

PERFORMANCE ANALYSIS OF WIRELESS MULTI-HOP NETWORK

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To my mother and father,

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ABSTRACT

In recent years, there has been an upsurge of interest in wireless broadband access network in both industry and academic. Wireless Local Area Network (WLAN) allows the user to move around within a local coverage and still be connected to the network. Arising demand of this network leads to the expanding of the network access to poorly serve or highly loaded areas for a wider coverage. Wireless multi-hop networks (WMN) are a promising technology which provides wireless broadband connectivity to the Internet. This study aims at evaluating the performance analysis of wireless multi-hop networks (WMN). A study about the wireless multi-hop networks and simulation software has been done. An implementation model is developed with the objectives to analyze the networks performance parameters including the number of packet (throughput) and average packet delay. A detailed analysis of the results gathered from the simulation runs in Network Simulator 3 (NS3) explain that in wireless multi-hop network, different number of hops results the different throughput and average packet delay.

ABSTRAK

Di zaman globalisasi ini, penggunaan rangkaian akses wayarles sangat penting tidak kira dalam bidang industri mahupun akademik. WLAN membolehkan pengguna untuk bergerak dan masih menggunakan perkhidmatan Internet dalam lingkungan kawasan WLAN tersebut. Disebabkan permintaan yang tinggi terhadap perkhidmatan Internet, perkhidmatan ini telah tersebar hingga ke kawasan pedalaman dan kawasan kurang penduduk untuk liputan yang lebih meluas. Rangkaian Multi-hop Wayarles adalah penyelesaian yang menyediakan Internet melalui sambungan jalur lebar tanpa wayar. Kajian ini dijalankan untuk menilai prestasi rangkaian multi-hop wayarles. Satu kajian tentang rangkaian multi-hop wayarles dan perisian simulasi telah dijalankan. Satu model simulasi telah dibuat dengan harapan untuk menganalisis parameter rangkaian dari segi bilangan paket yang diterima dan purata paket delay. Analisis yang terperinci dari Network Simulator 3 (NS3) menunjukkan dalam rangkaian multi-hop wayarles, jumlah hop yang berlainan akan menghasilkan bilangan paket yang diterima dan purata paket delay yang berlainan.

CONTENTS

CHAPTER	CONTENT	PAGE
	PROJECT TITLE	i
	CANDIDATE’S DECLARATION	ii
	SUPERVISOR AUNTHENTICATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	CONTENTS	viii-ix
	LIST OF TABLE	x
	LIST OF FIGURE	xi-xii
	LIS OF ABBREVIATION	xii
1	INTRODUCTION	
	1.1 Introduction to project	1-2
	1.2 Problem statement	2-3
	1.3 Objectives	3
	1.4 Scope of work	3-4
	1.5 Methodology	4-5
	1.6 Project outline	5

2	LITERATURE REVIEW	
2.1	Literature review	6-8
2.2	Overview of wireless network	8-10
2.3	IEEE802.11 standards	10
2.3.1	IEEE802.11s	11
2.4	Overview of wireless multi-hop network	12-13
2.5	Advantage of WMN	14
2.6	Overview of network simulator	15
2.6.1	Network simulator 2 (NS2)	15-16
2.6.2	Network simulator 3 (NS3)	16-18
2.6.3	Basic commands in NS3	18-19
2.7	Optimized link state routing (OLSR) protocol	19
2.8	Performance parameter : throughput	20-21
2.9	Performance parameter : average packet delay	21
3	METHODOLOGY	22
3.1	Introduction	22-23
3.2	Phase 1 : Literature study	24
3.3	Phase 2 : Simulation of Network Simulator 3	25-27
3.3.1	Point to point network	28
3.3.2	Point to Point by Hanging A Bus network	29-30
3.3.3	Wireless multi-hop network (WMN)	30-33
3.4	Phase 3 : Analysis and discussion	33
4	RESULT AND DISCUSSIONS	34

4.1	Introduction	34
4.2	Point to point analysis	35
4.3	Point to point by hanging a bus analysis	36
4.4	WMN Analysis : NS3 Classes	37-38
4.5	WMN Analysis : Throughput	38-43
4.6	WMN Analysis : Packet delay	43-49
5	CONCLUSION AND RECOMMENDATIONS	50
5.1	Conclusion	50-51
5.2	Recommendations	51
	REFERENCES	52
	APPENDIX	xv-xv

LIST OF TABLE

No	TITLE	PAGE
2.1	IEEE802.11 standards	10-11
3.1	Parameter setting	28
3.2	Parameter setting	30
3.3	Parameters setting	31
4.1	Throughput for different packet size	40
4.2	Result of packet delay	44

LIST OF FIGURE

NO	TITLE	PAGE
2.1	Layout of OPNET scenario	7
2.2	Global average throughput	8
2.3	IEEE802.11 LAN Topology	9
2.4	Wireless Multi-hop network	13
3.1	Flow Chart of Working Principle Phase	23
3.2	Point to Point Network	28
3.3	Point to Point by Hanging A Bus network	29
3.4	Wireless multi-hop network topology	30
3.5	Scenario 1, single hops	32
3.6	Scenario 2, 2 hops	32
3.7	Scenario 3, 3 hops	32
3.8	Scenario 4, 4 hops	33
4.1	Result of Point to Point network	35
4.2	Result of Point to Point by Hanging A Bus network	36
4.3	<i>mypsm.cc</i> script	39
4.4	Results from <i>mypsm.cc</i> script	40
4.5	Throughput for video traffic	41
4.6	Throughput for data traffic	42
4.7	Throughput for voice traffic	42

4.8	Packet delay for video	44
4.9	Packet delay for video with 2Mbps	45
4.10	Packet delay for data	46
4.11	Packet delay for data with 2Mbps	47
4.12	Packet delay for voice	47
4.13	Packet delay for voice with 2Mbps	48

LIST OF ABBREVIATIONS

WLAN	-	Wireless local area network
WMN	-	Wireless multi-hop network
NS3	-	Network Simulator 3
NS2	-	Network Simulator 2
UDP	-	User datagram protocol
LAN	-	Local area network
BSS	-	Basic service set
DS	-	Distribution system
AP	-	Access point
STA	-	Station
IBSS	-	Independent BSS
PHY	-	Physical
MAC	-	Media Access Control
AODV	-	Ad-hoc on demand distance vector routing
DSDV	-	Dynamic distance-sequenced distance-vector routing
OLSR	-	Optimized link state routing

CHAPTER 1

INTRODUCTION

1.1 Introduction to project

Nowadays, internets have become the most important thing in our life. We can get connected through all over the world by using internet access. Wireless local area network (WLAN) provides us the internet access connection through an access point using wireless distribution method. WLAN allows the users to move around within a local coverage and still be connected to the network. Arising demand of this network leads to the expanding of the network access to poorly serve or highly loaded areas for a wider coverage. So, wireless multi-hop network have been created with the additional WLAN access points are connected to wire internet gateways through wireless links to other access points using decentralized architectures.

Wireless multi-hop network (WMN) is a wireless network that formed independently by mobile, wireless network nodes without the use of wired backhaul links. This network's nodes depend on each other's traffic and connections between node pairs because it is formed over multiple transmission hops. The main purpose of

this project is to develop and analyze the performance of WMN. This is done by optimizing certain parameters. The desired parameters such as throughput and average packet delay of the WMN are the parameters that are being considered in order to achieve the desired objectives. The simulation of the development of WMN is done using Network Simulator 3 (NS3). The application of WMN is generally divided into two scenarios which are sensor networks consisting of dedicated devices that provide monitoring or measurement data on their surroundings and ad-hoc networks formed anywhere and at any time, with communication as the primary purpose. This project focused on WMN as ad-hoc networks that perform communication barrier.

1.2 Problem statement

As a senior futurist Thomas Frey predicted in 2006, “ The world of wires has already begun its long descent into oblivion as wireless technology improves to the point where wires become obsolete” (Frey, 2006). Although fibre optics has overwhelming advantages in bandwidth and transmission loss, the cost in installation and maintenance, especially for rural areas, limit their applications in access network services [1]. The present WLAN, IEEE 802.11 interconnections rely on wired networks to carry out bridging functions. For a number of reasons, this dependency on wired infrastructure must be eliminated because :

- This dependency is costly and inflexible, as WLAN coverage cannot be extended beyond the backhaul deployment.
- Centralized structures work inefficiently with new applications, such as wireless gaming, requiring peer-to-peer connectivity.
- A fixed topology inhibits stations from choosing a better path for communication.

Beside, the arising demand of having the ability to communicate wherever and whenever has lead to an inevitable trend in wireless access. So, wireless multi-hop network (WMN) have been created with the additional WLAN access points are connected to wire internet gateways through wireless links to other access points using decentralized architectures. WMN hold the promise to get over the emerging needs.

1.3 Objectives

The purpose of this project are :

- To study in details about the performance of WMN and open source software, Network Simulator 3 (NS3).
- To develop and simulate the WMN model using NS3.
- To analyze the performance of WMN in terms of throughput and packet delay for different type of packet.

1.4 Scope of work

This project will focus on what is the wireless multi-hop network is about and their effect to the internet access network development. Besides, this project also focuses on open source software, Network Simulator 3 (NS3). Using NS3, a wireless multi-hop network's model is developed and simulates in order to analyze the network's performance. WMN for this project is based on WiFi multi-hop network. So, all the

application and class using in NS3 script is based on WiFi. This WMN is applying OLSR routing protocol and sending a User datagram protocol (UDP) packet transmission. This project also will focus on network's throughput and average packet delay by using NS3. From that, the real performance of the actual wireless multi-hop network can be analyzed. The gathered information will allow us to enhance the understanding about wireless multi-hop network. All of these are important in order to make sure that performance analysis of wireless multi-hop network is successfully done.

1.5 Methodology

The method used for achieving the above objectives can be divided into three stages. Firstly, a literature review on the current literature published based on WMN was carried out. Most of the information was collected from the journal, internet web explorer, data based online data, books, manuals and magazines. From the gathered data and information, only the important point are being highlighted and analyzed. This was done in order to identifying the trends and issues, and defining the scope of study. Study on the various type of software such as Network Simulator 2 (NS2) and Network Simulator 3 (NS3) has been done too. It was necessary in order to choose the best and suitable software to develop the basic WMN.

After that, the basic WMN was developed using NS3. Since the goal was to study the performance of WMN, the networks was varied for different number of packets and different data rates. The variations of the network parameters like throughput and average packet delay were taken into consideration in the model. The number of packets was divided into three different types which are data, video and voice. Then, the third stage of the study was to make comparisons and analysis of the results

gathered from the simulations in the previous stage. The performance of the WMN in terms of throughput and average packet delay was analyzed.

1.6 Project outline

The first chapter introduces brief idea of Wireless Multi-hop Network (WMN). This chapter also covered problem statements, detailing the objectives, scopes and methodology of the project.

Chapter 2 provides in depth discussions on the background and literature review on the current state of WMN issues. The literatures on the characteristics, open issues and research trends are reviewed in this filed. This chapter also consists of definition of terms used throughout the report.

Chapter 3 will discuss on project methodology in completing this project. There are three stages that have done in order to complete this project. This chapter explains the flow of the procedure taken throughout the project.

Chapter 4 presents the analysis result obtained from the NS3 simulations. The throughput and average data packet for different scenarios are compared respectively. Then, the result of each scenario was discussed.

In chapter 5, the conclusion of this project was stated and the recommendation for future study in the area of the topic was presented.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

The first paper that was being referred for this project is “Performance evaluation of IEEE 802.15.4 wireless multi-hop networks: simulation and testbed approach” [2]. This paper explains the performance evaluation of IEEE 802.15.4 wireless sensor network for both simulation and testbed. The performance of the network is analyzed in terms of throughput, packet delivery ratio and average packet delay using Network Simulator 2 (NS2). Even though this paper is about the different network from this project, the performance parameter is being referred for this project. The paper is being referred on how they measure the throughput and average packet delay. This paper use NS2, so it’s coding quite complicated since NS2 does not really support wireless network.

Next, “Performance Evaluation of Multihop wireless network” [1] has been referred. This paper does the same project like this project which is performance evaluation of multi-hop wireless network but using OPNET. For this paper, the

comparison of different simulators has been referred. Different simulators have their advantages and disadvantages. OPNET has a layout of the scenario like Figure shown below :

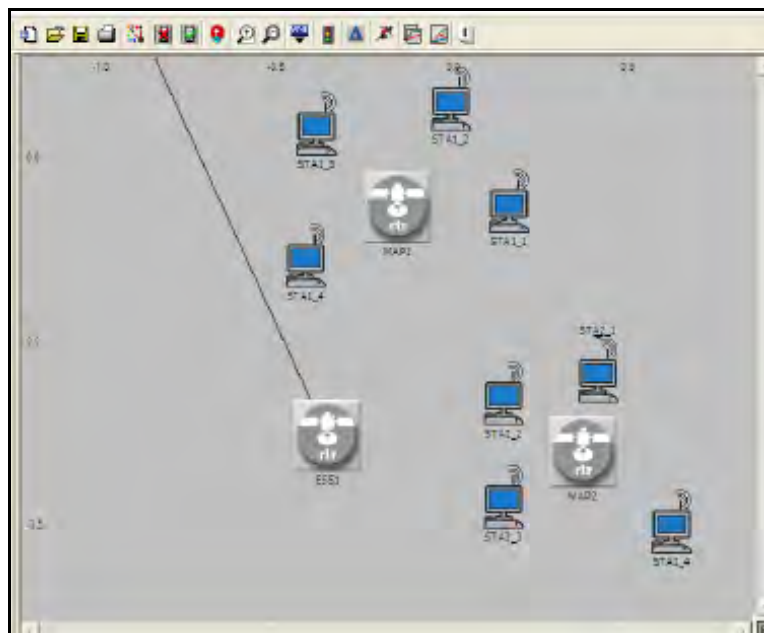


Figure 2.1 : Layout of OPNET scenario

This paper also covers the wireless multi-hop network, so there is a lot of information can be referred from this paper. The result of throughput like Figure 2.2 and delay also can be compared.

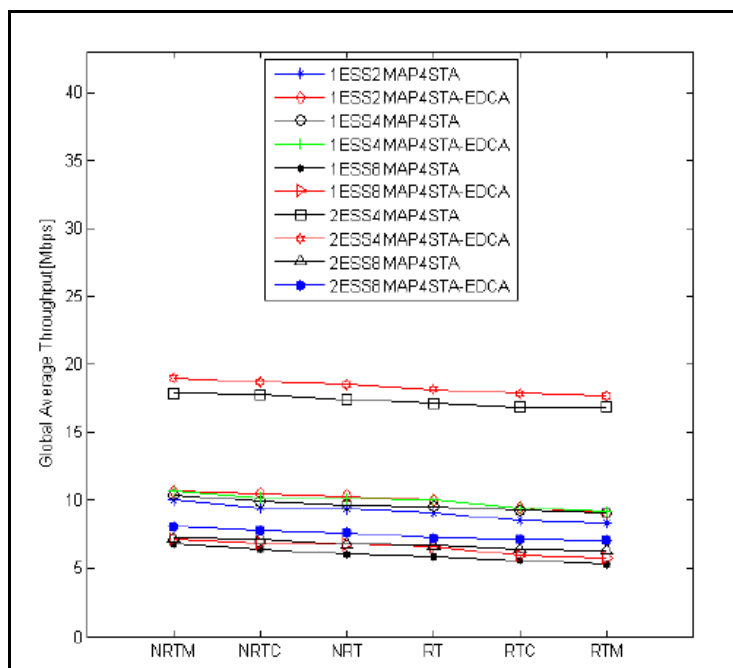


Figure 2.2 : Global average throughput

Third technical paper that has been referred is “Throughput Analysis of IEEE802.11 Multi-hop Ad hoc Networks” [3]. This paper focuses on the throughput analysis of IEEE802.11 Multi-hop Ad hoc networks. To verify the simulation results, it set up a real 6 node multi-hop network using NS2. The experimental measurements confirm the existence of the optimal offered load.

2.2 Overview of Wireless Network

Wireless networks based on IEEE802.11 standards have fundamental characteristics that make them significantly different from traditional wired LANs. The

Physical (PHY) layer used in IEEE802.11 is different from wired network. Figure 2.3 below shows the IEEE802.11 LAN topology [1] :

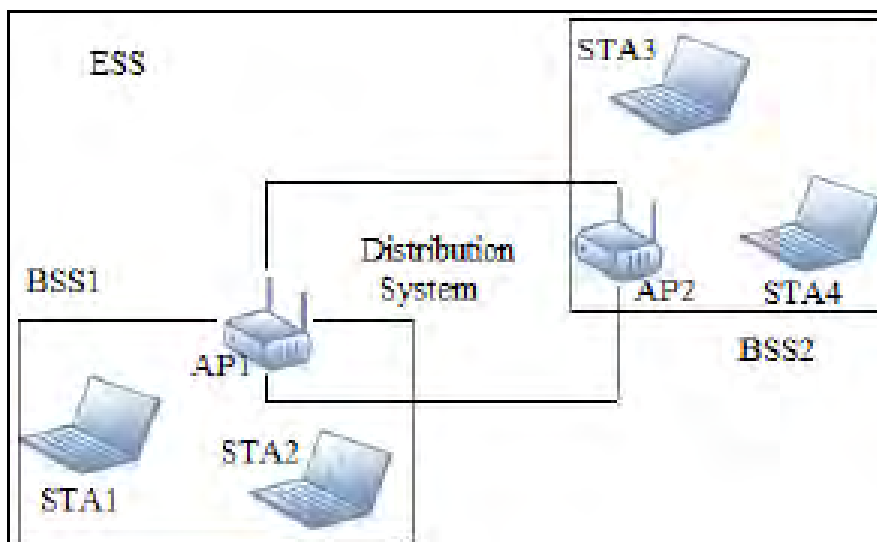


Figure 2.3 : IEEE802.11 LAN Topology

The concept of service set is the basis of the different types of wireless LAN topologies. Service set is a grouping of devices that access the network by broadcasting a signal across a wireless radio frequency (RF) carrier. Basic service set (BSS) is a stations competing for access to shared wireless medium. BSS usually isolated or connected to backbone distribution system (DS) through access point (AP). Figure 1 above shows two BSS where each of them has two station (STA). The two stations in BSS communicate to each other via AP which acts as relay and AP also act as a bridge to the DS.

Independent BSS (IBSS) occurred when all stations in the BSS are mobile station and no connection to other BSS. Typically an ad hoc network, all stations communicate directly and no AP is involved. While extended service set is the most