PERFORMANCE EVALUATION OF AD HOC ROUTING PROTOCOL IN VANET

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DECLARATION

I hereby declare that the report is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Sultan Zainal Abidin or other institutions.

____

Name: Nor Amalina Nabila Binti Adam
Date:

CONFIRMATION

This is to confirm that:

The research conducted and the writing of this report were under my supervision.

____

Name: Dr. Muhammad Danial Bin Zakaria
Date:

DEDICATION

In the Name of Allah, the Most Gracious and the Most Merciful.

Alhamdulillah, I thank God for His grace and grace, I can prepare and complete this report successfully.

First of all, I would like to thank my supervisor, Dr. Muhammad Danial Bin Zakaria because with guidance, the advice, and the thoughtful ideas are given me the opportunity to prepare this report successfully.

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May Allah SWT bless all the efforts that have been given in completing this
report.

Thank you.

ABSTRACT

Vehicular Ad Hoc Network (VANET) is a sub class of Mobile Ad Hoc Network (MANET). VANET provides a wireless communication link between vehicles to vehicles or vehicle to infrastructure located on roadsides. They are characterized by a dynamic topology and are generally ad hoc networks, in other words without management and control infrastructure of communication. The communication between vehicles must be utilized for safety, comfort and for diversion as well. The performance of a communication link relies upon how good the routing protocols take place in the network. This project is to study Optimized Link State (OLSR) routing protocol performance on mobility speed. The performance metrics considered in this study is measured based on packet drop, throughput and end-to-end delay.

ABSTRAK

Rangkaian Ad Hoc Kenderaan (VANET) adalah sub kelas Rangkaian ad hoc mudah alih (MANET). VANET menyediakan hubungan komunikasi tanpa wayar antara kenderaan ke kenderaan atau kenderaan ke infrastruktur yang terletak di tepi jalan. Mereka dicirikan oleh topologi yang dinamik dan umumnya rangkaian ad hoc, dengan kata lain tanpa pengurusan dan infrastruktur komunikasi. Komunikasi antara kenderaan mesti digunakan untuk keselamatan, keselesaan dan juga pengalihan. Prestasi pautan komunikasi bergantung kepada berapa baik protokol penghalaan dilakukan dalam rangkaian. Project ini bertujuan untuk mengkaji Optimized Link State (OLSR) prestasi protokol penghalaan pada kelajuan pergerakan. Metrik prestasi yang dipertimbangkan dalam kajian ini diukur berdasarkan penurunan paket, keupayaan dan kelewatan hujung ke hujung.

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LIST OF ABBREVIATIONS

VANET	Vehicular Ad Hoc Network
OLSR	Optimized Link State Routing
LSR	Link State Routing
FSR	Fisheye State Routing
AODV	Ad Hoc On Demand Distance Vector
DSR	Dynamic Source Routing
TORA	Temporally Ordered Routing Algorithm

CHAPTER 1

INTRODUCTION

1.1 Background

1.1.1 Vehicular Ad Hoc Network (VANET)

The Vehicular Ad Hoc Network (VANET) is a special type of Mobile Ad Hoc Network (MANET). In 2001, VANETs were first described and implemented under "car-to-car ad-hoc mobile communication and networking" application, where networks can be established and information can be relayed between cars. VANET is designed to promote contact between vehicles (V2V) and roadside vehicles. Intelligent inter-vehicle communications and flawless internet access by incorporating the capabilities of next-generation wireless networks into vehicles are a promising new technology. The wireless networking network is autonomous, self-organizing and self-managing, similar to MANET. VANET nodes involve themselves as servers or clients via mutual radio transmission to exchange and transfer information. High node mobility and unreliable channel conditions, which pose the challenges of frequent changes in network topology, are the specific characteristics of VANET. It is therefore a very difficult job for VANETS to identify and manage roads.

A VANET not only encounters rapid shifts in wireless link connection, but may also have to deal with various types of network topologies, unlike traditional ad hoc wireless networks. For example, during rush hours, VANETs on freeways are more likely to form highly dense networks, whereas VANETs are expected to experience regular fragmentation of networks on sparsely populated rural freeways or late night. High and restricted node mobility, radio range sorting, node density varying makes routing in VANETs a challenging task. Some significant features that separate VANETs from other forms of ad hoc network include:

- High mobility that leads to extremely dynamic topology.
- Regular movement, restricted by both road topologies and traffic rules.
- Vehicles have sufficient power, computing and storage capacity.
- Vehicles are usually aware of their position and spatial environment.

Over the years, there have been several studies on the development of applications and usage models for the communication form of VANET. As more people spend time on the road, more internet connections are needed to communicate with each other, to access real-time news, traffic updates, weather forecasts, etc. the use of the correct routing protocol is of great concern due to the elevated mobility function of VANET. The network packets are sent from vehicle to vehicle, travelling with speed and the density of vehicles is also growing and decreasing, increasing the difficulties associated with routing protocols. The investigator came up with various types of protocols due to the extremely demanding existence of VANET, which will be explained in the following parts.

1.1.2 VANET Routing Protocols

In VANET, the routing protocols are divided into five categories which are Topology based routing protocol, Position based routing protocol, Cluster based routing protocol, Geo cast routing protocol and Broadcast routing protocol. These protocols are characterized on the basis of area/application where they are most suitable. Figure 1 shows the different routing protocols in VANET.

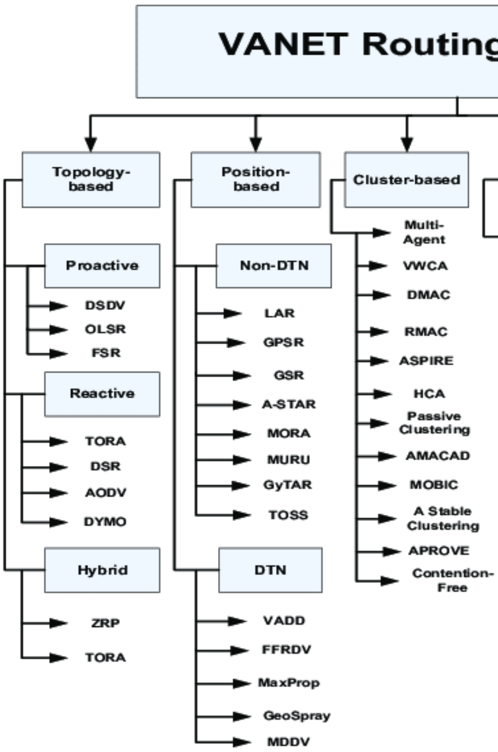

Figure 1.1: Classification of Routing Protocol in VANET [8]

- **Topology Based Routing Protocols**

  These routing protocols use links information that exist in the network to carry out the forwarding of packets. They are further divided into Proactive and Reactive

  - **Proactive Routing Protocols**

    The proactive routing means that the routing information, like next forwarding hop is maintained in the background irrespective of communication requests. The benefit of the proactive routing protocol is that, because the destination route is stored in the past, there is no route discovery, but the downside of this protocol is that it provides real time implementation with low latency. A table is constructed and maintained within a node. So, each of the entries in the table displays the next hop node to a given destination. This also contributes to the preservation of unused data routes, which allows the usable bandwidth to be limited. The various types of proactive routing protocols are LSR and FSR.

- **Reactive/Ad Hoc Based Routing**

  Reactive routing only opens the path when a node wants to be able to connect with each other. Only the roads that are actually in operation are preserved. This reduces the pressure on the network as a result. Reactive routing consists of a route discovery stage in which the demand packets for path search are flooded into the network and this stage is complete when the route is discovered. The various types of reactive routing protocols are AODV, PGB, DSR and TORA.

- **Position Based Routing Protocols**

  Position based routing made up of the routing algorithm class. In order to pick the next forwarding hops, they share the property of using geographic positioning information. The packet is sent to the one-hop neighbour that is nearest to the destination without any map information. Position based routing is useful because it is not necessary to build and manage any global route from the source not to the destination node.

- **Cluster Based Routing**

  Cluster based routing is preferred in clusters. A group of nodes recognizes itself as part of the cluster and a node is designated as the head of the cluster that broadcasts the packet to the cluster. For large networks, good scalability can be provided, but network delays and overhead are incurred when highly mobile VANET clusters are created. In order to provide scalability, a cluster-based virtual network routing architecture must be built by node clustering.

- **Geo Cast Routing**

  Geo cast routing is essentially multicast routing based on a location. Its purpose is to deliver the packet from source node to all other nodes within a specified geographical region (Zone of Relevance ZOR). Vehicles outside the ZOR are not alerted to prevent unnecessary hasty response in Geo cast routing. Geo cast is considered within a particular geographic area as a multicast operation.

- **Broadcast Routing**

  In VANET, broadcast routing is commonly used for sharing, traffic, weather and emergency, vehicle road conditions, and distribution of advertising and announcements. The various types of Broadcast routing protocols are BROADCOMMD, DV-CAST, V-Trade and UMB.

1.1.3 Ad –Hoc Demand Distance Vector (AODV) Routing Protocol

Upon receipt of a broadcast query (RREQ) in AODV routing, nodes record in their routing table the address of the node sending the query. Backward learning is called this procedure of documenting the previous hop. A reply packet (RREP) is then sent through the complete path obtained from backward learning to the source upon arrival at the destination. The AODV algorithm allows dynamic, self-starting, multi-hop routing between participating mobile nodes that want an ad hoc network to be set up and maintained. AODV allows mobile nodes to easily acquire routes for new destinations and does not need nodes to maintain routes for non-active communication destinations. The operation of AODV is loop-free and provides rapid convergence when the adhoc network topology changes by preventing the Bellman-Ford "counting to infinity" problem (typically, when a node moves in the network). AODV allows the affecte group of nodes to be alerted when ties break, so that they can invalidate the routes using the missing connection. The message types identification by AODV are Route Requests (RREQs), Route Replies (RREPs) and Route Errors (RERRs).

1.1.4 Optimized Link State Routing Protocol (OLSR)

The Optimized Link State Routing Protocol (OLSR) is a link-state protocol, which optimizes the way of broadcast of control messages to save bandwidth consumption through the use of the concept of "multipoint relays" (MPRs). Figure 2 shows each node selecting a subset of its neighbors to forward their packets while broadcasting. In OLSR, olny nodes selected as such MPRs are responsible for transmitting control traffic to the entire network for distribution. MPRs provide an important flood control traffic mechanism by reducing the number of transmissions required. Nodes, selected as MPRs, also have a special responsibility when declaring link state information in the network. Indeed, the only requirement for OLSR to provide all destinations with the shortest path routes is that MPR nodes announce their MPR selectors' link-state information. Nodes selected by some neighbouring nodes as multipoint relays periodically announce this information in their control messages. A node thus notifies the network that it is open to the nodes that have selected it as an MPR. The MPRs are used in route calculation to shape a route from a given node to any network destination. In edition, the MPRs are used by the protocol to allow successful flooding of control message on the network.

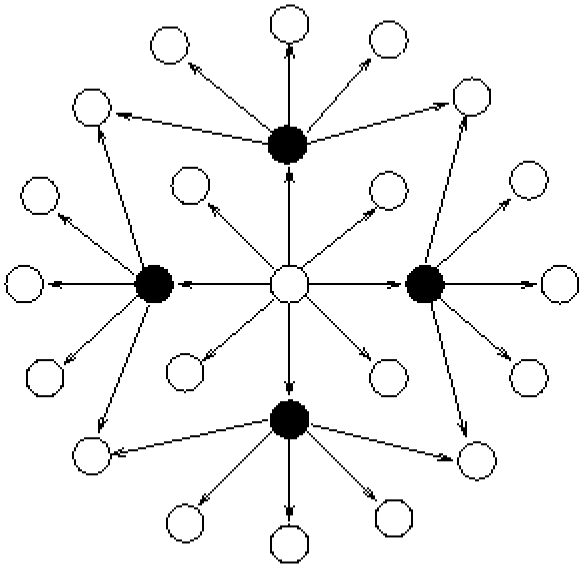

Figure 1.2: Multipoint Relays in OLSR

1.1.5 Destination Sequance Distance Vector (DSDV)

The Destination Sequenced Distance Vector (DSDV) Routing Algorithm is based on the idea of the classical Bellman Ford Routing Algorithm with certain improvements. A routing table that lists all available destinations, the number of hops to reach the destination, and the sequence number allocated by the destination node is maintained by each mobile station. The sequence number is used to differentiate between stale and new routes and thus prevent loops from forming. The stations send their routing tables to their immediate neighbors regularly. If a major change has occurred in its table from the last update sent, a station also transmits its routing table. So, the update is time-driven as well as event-driven. It is possible to submit routing table updates in two ways: a "full dump" or an incremental update. A full dump sends the entire routing table to the neighbors and can cover several packets, while only those entries from the routing table that have a metric adjustment since the last update are sent in an incremental update and must fit in a packet. If there is space in the incremental update packet, it is possible to include those entries whose sequence number has changed. Incremental updates are sent to prevent unnecessary traffic when the network is reasonably secure, and complete dumping is relatively uncommon. Incremental packets will grow large in a fast-changing network, so complete dumps would be more frequent.

1.2 Problem Statement

As wireless technology is improving, extensive research on VANETs is being carried out. There is a need for vehicles to be fitted with infotainment system. When a vehicular ad hoc network is established, it should aid in the sharing of data. So that data should be set before the network setup and sharing route. Energy consumption, network efficiency are the difficulties and challenges facing ad hoc networks. Various parameters such as packet drop, end-to-end delay, throughput is used in this paper to verify the network performance.

1.3 Objectives

The primary objectives of this study are to solve the problem stated in 1.2 implementing the suggested routing protocol for VANET. This project is therefore specifically based on the following objectives:

- To study Optimized Link State (OLSR) routing protocol.
- To apply the OLSR routing protocol in VANET using NS2 simulation tools.
- To evaluate the performance of OLSR routing protocol in VANET using NS2

1.4 Scope

The scopes in this thesis are to evaluate the OLSR routing protocol's performance in terms of packet drop, end-to-end delay and throughput in a highly mobile environment of VANET.

1.5 Limitation of Work

VANET is difficult to implement in a real-world experiment since this project is only on the simulation network, NS-2. There is some limitation in this project which is:

- A high cost is needed because there are more nodes required to prepare which may lead to high cost to afford them.
- A complex configuration because it takes a long time to set up.
- This simulation works on limited operation systems such as Linux, UNIX and an older version of Windows (XP, Vista).

1.6 Summary

This chapter has been discussing the introduction on VANET, the problem statement, objective, scope and limitation of the project. The next chapter will discuss literature review which refers to previous research papers and journal articles that are related to the project. In chapter three, the methodology was discussed including the methods and techniques used for the development of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A sufficient amount of research was carried out on the published literature related to this subject prior to the implementation of the proposed project. In this chapter, as a literature review, a few research papers related to the project are chosen. To give a better understanding of how the process works and how it profits from the project, data and information are collected. The literature review is a text of a trusted paper with current knowledge of theoretical and methodological contribution, such as a journal, article and book.

As defined in chapter 1, the concept of routing protocol in VANET is clearly stated. VANET simulations require realistic wireless network and mobility models. However, it remains an open issue to build an open and scalable simulation framework that will incorporate wireless communications and road traffic simulation platforms in an environment that is easily suited to specific circumstances, allowing cooperative ITS performance analysis at the urban level.

2.2 Related Work

The performance evaluation of various ad hoc routing protocols is proposed to this project in order to compare which ad hoc routing protocol has better performance in the highly mobile environment of VANET.

In a research paper “Performance Evaluation of Ad Hoc Routing Protocol in VANETs" by Mohammed ERRIT ALI, and Bouabid El Ouahidi (2013). According to the particular paper, they study five routing protocols which are AODV, DSR, TORA, OLSR and GRP. These protocols are analyzed in relation to the debit, sent routing traffic and delay. They conclude after the studies that OLSR outperforms AODV, DSR and TORA in debit and delay but OLSR has the worst performance in routing traffic generated. Thus, for high debit networks, it is well equipped. High traffic routing indicates that for low debit networks, OLSR is not suitable. Next, in networks of low debit and medium scale, DSR is the highest. However, in case of long roads, it has a wide traffic route (large networks). It inserts the IP addresses of all the nodes of the path it uses into the packet. Although AODV is sufficient for low and medium load, low-speed mobility networks. Therefore, TORA is sufficient for small networks. Under rapid extension, it loses its efficiency. Finally, they concluded that GRP reduces signaling (control packets) significantly, especially on large and dynamic networks. Low memory requirements and simplicity, and more suited to large networks. Because of its low latency and low amount of routing traffic, they found that geographic routing is being suited for highly dynamic vehicular networks. The problem remains the ability to choose metrics that give both vehicular environments with different characteristics adequate results.

This recent research paper, entitled “Traffic Analysis in Rural/Urban Area Using VANET Routing Protocols” was written by Arif Nawaz and Ahsan Raza Sattar. AODV, DSDV and DSR in both rural and urban areas are performed in this paper study following protocols and comparison. The study shows that reactive protocol performance is good because in nearly all reactive routing protocols, path discovery mechanism, route maintenance and minimization of periodic broadcasting are found. They evaluated from the performance that end-to-end delay in DSDV is minimal, which is the main achievement and necessity in all real-time systems. Minimal end-to-end delay is the trait of the table-driven process.

In addition, the research paper titled “On the Performance Evaluation of VANET Routing Protocols in Large-Scale Urban Environments” written by Nicholas Loulloudes, George Pallis, and Marios D. Dikaiakos, studies the effects that mobility, road topology and network applications have on the performance evaluation of VANET. Specifically, they evaluate the performance of three known and highly established VANET routing protocols by employing realistic mobility from a large-scale urban topology and imposing network load. They argued that a practical and full assessment should be followed in the design of VANET routing protocols to increase the possibility of detecting issues as well as consequences that need to be considered and resolved in order to achieve optimum efficiency. They support their argument by assessing the efficiency of three widely known GPCR, VADD and LOUVRE VANET routing protocols in a large-scale urban environment with practical vehicle mobility and network traffic created by a new traffic query application called V-RADAR.

On the order hand, the research paper written by Zineb Squalli Houssaini, Mohammed Oumsis, Imane Zaimi, and Said El Alaoui Ouatik, entitled “Comparative Study of Routing Protocols Performance for Vehicular Ad Hoc Networks". The numerous routing protocols proposed in the literature are discussed in this paper, including proactive (DSDV, OLSR, FSR), reactive (AODV, DYMO, DSR), hybrid (ZRP) and position-based protocols (GPSR). In an urban scenario, they studied a global output assessment with different numbers of nodes and different numbers of traffic. This paper contributed in three areas; the first shows a literature survey where a global overview of VANET is given, including routing protocols and their classification. The second field is the effect of urban scenarios on routing protocols, and the use of this broad series of routing protocols for ad hoc vehicle networks has finally been proposed. Their aim is to provide a better understanding of these protocols and their actions, and to provide a valuable and useful guide for further research on various groups of protocols for vehicular routing to support QoS. According to the result study, compared to the other routing protocols, the geographic routing protocols perform better in the vehicular ad hoc network as this type of protocol uses the location information that is necessary for such a network.

2.3 Summary

This chapter describes the research that has to do with the performance of VANET has implemented several routing protocols. This study is necessary in order to obtain an idea and as a guide to a successful project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will discuss the project methods and alternatives used from the beginning to the end of the project. The simulation tools that will be used in this are also discussed in this chapter and the NS-2 simulator is the method used for network simulation. This chapter provides the system structure and flow chart for a better understanding of visualization when implementing the project in order to move deeper through the project.

3.2 Reasearch of Methodology

In terms of research methodology, the preparation of the project is very important for the development of the project. Based on figure 3.1, there are few phases of the methodology mentioned. The first phases is linked to the identification of research issues. The issues of VANET are defined for this project in this process. The second phase is designing and developing. The main goal of the following phase is to find the best approach for the project to be implemented. The next phase is project simulation. The simulation tools that will be used in this project is disscussed in the following phase. The Network Simulation (NS-2) is the simulation tool used for this project. Performance must be evaluated and analyzed for this project. The performance metrics to be evaluated are packet drop, end-to-end delay and throughput.

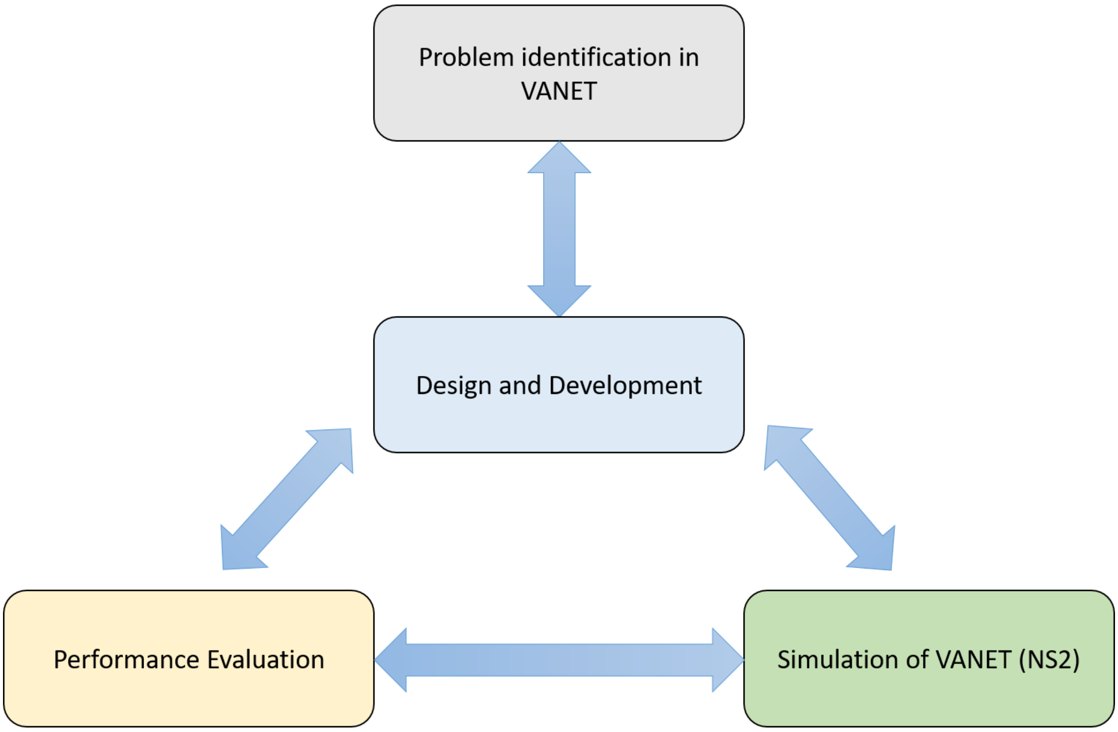

Figure 3.1: Research Methodology

3.3 Simulation

The simulation of the project is performed with NS2 due to the constraints in real-life experiment which consume a lot of time and cost. The Network Simulator (NS) is one of the simulations that used to simulate the network environment such as VANETs and MANETs. Network Simulator 2 (NS2) provides significant support for the simulation over wired and wireless networkswith various protocols. It also provides a highly flexible platform that supports various components, protocols, traffic and routing types for wired and wireless simulations. It is usually compatible on Linux (Ubuntu).

NS2 is a simulation package that supports several network protocols, including TCP, UDP, HTTP and DHCP, and this package can also be used to model the simulation. The C++ programming language and Otcl were used in NS2. In NS2, C++ is used for thorough implementation of the protocol, and Otcl is used for the configuration. The C++ objects that have been compiled are made accessible to the

NS2 Otcl interpreter. This provides the C++ objects from the Otcl level of the simulator to be controlled. For this project, the NS2 is used because it benefits from a wide range of models avaialable. Table 3.1 below shown the comparison of network simulators.

	NS2	OPNET	OMNET
The Simulation Method	Event-driven	Event-driven	Event-driven
Model Extension	C/C++	C/C++	C/C++
Modelling Environment	Command editor	Graphical Editor (GUI)	Graphical eeditor (GUI)
Scope of application	Network Protocol	Network	Communication simulation
Runtime environment	Unix, Linux, win95/98/2000/XP/7	Unix, Solaris, HP-UX, win95/98/2000/XP/7	Linux, win95/98/2000/XP/7
Price	Free	High	Free

Table 3.1: Comparison of Network Simulator

3.4 Project Framework

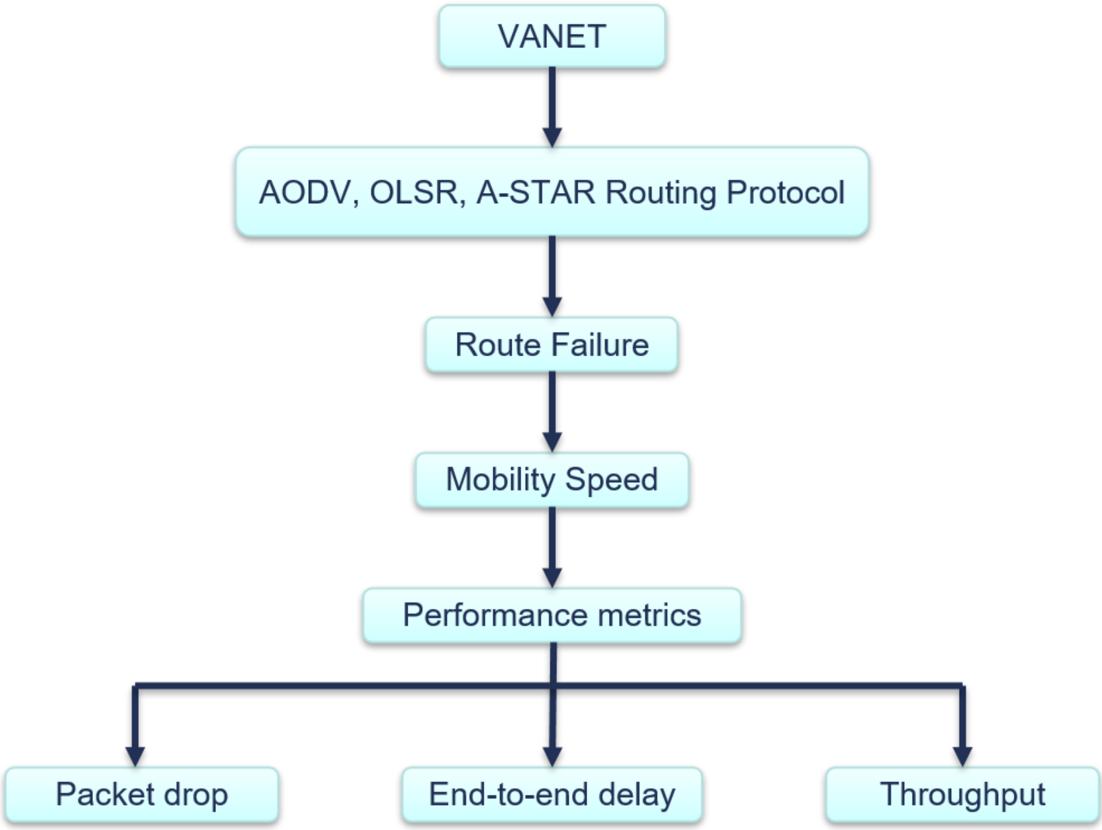

Figure 3.2: Framework of Mobility Speed

3.5 Project Flowchart

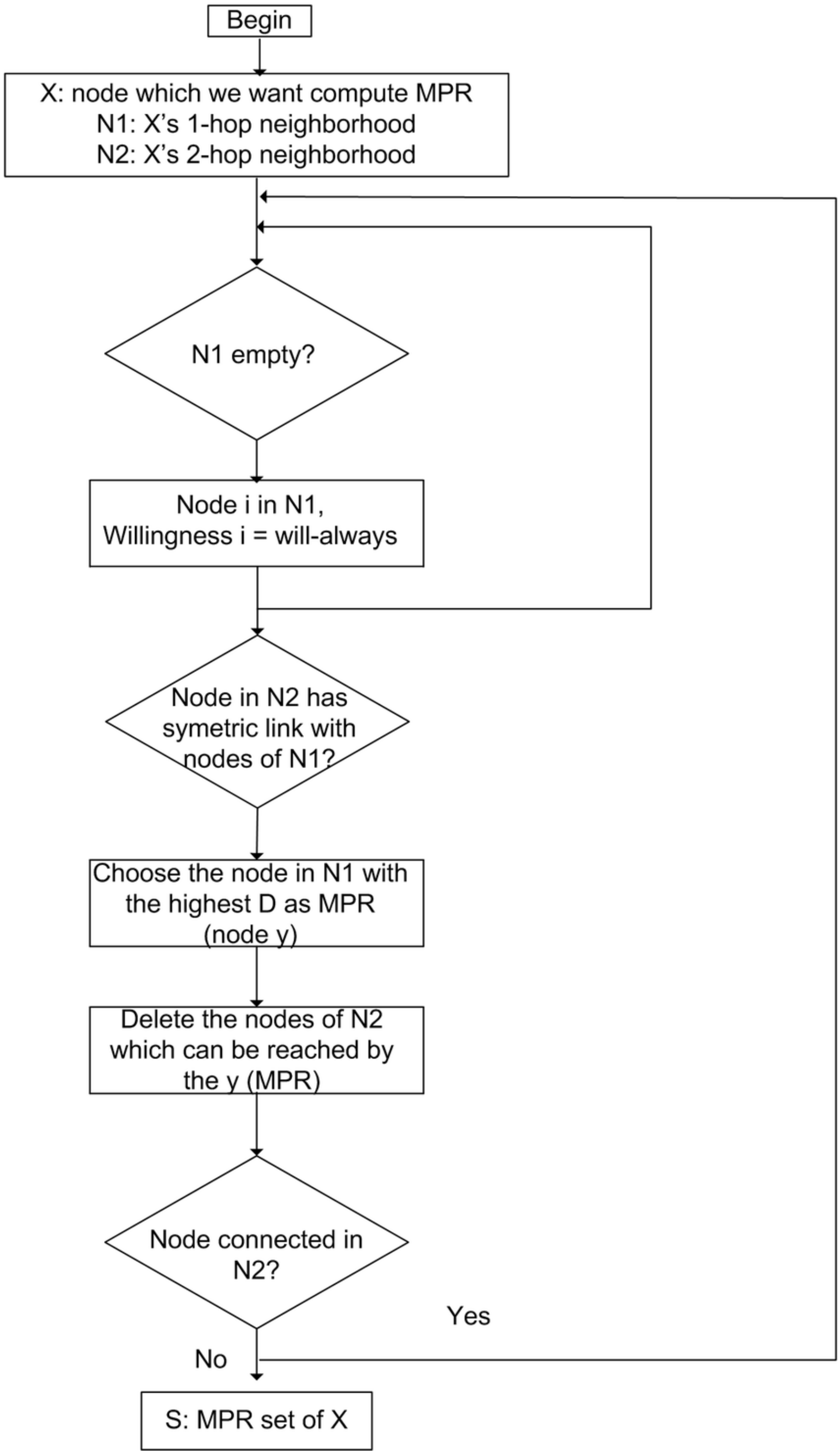

Figure 3.3: Flowchart for OLSR MPR selection

OLSR is also regarded as a routing protocol that is constructive and table-driven. Routing protocols are not subject to the Link State Routing Protocols. In addition, there is no issue with the Link State Routing Protocol in terms of scalability. However, during the exchange of topological data on mobile nodes, the link state routing protocol generates a significant amount of traffic. To significantly reduce the amount of traffic involved in the process of exchanging topological data between nodes, the OLSR protocol introduced a new procedure or technique. All the nodes are permitted in the OLSR protocol and allowed to receive the topological data message. Nevertheless, all these messages can be distributed through the network only by a limited number of nodes known as multipoint relays (MPRs). The MPRs of the node in question are, in explanation, the minimum number of its immediate neighbours who are expected to contact all their neighbours in two hops. The MPRs therefore ensure that the network topology data message is received by any node in the network.

3.6 Proof of Concept

Figure 3.4: Ubuntu Operation System

Figure 3.5: Network Simulation 2 tools

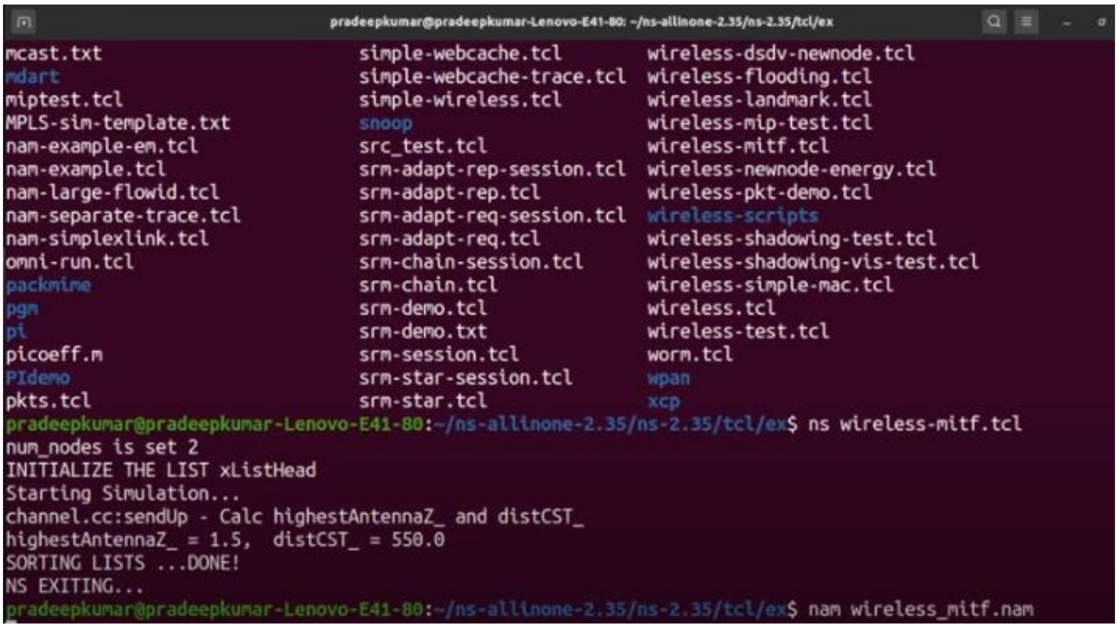

Figure 3.6: NS2.35 installed in ubuntu

3.7 Summary

The following chapter clarifies and explains the definition of the project's research methodology, structure, and flowchart. It offers a deeper understanding of the simulator we selected for the implementation of this project.

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