PERFORMANCE ANALYSIS OF OLSR ROUTING PROTOCOL IN VANET FOR HIGHLY CONGESTED AREA

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DECLARATION

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

Signature : ……

Name : Muhammad Aliff Haziq Bin Tarmizi

Date : 28th January 2021

CONFIRMATION

This is to confirm that:

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

Signature : _____

Name : Dr. Muhammad Danial Bin Zakaria

Date : 28th January 2021

DEDICATION

All praise is due to Allah who has given me this opportunity to conduct this report for this final year project.

I want to express my greatest gratitude to my family and friends who have helped me and encouraged me to complete my project during the process. I would like to express my sincere appreciation and gratitude to Dr. Muhammad Danial Bin Zakaria, my supervisor, for his encouragement, guidance, criticism, advice, inspiration and support.

Sincere thanks to all my fellow friends for their help in completing my final project.

ABSTRACT

A sub class of mobile ad hoc networks (MANET) is the Vehicular Ad Hoc Network (VANET). Wireless communication between vehicles and vehicles is provided by VANET to roadside utilities (access point). For safety, comfort and also for entertainment, contact between vehicles is used. Many problems will arise because the network performance in the congested area not stable. Suitable protocol is needed to solve this problem, therefore will consider to implement OLSR protocol. In this project, I focus the scope of my research on only at congested area like jammed traffic lights and big city with many users.

ABSTRAK

Sub kelas rangkaian ad hoc mudah alih (MANET) adalah Rangkaian Ad Hoc Kenderaan (VANET). Komunikasi tanpa wayar antara kenderaan dan kenderaan disediakan oleh VANET ke utiliti pinggir jalan (pusat akses). Untuk keselamatan, keselesaan dan juga hiburan, hubungan antara kenderaan digunakan. Banyak masalah akan timbul kerana prestasi rangkaian di kawasan yang sesak tidak stabil. Protokol yang sesuai diperlukan untuk menyelesaikan masalah ini, oleh itu akan mempertimbangkan untuk melaksanakan OLSR protokol. Dalam projek ini, saya memfokuskan skop kajian saya hanya di kawasan yang sesak seperti lampu isyarat yang macet dan bandar besar dengan banyak pengguna.

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CHAPTER 1

INTRODUCTION

1.1 Background

1.1.1 Vehicular Ad-hoc Networks (VANET)

Vehicular Ad-hoc Networks (VANETs) are a rapidly developing and demanding class of mobile ad hoc networks (MANETs). VANETs are distributed, self-organizing communication networks formed by moving vehicles and are therefore characterized by very high node mobility and restricted levels of freedom in the patterns of mobility. Ad hoc routing protocols must also adapt to these inconsistent situations on an ongoing basis, as a result of increasing efforts to develop communication protocols relevant to vehicular networks.

When testing routing protocols for VANETs, one of the essential aspects is the use of mobility models that represent the real actions of vehicular traffic as closely as possible. Following the recent interest in realistic VANET mobility models, new studies have been published on performance assessments of VANETs in urban or highway traffic conditions. Their models, however, were very limited, especially the macro-model, which also limited their results in reach.

In this paper, this project's objective is to evaluate OLSR in congested area environment. In my condition, I will instruct how I manage and operate using NS2 to show OLSR is a better routing protocol for VANETs depends on my scenario.

1.1.2 Optimized Link State Routing (OLSR) Protocol

OLSR is a proactive link-state routing protocol designed for MANETs (VANETs), which show low bandwidth and high mobility. OLSR is a type of classical link-state routing protocol that relies on employing an efficient periodic flooding of control information using special nodes that act as multipoint relays (MPRs). The use of MPRs reduces the number of required transmissions.

OLSR daemons periodically exchange different messages to maintain the topology information of the entire network in the presence of mobility and failures. The core functionality is performed mainly by using three different types of messages:

1) HELLO; 2) topology control (TC); and 3) multiple interface declaration (MID) messages.

1) HELLO messages are exchanged between neighbour nodes (one-hop distance). They are employed to accommodate link sensing, neighbourhood detection, and MPR selection signalling. These messages are generated periodically, containing information about the neighbour nodes and about the links between their network interfaces.

2) TC messages are generated periodically by MPRs to indicate which other nodes have selected it as their MPR. This information is stored in the topology information base of each network node, which is used for routing table calculations. Such messages are forwarded to the other nodes through the entire network. Since TC messages are broadcast periodically, a sequence number is used to distinguish between recent and old ones.

3) MID messages are sent by the nodes to report information about their network interfaces employed to participate in the network. Such information is needed since the nodes may have multiple interfaces with distinct addresses participating in the communications.

Topological packet dissemination is performed by spreading TC packets using optimized diffusion or MPRs. The TC message packet contains a list of links in the network node neighbourhood. The OLSR protocol also takes into consideration all interfaces that are connected to the MID message node. Thus, the nodes are able to effectively use all available routes, regardless of the type of each hop. One of the network's interface addresses will be selected as the main address and being used as a reference in control messages. In addition, HNA messages are used outside of MANET for subnet and host declaration reasons. A node acting as a gateway will render the subnetworks and hosts available.

During the normal diffusion of the message, the main objective of MPRs is to reduce the amount of redundant or unneeded transmission. For the transmission of control messages over the network, MPRs are especially useful. The MPRs optimize the classical diffusion mechanism implemented in the link state protocol. A group of MPRs is selected by a given node based on two-hop neighbourhood knowledge. The MPRs had to be recalculated every time the two-hop neighbour set experiences changed in the MANET network with topology that changes randomly. For this reason, the status of MPRs in the neighbourhood is set for a limited time.

1.2 Problem Statement

As the wireless technology is improving and intensive research is being conducted on VANETs. Many vehicle that jammed in a one single road like on traffic light can cause the network traffic become congest. This happened because the usage of many user that still rely on the same access point can. From that, suitable routing protocol like OLSR is needed to overcome network congestion problem. The sharing of data between user when using vehicular ad hoc network will be created. So that data of network configuration and sharing path can be established. Various parameters such as Packet Delivery Ratio, Routing Overhead and Average Delay is used in this paper to verify the network performance.

1.3 Objective

1. To study OLSR (Optimized Link State Routing) protocol to be used in VANET in congested area.
2. To design simulation model that can analyze the behavior of OLSR in VANET in congested area.
3. To evaluate the performance of VANET ad hoc network for congested area using NS2

1.4 Scope

Evaluate the performance of OLSR routing protocol in VANET in terms of Packet Delivery Ratio, Routing Overhead and Average Delay scenario using NS2 on congested area.

1.5 Limitation of work

This project is difficult to analyze bigger area with more access point. Next, it’s also difficult to combine with mobility scenario.

1.6 Summary

The background, VANET introduction, problem statement, objective, scope and limitation were covered by this chapter. Because of the presence of VANET, developing this research project as a contribution to VANET's field is promising in terms of education.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is a text of scholarly paper, which included in the current knowledge include substantive findings, as well as a theoretical and methodological contribution to a related works. There are a few researches related to Performance Analysis of OLSR Routing Protocol in VANET For Highly Congested Area.

2.2 Related Works

The ad hoc routing protocol is considered to be the convention and the typical term for defining the protocol that helps to determine which paths to route packets in VANET between the source and destination of computing devices. In ad hoc networks, nodes do not have knowledge of their network topology. Routing can be a challenge for VANET due to the existence of limited resources and random node movement. In order to solve the situation and an optimal route from the origin node needs to be selected.

In a research paper "Performance comparison of AODV and OLSR in VANETs urban environments under realistic mobility patterns" from Jérôme Härri, Christian Bonnet and Fethi Filali. In this paper, they evaluate AODV and OLSR performance in realistic urban scenarios. They study those protocols under varying metrics such as node

mobility and vehicle density, and with varying traffic rates. They configure Vehicular Mobility Model (VMM) to model urban environment then evaluate the performance of AODV and OLSR in terms of in terms of Packet Delivery Ratio (PDR), Control Traffic Overhead (RO), Delay, and Number of Hops. They test AODV and OLSR in three different conditions (i) variable velocity (ii) variable density (iii) variable data traffic rate. In that papers, they consider squared urban areas of 1000x1000m constituted of three different cluster categories: downtown, residential and suburban. The result from the simulation shows that OLSR outperform AODV in the most of the tests because OLSR, a proactive protocol, is more fitted to VANET than reactive ones.

In a research paper from Neeraj Sharma and Jawahar Thakur titled "Performance analysis of AODV & GPSR routing protocol in VANET" make a perform analysis the AODV & GPSR routing protocol used in VANET and conclude them. The routing protocols that chosen for the performance analysis is Ad hoc on demand distance vector routing (AODV) and Greedy Perimeter Stateless Routing (GPSR). The network stimulation is split into 3 different scenario which is packet delivery ratio, delay of first data packet and Normalized routing load for city and highway scenario. The packet delivery ratio for city and highway scenario in which AODV performs well at low and medium density of vehicle but as the density increase the performance of AODV decreases on the other hand PDR of GPSR is less than AODV but improves as density of vehicles increases. the delay of first data packet in which GPSR perform better than AODV in both scenarios. In case of AODV as the density of vehicle increases its delay is also increases. Normalized Routing Load (NRL) of AODV and GPSR is increasing with increase in the vehicular density, but GPSR have low NRL than AODV. The simulation outcome concludes that AODV is well suited in VANET where packet ratio is very important and vehicular density is low but

not in application where quick response time is required and GPSR performed well in geographically sparse network having high vehicular density.

Lastly, Muhammad Rizwan Ghori, Ali Safa Sadiq and Abdul Ghani conducted "VANET Routing Protocols: Review, Implementation and Analysis". In this paper the authors investigate and studies related to the routing protocols to judge which one is the best for video applications in VANET. Author study those protocols under varying metrics such as Delay and Throughput. The network stimulation is split into two different scenarios which is Simple VANET scenario that have two parts having 20 and 40 nodes (mobile stations) respectively and given them the random trajectories for the movement while the other one is Complex VANET scenario that added the road side units (RSU) along with 20 nodes. The parameter that been test on both scenario are Maximum Simulation Time equal to 1 Hour, Environment size is 100 X 100 km, the Mobility is Random way point, Speed is 10 km/ hour, Type of Traffic are FTP and HTTP and The Routing Protocol used are AODV and DSR. From the result of simulation, they deduced that lot of effort is required to get a good quality video streaming in VANET and AODV again is proven to be better for video applications. Both the aforementioned situations have shown that AODV performance is far better than the DSR.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is the outline of the way a process or task will be carried out. The methods and alternative methods used from the beginning to the end of the following project are discussed in this chapter. There will also be discussion about the simulation of the project. The method used to stimulate network scenario is the NS2 Simulator. In addition, the research methodology and flow chart of the project will also be reviewed in this chapter.

3.2 Research of Methodology

The preparation and planning of the project is important for the production of the project in the analysis of methodology. There are only a few stages of the technique described, based on the figure below. The first stage involves the detection of issues in the field of science. The issues of VANET in this process are defined for this project. For a better understanding of VANET and the issues that occurred on VANET, the problem statement is defined based on the associated research paper. Designing is the second step. The main aim of the following step is to find the best method for the project to be implemented. For this project, the OLSR routing protocol uses different network density. The next step of the technique is

project simulation. The simulation that will be used in this project will be discussed in the following stage. For this project, the stimulation tool used for this project will be Network Simulator 2 (NS2). The last stage is evaluating the output. There is a need to measure and examine the success metrics of this project. The performance metrics that will be evaluated are packet delivery ratio (PDR), routing Overhead and average Delay.

3.3 Simulation

Due to the constraints of real-life experiments that consume a lot of time and cost, the project simulation is performed in NS2. In current ventures, NS2 is used to improve the OLSR routing protocol. NS2 is one of the styles of simulation used, such as MANET and VANET, in network stimulation. For routing and multicast protocols, it provides emulation for both wired and wireless networks. The Network Simulator is certified under version 2 of the GNU (General Public License) and is commonly known as NS2. NS2 is therefore an even-driven simulator, object-oriented and discrete. It is written in a combination of the programming languages C++ and Octl/tcl. C++ is used in NS2 for the detailed implementation of the protocol and Octl is used for the configuration. This provides the objects of C++ to be controlled from the level of the simulator Otcl. For this project, the NS2 is used because it has the advantage of a large number of available models. Moreover, for the ns2 network emulator, UM-OLSR is an OLSR implementation. Therefore, UM-OLSR will be used in this project to simulate VANET's OLSR routing protocol.

```
Please put /home/akshay/ns-allinone-2.35/bin:/home/akshay/ns-allinone-2.35/tcl8.5.10/unix:/home/akshay/ns-allinone-2.35/tk8.5.10/unix
into your PATH environment; so that you'll be able to run itm/tclsh/wish/xgraph.

IMPORTANT NOTICES:

(1) You MUST put /home/akshay/ns-allinone-2.35/otcl-1.14, /home/akshay/ns-allinone-2.35/lib,
    into your LD_LIBRARY_PATH environment variable.
    If it complains about X libraries, add path to your X libraries
    into LD_LIBRARY_PATH.
    If you are using csh, you can set it like:
            setenv LD_LIBRARY_PATH <paths>
    If you are using sh, you can set it like:
            export LD_LIBRARY_PATH=<paths>

(2) You MUST put /home/akshay/ns-allinone-2.35/tcl8.5.10/library into your TCL_LIBRARY environmental
    variable. Otherwise ns/nam will complain during startup.


After these steps, you can now run the ns validation suite with
cd ns-2.35; ./validate

For trouble shooting, please first read ns problems page
http://www.isi.edu/nsnam/ns/ns-problems.html. Also search the ns mailing list archive
for related posts.

root@akshay-UBPC:/home/akshay/ns-allinone-2.35#
```

Figure 3.1: NS2.35 installed in ubuntu 16.04.

```
cett@cett-VirtualBox:~/ns-allinone-2.35/ns-2.35/olsr$ ls
CHANGELOG         OLSR_printer.h        OLSR_state.h
LICENSE           OLSR_printer.o        OLSR_state.o
OLSR.cc           OLSR_repositories.h   README
OLSR.h            OLSR_rtable.cc        um-olsr_ns-2.29_v0.8.8.patch
OLSR.o            OLSR_rtable.h         um-olsr_ns-2.33_v1.0.patch
OLSR_pkt.h        OLSR_rtable.o         um-olsr_ns-2.34_v1.0.patch
OLSR_printer.cc   OLSR_state.cc         um-olsr_ns-2.35_v1.0.patch
```

Figure 3.2: UM-OLSR is patched into NS2.35.

3.4 Project Framework

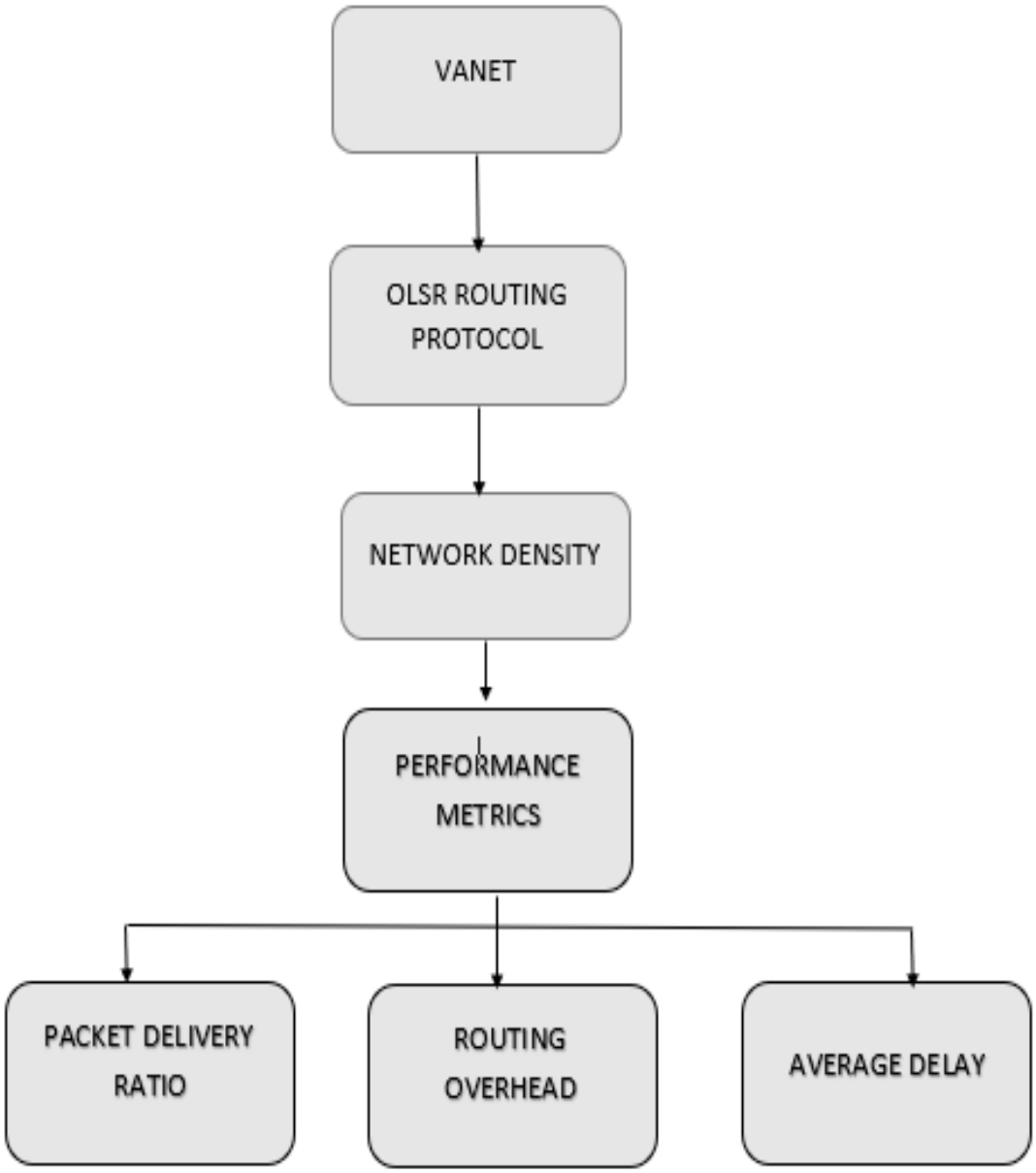

Figure 3.3: Framework of OLSR Routing Protocol.

The OLSR protocol consists of two main mechanisms for topology control, which are neighbourhood detection and neighbourhood sensing. The OLSR protocol uses four types of control messages for each of these mechanisms: HELLO, TC, MID, and HNA. In addition, neighbourhood sensing is done using the HELLO packets by the OLSR protocol. The TC messages contain a list of mobile node neighbourhood ties for OLSR protocol packet management. In addition, through the use of MID messages, the OLSR protocol takes into account all interfaces connected to mobile units. Therefore, all available routes can be used by the network nodes independently of the form of interfaces used on each hop. The TC messages contain a list of mobile node neighbourhood ties for OLSR protocol packet management. In addition, through the use of MID messages, the OLSR protocol takes into account all interfaces connected to mobile units. Therefore, all available routes can be used by the network nodes independently of the form of interfaces used on each hop. The OLSR node chooses one of its interfaces addresses as its main address, which can then be used in control messages as a reference. In addition, HNA messages in the OLSR protocol are used to declare subnets and hosts that are accessible by a node acting as a gateway outside the VANET.

In neighborhood sensing, a number of information tables are maintained by the OLSR protocol as a derivative of classical link-state protocols. Every time control messages are received and every time they are sent out, the tables are changed. In the cache, the nodes store a number of different tables:

Information tables	Explanation
MPR selector set	It contains all the local nodes that are selected as MPRs in the network.
Neighbour Set	All the neighbour at one hop distance is saved in the following table. It is updated dynamically through link set data. The information involved the symmetric and asymmetric link neighbours is also stored at this table.
Two-hop neighbour set	It contains information which is accessible via one hop paths and this also include the node that inquiry about the information itself. In addition, this table may contain similar information of the same nodes that are appeared in the neighbour set table.

Table 3.1: Table in the cache of the nodes

In addition, HELLO messages in the OLSR protocol have three separate functions. The messages are sent to the neighbor for connection sensing and neighbor sensing at a one hop distance and to the neighbor for the two-hop sensing at two hops apart. Finally, it functions as a sensing MPR selector which declares the network MPRs.

3.5 Project Flowchart of the Route Selection Technique

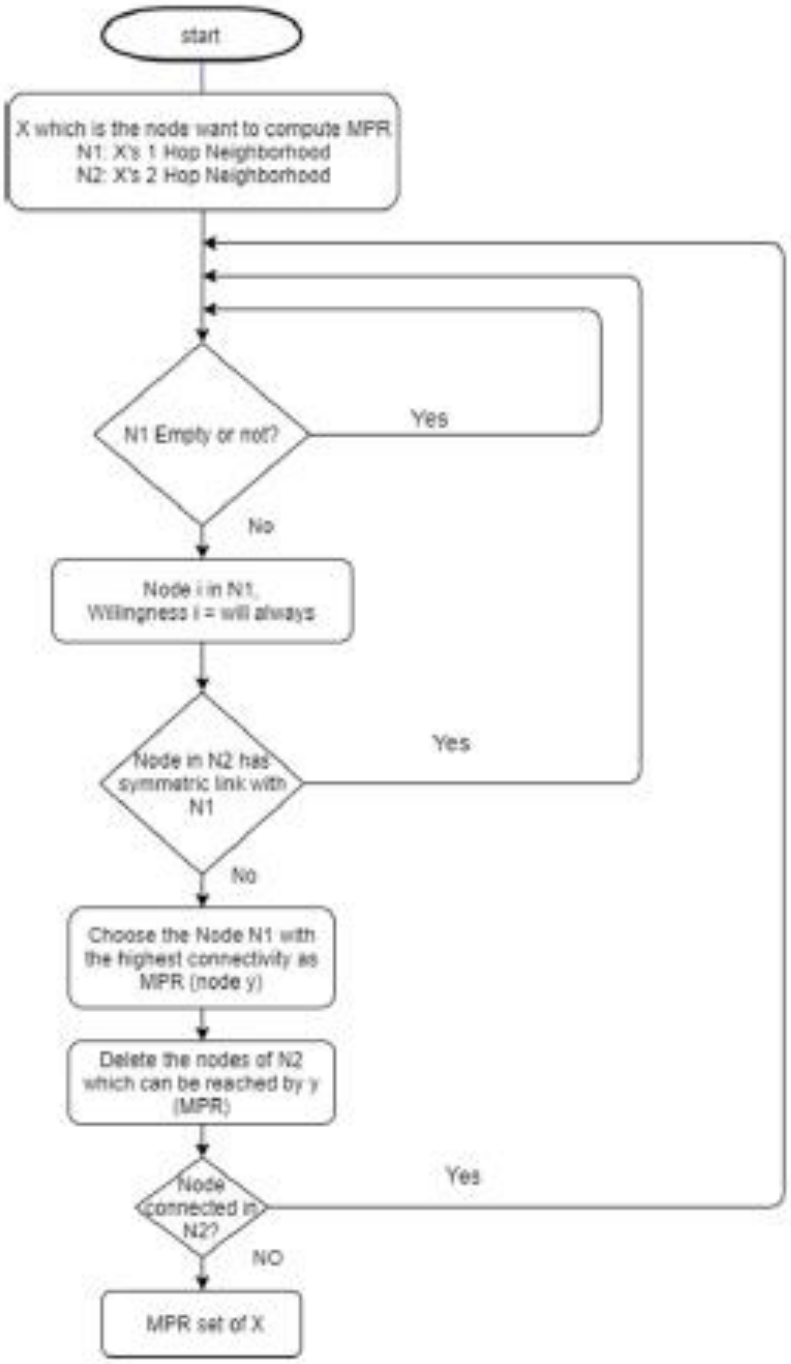

Figure 3.4: Routing Selection Technique (MPR)

OLSR is also recognized as a routing protocol that is proactive and table-driven. Routing loops 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 large amount of traffic. Due to limited resources available in VANET, a large amount of traffic is an undesirable attribute in VANET. 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 authorized in the OLSR protocol and allowed to receive the topological data message. Nevertheless, all these messages can be transmitted through the network only by a limited number of nodes known as multipoint relays (MPRs). The MPRs of the given node are the minimum number of its immediate neighbours who need to contact all of their neighbours in two hops. The MPRs therefore ensure that the network topology data message is received by every node in the network.

3.6 Summary

The following chapter clarifies and demonstrates the concept of the project's research methodology, structure, and flowchart. It provides a better understanding of the simulator we selected for the implementation of this project.

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