparable outcomes. With roughly 2129 missed packets at maximal mobility, DSDV did not function adequately. Because of the nodes having sufficient time to adjust the table for routing, DSDV performs effectively as mobility drops or halt times lengthens.[9]

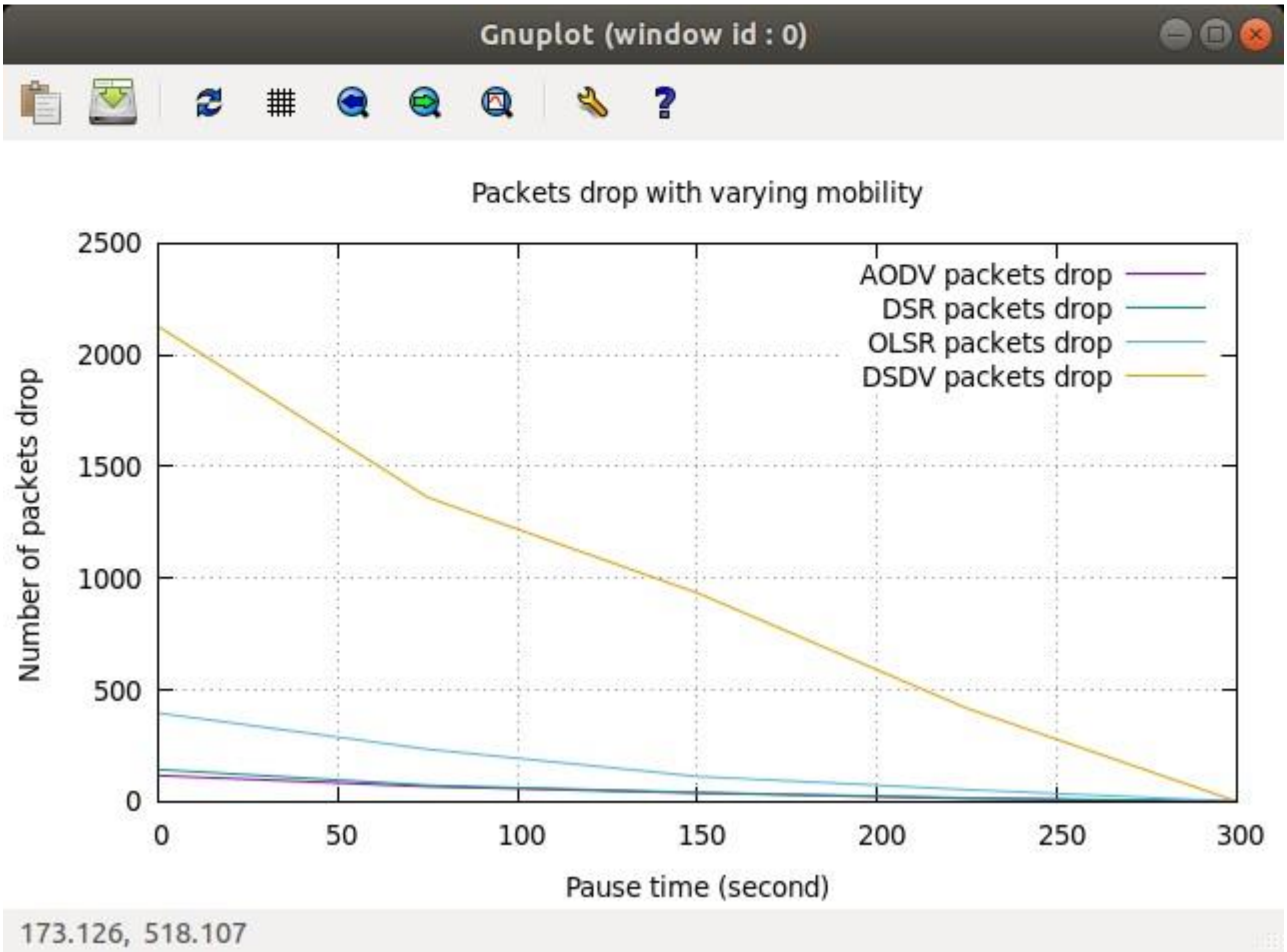

Figure 4.3: Plotting of the packets loss rate with varying mobility

4.3 Analysis of performance with different speeds

The simulation parameters used in the second part of this investigation are shown in Table 4.2. The maximum speed of the nodes fluctuates in the current simulation, while the total number of nodes stays fixed at 50. To take into consideration the widest range of potential mobility differences, the pause period is set to 0 seconds. This stage involves the calculation of throughput, packet delivery fraction, and packet drop rate. The results may be effectively recreated at different speeds, and their effectiveness is compared with that of OLSR, another proactive treatment. The top speed has been raised to 50 m/sec, which is the equivalent of a fast car, from 2 m/sec, which is the speed at which one can walk slowly.[9]

Parameters	Value
Time for Simulation	300 seconds
Size of Environment	1500 x 1500
Size of Packet	1024 bytes
Type of Traffic	CBR
Rate of per Packet	5 packets per second
Model of Mobility	Model of Random Way-point
CBR sources	15
Maximal Average Speed	2,4,10,20,30,50
Pause Time	0
Protocols Name	AODV, DSR, DSDV, OLSR
Amount of nodes	90

Table 4.2: Phase 2 of simulation setting up

Figure 4.4 illustrates how, during the simulation, the supplementary protocol OLSR performed better than its peer, DSDV. DSR offers maximum throughput at all speeds that is steady. It is quicker than AODV (129 kbps) and OLSR (121 kbps) with an average speed of 141 kbps. When DSDV reaches its maximum speed of 5 meters/sec, its throughput drops by over 68 kbps. This is because connection errors and frequent link changes are to blame. It should be mentioned that because OLSR is proactive, throughput has started to rapidly decline.[9]

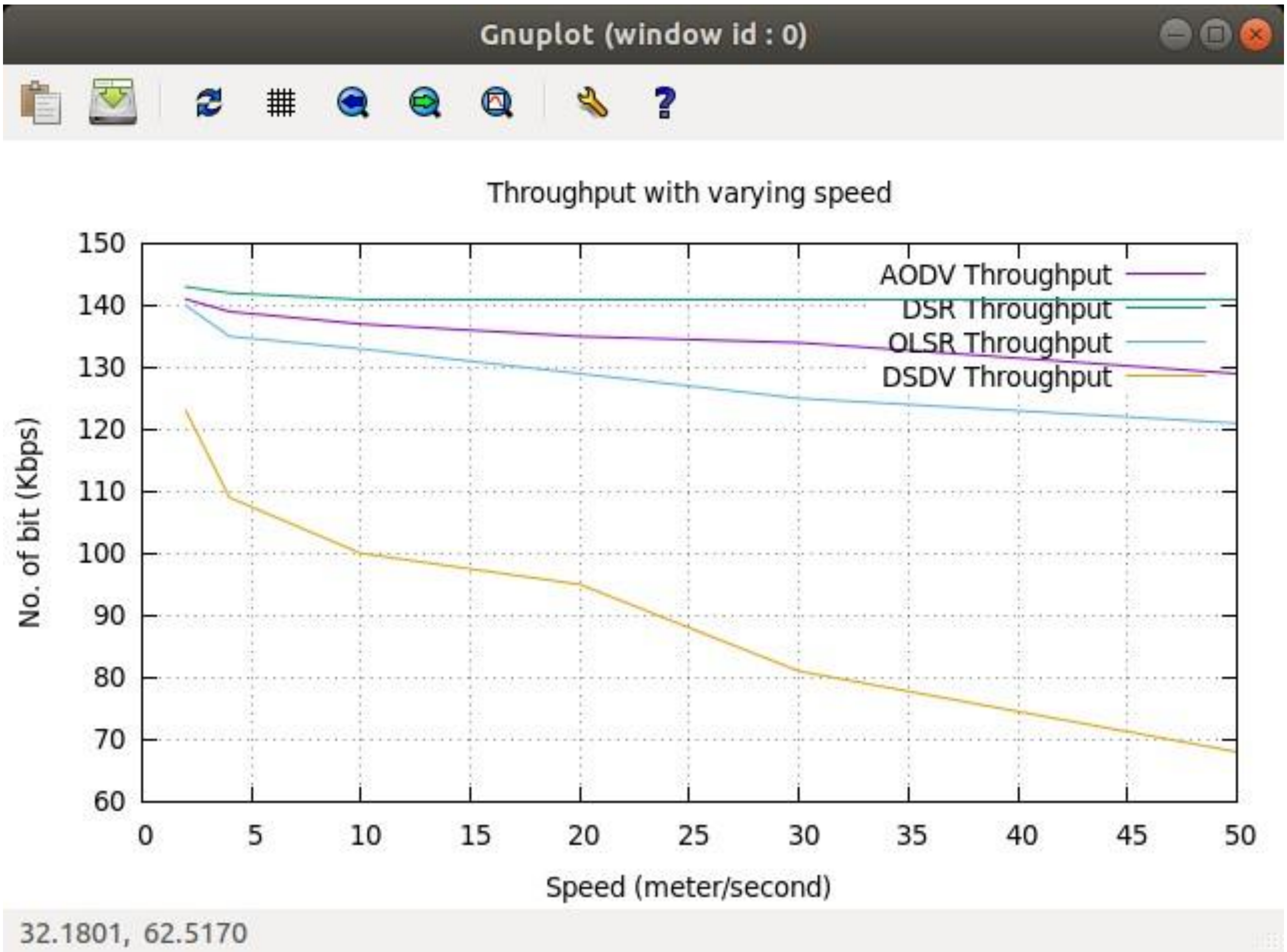

Figure 4.4: Plotting of throughput with varying speed

Figure 4.5 demonstrates how DSR maintains packet delivery percentage approximately 100% while surpassing all protocols at all speeds. With over 98% of packets delivered, AODV performs comparably to DSR. Nearly 94% of packets are delivered by DSDV at low speeds; but, because of regular network changes as well as connection failures, it is unable to sustain the same rate at higher speeds. At high speeds, packet delivery with DSDV lost to as little as 49%. Once again, OLSR performed better than DSDV, matching the performance of the reactive protocol and delivering about 97% of the packets.[9]

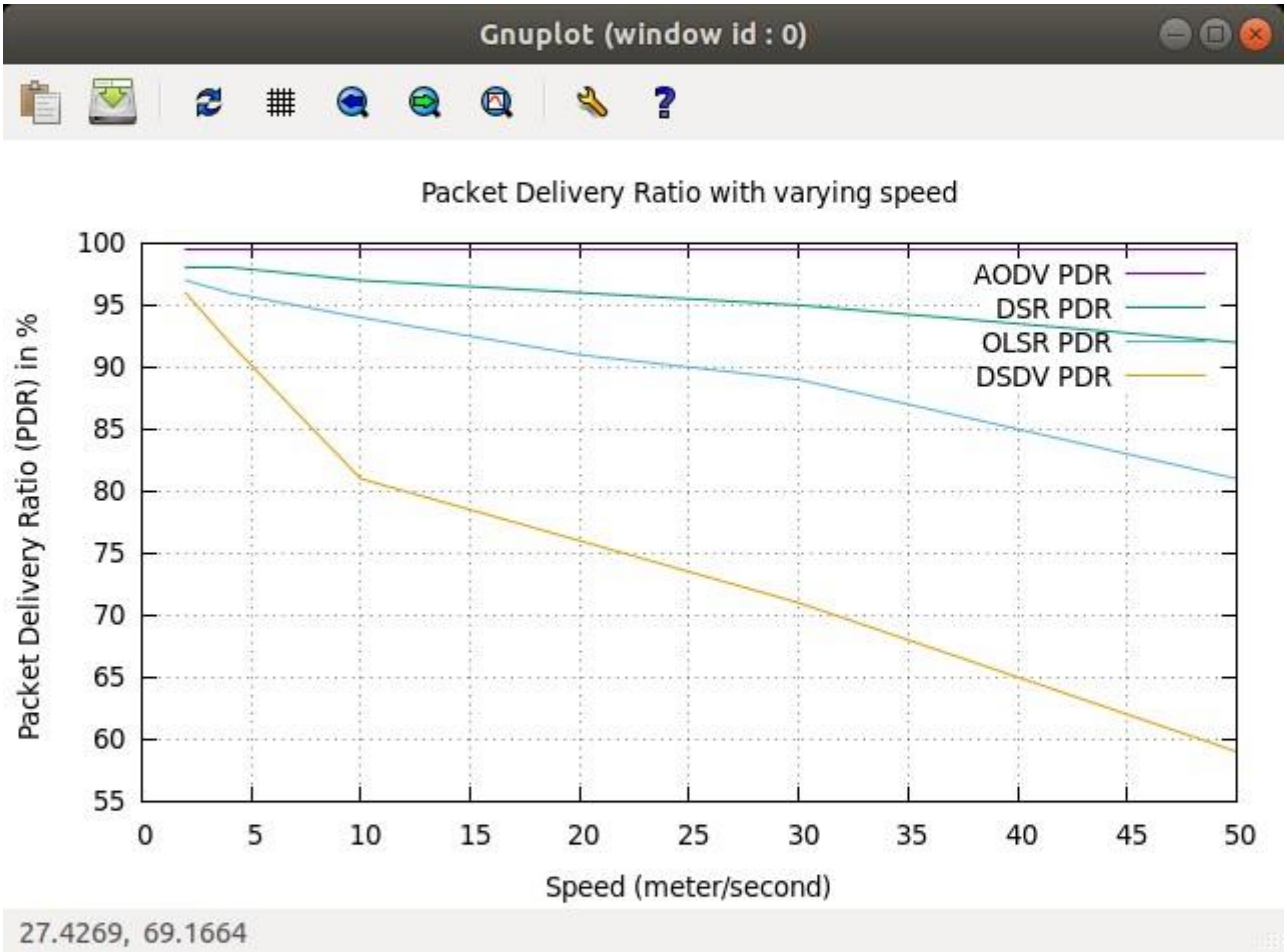

Figure 4.5: Plotting the packet delivery fraction by speed variations

Figure 4.6 presents a graph of dropped packets as a function of speed. Once more, DSR yields very good results with very few packets missing. Because of its effective dynamic routing technique, DSR can maintain a low drop rate even at very high speeds. At low speeds, AODV and OLSR performed admirably, but as the speeds increased, so did the quantity of dropped packets. Once more, DSDV was unable to perform as intended in high-speed scenarios, with over 3613 drops at a top speed of 50 metres per second.[9]

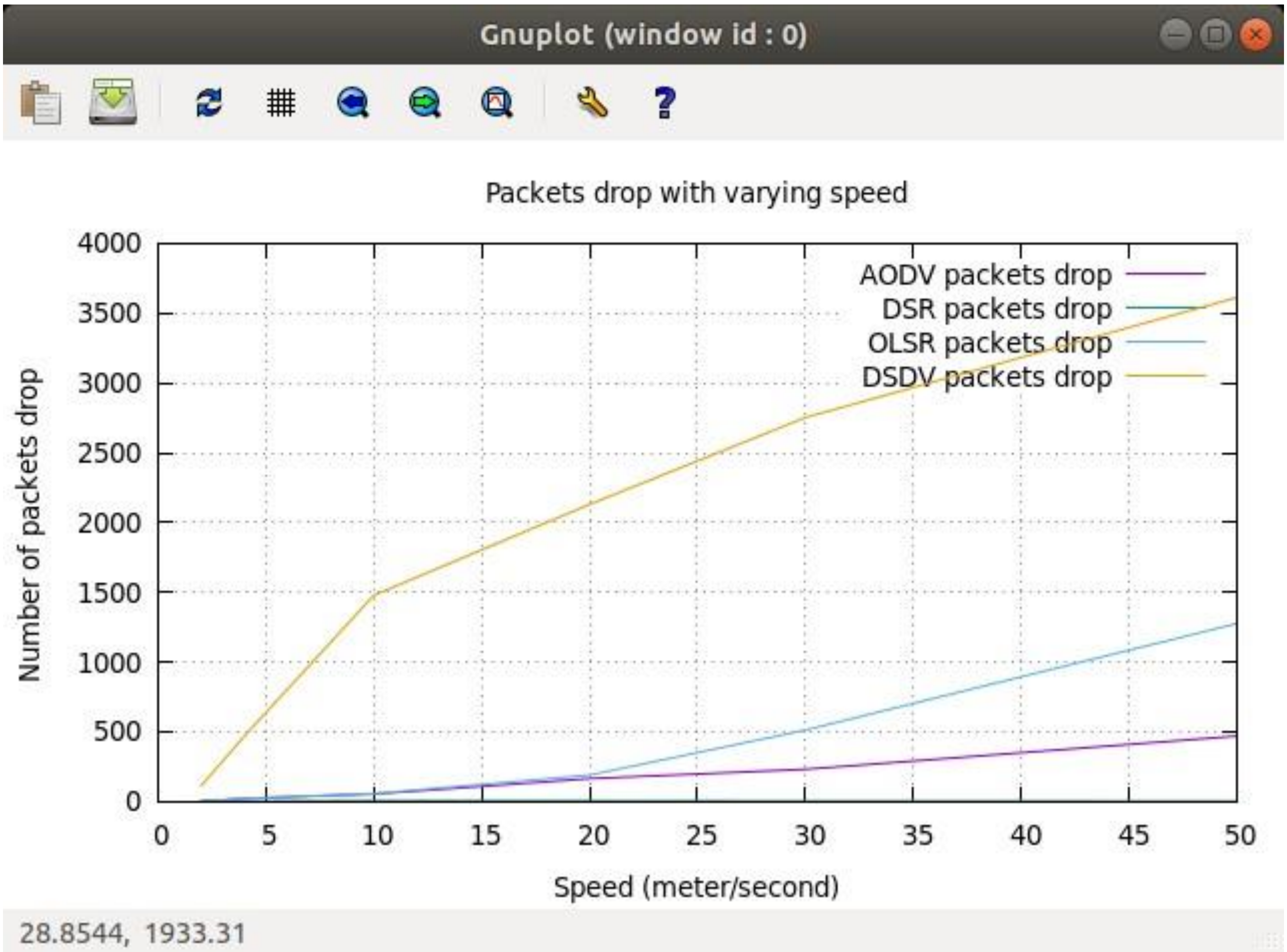

Figure 4.6: Plotting of packets lost by varying speed

4.4 Analyzing performance with different network loads

The final stage for simulation environment involves varying with network load according to assess the effectiveness of the protocols for routing. During this stage, the network load is varied to assess throughput, PDR or packet delivery ratio, and packet loss. This step is required for small-size, medium-size, and big-size networks to ascertain the degree of flexibility in the routing protocols. A small, medium, and large network can be replicated by changing the total amount of nodes from 18 to 90. The quantity of CBR sources is altered together with the number of nodes. Following the previous stage, there were 15 CBR sources, matching the fifty nodes. But at this point, the total amount of CBR sources are broadly understood to represent one-third of all nodes required to keep traffic consistent.[9]

Parameters	Value
Time for Simulation	300 seconds
Size of Environment	1500 x 1500
Size of Packet	1024 bytes
Type of Traffic	CBR
Rate of per Packet	5 packets per second
Model of Mobility	Random Way-point model
CBR sources	One-third of the nodes
Maximal Average Speed	50 meter per sec
Pause Time	0
Protocols Name	AODV, DSR, DSDV, OLSR
Amount of nodes	18,36,54,72,90

Table 4.3: Phase 3 of simulation setup

Figure 4.7 displays throughput s under various network loads. It is shown that, in comparison to all other protocols, AODV performs the best, with a maximum throughput of 167 kbps. Performance was not maintained by DSR as the network load rose. Because of regular changes to the connectivity and intermittent disconnections, DSDV performs significantly worse. [7] Although OLSR can operate in large networks due to its higher efficiency over DSR and DSDV, it may cause severe overload and congestion issues as stated in. Although OLSR takes longer to establish its routing tables before sending packets, the average throughput is constantly high because packets appear to be properly routed and received. [8]

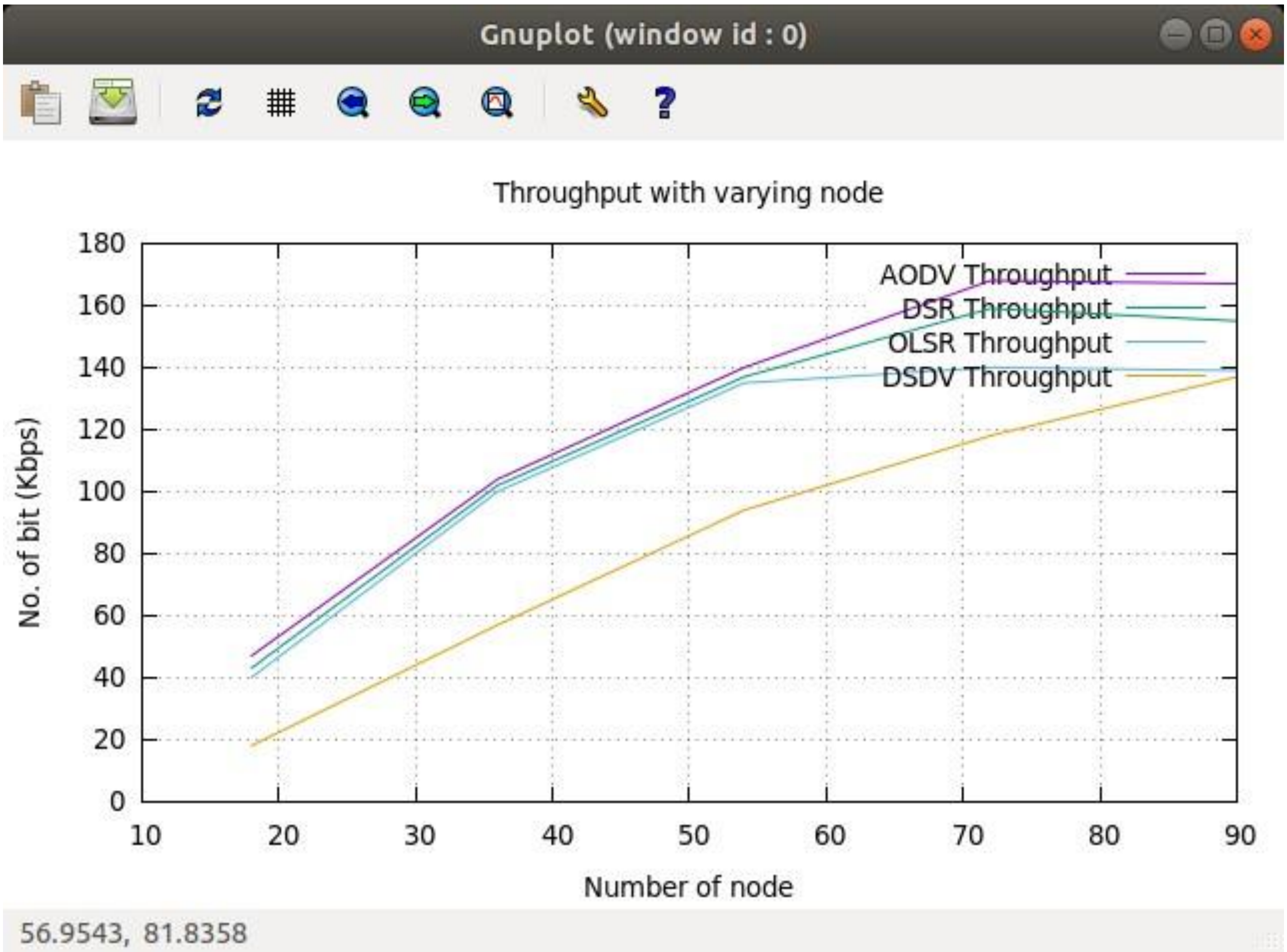

Figure 4.7: Plotting throughput with different network loads

The packet delivery percentage for each protocol, when the nodes are changed, is shown in Figure 4.8. Observing the pattern, It is evident that when network demand rises, the packet delivery rate for any protocol falls. In a small network with 18 nodes, DSR has a maximum packet delivery percentage that is almost 100%. But performance suffers with increasing load. [9] The packet delivery rate drops to as low as 35% for a big network situation (90 nodes), demonstrating that DSR performs poorly in complicated network sizes. Similar trends are shown by OLSR and AODV, with AODV marginally outperforming it in both small and big networks. Across a range of network sizes, DSDV has a poor packet delivery percentage but a reasonable level of consistency. The DSDV packet delivery fraction remains constant across various network sizes, ranging from 50% to 60%. [9]

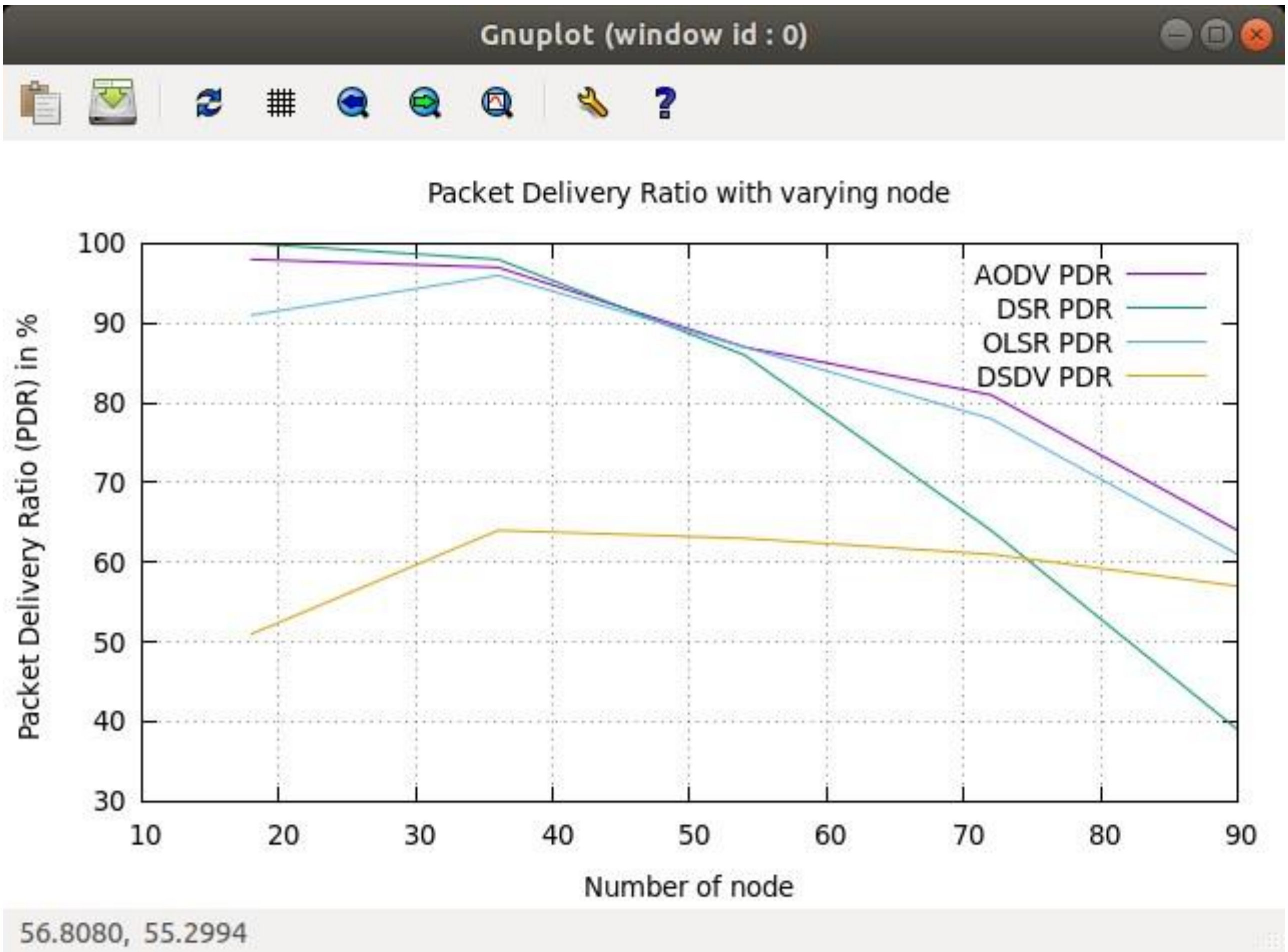

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Figure 4.8: Plotting of the Packet Delivery Ratio for different network loads

Figure 4.9 shows that all protocols are susceptible to big networks since, above 60 nodes, more packets began to fail. Even in small networks, DSDV began discarding up to 1670 packets, and in large networks, over 6442 packets. [8] Therefore, DSDV a more difficult option for a reliable routing system in densely populated ad hoc networks. DSR works very well for smaller networks, but the network grows larger, it can lose up to 99458 packets. DSR's performance is on par with that of its other peer, AODV, although it deteriorates as the network's load increases. This is most likely due to DSR's rising aggression with storing as network size grows. Large networks have longer paths, which raises the likelihood of stale routes and route faults, both of which can cause more packets to be dropped. While OLSR outperforms AODV in both small and big networks, it dropped more packets overall. In big networks, OLSR lost approximately 6460 packets and AODV lost nearly 5824 packets. [9]

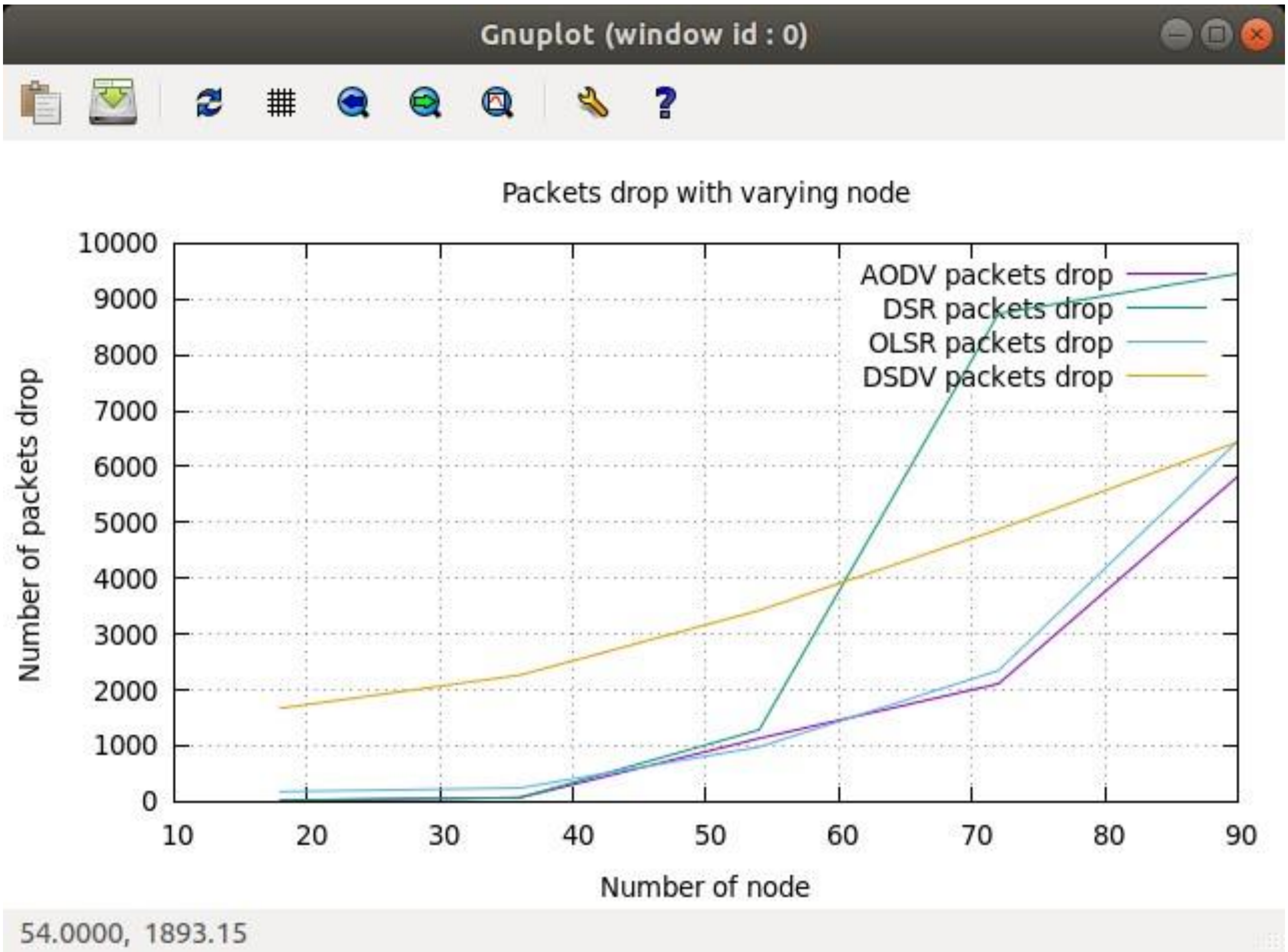

Figure 4.9: Plotting of packets lost due to different network loads

4.5 Analysis of packet on maximal mobility through network load variation

This study examines packet analysis for some protocols according to various traffic situations. The following table presents a detailed examination of amount of packets delivered, accepted, and also transferred through various nodes as the total amount of nodes changes. The data below was obtained using maximal mobility, which is defined as pause duration 0 sec with velocity of 50 meter per second.

The total amount of nodes ranges from 18 to 90, indicating both a large and a small network scenario. The total amount of packets supplied through the different protocols is relatively stable across all node scenarios. For every 18 nodes, around 3400 packets of data, for 36 nodes around 6900 packets, 9700 packets, 1200 packets for 54 nodes, and 72 nodes, there were approximately 1500 packets along with 90 nodes. [9]

Nodes	Action	AODV	DSR	DSDV	OLSR
18	Send	3367	3367	3298	3402
	Received	3224	3252	1789	3026
	Forward	4580	4120	1460	2940

Table 4.4: Analysis of packet for 18 nodes

Nodes	Action	AODV	DSR	DSDV	OLSR
36	Send	6804	6785	6883	6918
	Received	6590	6452	4268	6332
	Forward	6670	6580	2863	5120

Table 4.5: Analysis of packet for 36 nodes

Nodes	Action	AODV	DSR	DSDV	OLSR
54	Send	9798	9769	9622	9742
	Received	8752	8370	6105	8780
	Forward	11350	16300	5778	7234

Table 4.6: Analysis of packet for 54 nodes

Nodes	Action	AODV	DSR	DSDV	OLSR
72	Send	12400	12458	12368	12379
	Received	9972	7714	7314	9280
	Forward	9717	18993	5560	6190

Table 4.7: Analysis of packet for 72 nodes

Nodes		AODV	DSR	DSDV	OLSR
90	Send	15217	14980	15072	15018
	Received	9048	5678	8290	8940
	Forward	10130	28790	5883	5479

Table 4.8: Analysis of packet for 90 nodes

This indicates that the simulation variables which have been considered for the various routing methods are appropriate. The packets that are received and forwarded are determined by the method of routing and how effective it is.
Tables of the above displays that information. AODV, DSR, and OLSR have all received around the same amount of packets up to the point when there are 54 nodes. DSR is a challenging protocol at greater network loads since, beyond 72 nodes, it fails to receive the same amount of packets as AODV. Comparable amounts of packets have been received by OLSR and AODV at 72 nodes, however at 90 nodes, AODV has received a greater number of packets rather than OLSR. [9]

When comparing DSDV against AODV, DSR, and OLSR, it performs the worst. The DSDV routing procedure, when utilized in big networks, receives around 45–60% more packets than the other protocols have combined. In comparison to the remaining protocols, DSR forwards an extremely high amount of packets, according to analysis of the total amount of packets delivered. This is a result of the DSR's extreme use of storing when the network demand increases, which causes many packets that need to be sent or received to be forwarded. [8]

4.6 Observations of Project

This study's simulations is broken up into three distinct stages. The evaluation of the effectiveness for DSR, OLSR, AODV and also DSDV, is carried out over three stages: the initial stage involves changing mobility; the second involves changing speeds; and the final one involves changing network load. The predicted outcomes are observed by both correctness and validity. [6]

Following this thorough simulation using the ad hoc protocols for routing, several important findings are noted. Whenever the nodes' speed and even movement are taken into account, DSR operates at the highest level possible. Among every one of the procedures, DSR operates with maximum mobility with the least amount of pause time. DSR performs optimally and keeps an extremely low packet loss rate regardless of whether the nodes are traveling at extremely fast speeds. The cache-based routing algorithm used by DSR, which enables DSR to keep up source routes effectively with minimum time or bandwidth required for keeping other routes, is the cause of this optimal performance. Yet, an important decrease in the efficiency of the network is observed as the number of connections grows. The nodes search farther for ways to pass packets towards the nearest neighbors as the network grows in size. As the quantity of nodes gets raised to 90, the data in the above Table shows that DSR has an unusually large amount of packets transmitted (28790). This forces DSR to employ buffering more frequently, resulting in a greater number of expired routes. The combination of these older routes and connection issues is what causes more packets to be lost. This is seen in Figure 4.7, whereby DSR loses more packets as the network's load reaches sixty nodes or higher. [2]

the most appropriate plotting of DSDV versus the duration of simulation provides the most accurate results. This could simply be accurate in situations of maximal mobility and minimal network coverage. Because they are more proactive, they should function well on network that are small. DSDV has an additional opportunity to make changes to its routing database and choose the optimal path whenever the nodes in the network are almost fixed. As a result, DSDV will be able to build a more reliable route from the starting point and the intended destination, thus improving throughput. several factors such as speed, high mobility, and network load are taken into account, The performance of DSDV drops short of the other protocols, making it evident that this protocol is not the ideal choice for an ad hoc routing network that is multi-hop. [3]

The main finding of this study is that, although OLSR is proactive, it may be effectively applied in many network environments due to its ability to perform on a level with reactive methods such as AODV and DSR. It performs better than the comparable DSDV, across all levels. By ensuring high throughput as well as near-to-reactive protocols for routing, OLSR, with its the use of MPR selection approach, offers outstanding performance in both small and big networks. Because of the MPR strategy's benefit in slow-motion situations, there is a strong chance that the routes will remain valid. The OLSR approach has performed outstandingly in big networks, which is an unexpectedly positive finding. In big networks, the OLSR is an excellent technique to utilize, as opposed to AODV, which would conceptually offer optimal performance. There are two primary reasons for this. The first is that proactive algorithms are thought to be more reliable than reactive ones. Second, it's clear from Table 4.7 that OLSR performs better in packet forwarding than AODV when there are 90 nodes, with a packet forwarding rate of 5479 versus 10130 in AODV methods. This is highly reliable regarding the possibility that a greater percentage of forwards may be affected by receiving packets, which leads to a loss of DSR performance over a high level of networks. Additionally, 14980 packets were obtained, which is a very amazing number considering that AODV only got 15217 packets. In complicated networks, OLSR is encouraged to be utilized. despite this, previous study has indicated that in complicated networks, OLSR could cause a large overhead. [4]

Despite being reactive, AODV's performance has demonstrated notable reliability. Although DSR has performed well within small-size networks, AODV has shown to be a more reactive approach in networks with a higher amount of traffic. Because DSR uses a storing method, it outperforms than AODV within the terms of flexibility as well as speed, whereas as network load grows, AODV outperforms DSR. Once the total amount of nodes reaches 56, it performs the best among any protocols for routing. In comparison with different protocols for routing, AODV also features a smaller delay. Due to AODV's greater neighbor information, which helps it avoid loops and identify the newest routes, the above results can be explained by it. The RREQ mechanism might also be considered a contributing element to the higher performance of AODV. Unlike AODV, where the destination responds simply to the first RREQ received, DSR allows the destination to respond to every RREQ. As a result, in heavy traffic networks, AODV minimizes time by selecting the initial path that has been previously saved, whereas DSR discovers it difficult to choose the smallest crowded path. [9]

CHAPTER FIVE
CONCLUSION AND FUTURE WORKS

5.1 Summary of Conclusion

This paper does a detailed outcomes evaluation of the MANET-based routing methods., including DSR, OLSR, AODV and DSDV, under various mobility, load of network, and also speed scenarios. DSR performs best on networks that are small with speed and mobility. A rise in network load makes DSR less attractive. [9] No matter the network's load, speed, or mobility, AODV has consistently shown positive outcomes. In large networks, it continues to perform better than DSR, but it is unable to outperform DSR on small networks
Previous study suggests that DSDV may function well but in small networks with low mobility. The protocol's performance hasn't been equivalent to that of the other two ad-hoc routing methods used in this study. [5]

Since OLSR acts as a proactive routing system, similar to DSDV, it offers an exceptional performance. It performs similarly to AODV and has outperformed DSR in situations where there is a lot of network traffic. Despite not being able to handle AODV's level, this protocol can nevertheless be considered better due to its proactive routing of packets and performance that is equivalent to AODV. [9]

When it comes to small networks that are movable or fast, DSR needs to be the top choice overall. When the network's load increases, AODV or OLSR need to be taken into account. [4] The proactive approach of OLSR and its performance is on a level with AODV and will definitely be a connection over AODV in big networks. However, in large networks, a significant determining factor in determining which performs better is the overhead for routing between the AODV and OLSR. [9]

5.2 Future Works

There are additional topics on which this study's findings could be developed. The power usage of nodes under different network traffic may remain studied to monitor the performances using ad-hoc routing methods. Many previous articles have utilized end-to-end delay, routing additional costs, and also standardized routing capacity to evaluate the efficiency of ad hoc routing techniques. Outcome the best effectiveness of OLSR algorithm through modifying the HELLO as well as TC messages to times can become as well. an important subject of study. The performance study of ad-hoc routing algorithms Can become as well. seen through varying the amount of bandwidth as well as transmission variety with nodes, as well as how they operate in response to network changes in load.

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