

DEPLOYMENT OF INDOOR TEST-BED DEPLOYMENT FOR WIRELESS
MESH NETWORK USING D-LINKS ROUTER

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Tajuk Projek : DEPLOYMENT OF INDOOR TEST-BED DEPLOYMENT
FOR WIRELESS MESH NETWORK USING D-LINKS
ROUTER

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Specially dedicated to

My beloved parents, brother, sister and my lover who have encouraged, guided and
Inspired me throughout my journey of education

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ABSTRACT

The work is based on measurement of the 802.11n Wireless Mesh Network (WMN) deployed over the FKEKK indoor main building. This project was built inspired by the existing technology which is a solution need to do instead a lots of wire need to be use at the certain area to extends the wireless coverage. It may create traffic of wire amount in (private automatic branch section room (PABX). This scenario will increase the development cost. If any failure happen at one of the router, it will be difficult to connect the wire among them. This way would be a disadvantage for the connection and cannot be used in the future. The coverage area can be widening without using wire as the connection medium if mesh connection are being use. This method has been proven that it can compete with the existing wire technology which is maintaining the throughput ($>1\text{Mbps}$). Statements above was supported by the test-bed process, which is data were collected and analyzed specifically in order to make sure the theory was proved scientifically. It uses a present version of the TCP and UDP protocol from IXchariot software that actually contained in a transport layer (run over IP packet). Test result prove that the mesh network performance has been maintained ($>1\text{mbps}$) during the data transfer process from server to the several client that located at several distance with range 1meter to 15 meter. A part from that, the transfer speed (server to client) is inversely proportional with the distance. It is because; transfer speed will slightly decrease when the distance is increase. The network performance is decrease when client located in the obstacle area such as behind the brick and table. At this part, the throughput will decrease about 40 to 50% compared with the measurement without obstacle.

ABSTRAK

Aktiviti ini berdasarkan ukuran rangkaian wayarles mesh yang dibina di sekitar bangunan utama FKEKK. Ia menggunakan TCP dan UDP versi terbaru daripada perisian IXchariot yang terkandung di lapisan transport (beroperasi ke seluruh paket IP). Wujudnya projek ini adalah kerana banyak dipengaruhi oleh teknologi yg sedia ada, dimana seperti sedia maklum, untuk membesarkan jalur wireless sesebuah kawasan itu memerlukan medium penghubung yang banyak iaitu wayar menyebabkan kesesakan bilangan wayar dalam PABX (private automatic branch section room). Keadaan ini juga secara tidak langsung memerlukan kos yang tinggi dalam membangunkan teknologi ini. Kelemahan pada teknologi berwayar ini juga menjadi antara pendorong utama dalam pembangunan projek ini, untuk kaedah sambungan menggunakan wayar sesebuah perhubungan antara router-router tidak boleh disambung semula jika berlakunya kerosakan pada salah sebuah router yang berada dalam talian tersebut. Kaedah penyambungan secara mesh digunakan kerana ianya dapat membesarkan liputan disesebuah kawasan tanpa memerlukan wayar sebagai medium penghubung. kaedah ini juga terbukti dapat menyaingi kaedah sedia ada di mana dapat menyamai keupayaan teknologi wayar iaitu mengekalkan throughput ($> 1\text{Mbps}$). Pernyataan diatas dapat dibuktikan dengan melakukan process test-bed dimana data akan dikumpul dan dianalisis secara terperinci bagi memastikan sesebuah teori yang dipelajari terbukti secara saintifik. Keputusan ujian telah membuktikan bahawa rangkaian mesh kekal ($>1\text{mbps}$) sepanjang proses penghantaran data daripada server kepada beberapa klien yang berada di tempat yang berbeza. Selain itu, kelajuan proses penghantaran data adalah berlawanan dengan jaraknya. Ini adalah kerana kelajuan penghantaran akan menurun apabila jaraknya meningkat. Keputusan juga menunjukkan apa yang akan terjadi apabila klien berada kawasan terhalang seperti di belakang meja atau dinding batu. Ini akan menghasilkan penurunan sebanyak 40 hingga 50 peratus pada ‘Throughput’ berbanding dengan keadaan tanpa halangan.

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LIST OF ABBREVIATIONS

HTTP	-	Hyper Text Transfer Protocol
IPV4	-	Internet Protocol Version 4
IP	-	Internet Protocol
LAN	-	Local Area Network
LOS	-	Line of Sight
MANET	-	Mobile Ad-Hoc Network
NLOS	-	Non-Line of Sight
PABX	-	Private Automatic Branch Exchange
QoS	-	Quality of Services
TCP	-	Transmission Control Protocol
TFTP	-	Trivial File Transfer Control
UDP	-	User Datagram Protocol
WMN	-	Wireless Mesh Network
WEP	-	Wire Equivalent Privacy
WPA	-	Wi-Fi Protected Access

CHAPTER I

INTRODUCTION

This chapter briefly explain the overview of the research, the problem statement that involved in wireless mesh network especially for indoor environment, clearly describe about the objective that want to achieve and scope of the project will define the significance of the research and also for the project application to the current environment.

1.1 Introduction

Wireless communication technologies continue to undergo rapid advancement. The attractiveness of Wireless Mesh Networks (WMN)s, in general, can be attributed to their characteristics the ability to dynamically self-organize and self-configure, coupled with the ability to maintain mesh connectivity, leads in effect to low set-up/installation costs, simpler maintenance tasks, and service coverage with high reliability and fault-tolerance. As a result, WMNs have found many useful applications in a broad range of domains. WMNs represent a key technology for future generation wireless networks, and this broad-ranging to address the challenges in future [6].

The emerging Wireless Mesh Networks (WMN) is a broadband access technology with the properties of multi-hop and self-organization, which has advantages of easy deployment, self-recovering, low cost and high scalability. Their capability of self-organization significantly reduces the complexity of network deployment and maintenance [6].

The wireless local area network standard IEEE 802.11 is the preferred solution for low-cost data services. A WMN is an IEEE 802.11 based hybrid network of wireless nodes and can be considered a variant of a Mobile Ad-hoc Network (MANET). Key to its success are the 2.4 and 5 GHz unlicensed bands. The transmit power limitations imposed due to regulatory requirements limit the range (coverage) that can be achieved by WLANs in these bands [6].

Basically, this project is using router D-link DIR-615 as a device. It is also need collaboration from open source firmware, called as DD-WRT .It use as an additional source code that will be inserted into router d-link which is related to WMN.

This project also introduces related works of wireless mesh networks, then describes the deployment of a real indoor test-bed Mesh architecture and click based implementation including hardware platform, software platform and system

integration and then presents real test-bed performance evaluation and analysis, finally it gives conclusions and future remarks.

1.2. Objective

The objectives of this project that need to achieve are;

- i. Create an 802.11 mesh benchmark test-bed using off-the-shelf equipments (D-Link router & dd-wrt firmware).
- ii. Extend the coverage area based on power transmit that configure in the router.
- iii. Investigate the network performances in indoor scenario in term of throughput for TCP and UDP protocol service.
- iv. Compare and evaluate critically the obtained network performances of indoor scenarios planned.

1.3. Problem Statement

Nowadays, router has been connected with each other only using LAN cable or wire and it just using plug and play method to connect the router devices. Meaning that, it required less configuration on router devices or make any programming. Even though there are lots of advantages using LAN, there is some weakness in the system:

- i. Customer at router A will disconnected when router A is not functioning, compared with WMN that automatically connected switch to another router that nearest to the router range.
- ii. Current methods highly cost inefficient and ad-hoc connection between router and client.

- iii. Easily expose to the cable damage, such as broken wire because of catastrophe.
- iv. Long Distance WiFi network deployments envisaged.

Other than that, Wireless Mesh Network is an application technology different from the traditional peer-to-peer wireless bridge, it provides the multi-hop and multi-path connection to form a wireless environment of MESH framework so that the occurrence of single point of failure can be prevented. Under the traditional mode of wireless bridge, if something wrong happens to just one of nodes, the whole network will be affected at once, with the result that data transmission cannot proceed continually.

1.4. Scope of Project

This project is Network performance TCP & UDP of indoor test-bed deployment for mesh wireless network. Basically this project involves with hardware and software part. In this project, the hardware that will be used is router D-Link DIR-615

There is some characteristic had to focus on, in order to make sure the effectiveness of this project, which are range of propagation for the router, speed of transferring data (using wireless method), security of router, minimum requirement (to run the router) and also regarding QoS of the D-Link DIR-615 router.

For range of propagate D-Link router, is normally followed by IEEE standard that using draft 802.11n technology with multiple intelligent antennas reportedly maximizes the speed and range of wireless signals. Other than that, speed of transferring data on the wireless range is 10/100Mbps. It also supported for WPA and WPA standards ensure that you will be able to use the best possible encryption, regardless of your client devices.

The DIR-615 also includes QoS (Quality of Service) Prioritization Technology that analyzes and separates multiple data streams based on sensitivity to delay, enabling multiple applications to stream smoothly across the network.

Secondly, for software that use for this project is DD-WRT. DD-WRT is a Linux based alternative Open Source firmware suitable for a great variety of WLAN routers and embedded systems. The main emphasis lies on providing the easiest possible handling while at the same time supporting a great number of functionalities within the framework of the respective hardware platform used.

This project also makes a several investigation regarding on, throughput capacity and fairness and also reliability and robustness. Otherwise, this project also concern about the differences between existing traffic which are traffic data of TCP and UDP protocol service.

Finally, data collection need to be done to make sure all the possible aspect is true base on the theory by using AirMagnet or IxChariot or Xirrus software.

1.5. Project Interest

Wireless Mesh Networks (WMN) is believed to be a highly promising technology and will play an increasingly important role in future generation wireless mobile networks. This project that commonly use WMN technology actually is characterized by dynamic self-organization, self-configuration and self-healing to enable quick deployment, easy maintenance, low cost, high scalability and reliable services, as well as enhancing network capacity, connectivity and resilience.

Due to these advantages, international standardization organizations are actively calling for specifications for mesh networking modes, e.g., IEEE 802.11. As a great extension to the ad hoc network, WMN is becoming an important mode complementary to the infrastructure based wireless networks. The experiences obtained from studying and deploying WMN provide knowledge and reference to the future networks evolution.

1.6 Methodology Outline

In this part, the project was started by doing research and literature review where it is a process to find out some theory that related to project. The theories that find out are about wireless mesh network topology that is used in this project and other basic knowledge that need to know is the actual meaning of throughput measurement and transmission control protocol and user datagram protocol services. After that, follow a line of investigation about DD-WRT firmware also made, it's because this free source firmware will functional the D-link DIR 615 as a wireless mesh. Then, hardware architecture needs various research and to know the system requirement.

After all the subject above has been done, the project was continue to 2nd phase whereby need to do some configuration for the router D-link. Actually to make the router mesh between each other, some DD-WRT firmware is need to download to the router. This configuration is called DD-WRT configuration. Further, setup the test-bed for wireless mesh network and checking network connectivity is the next step of the project. This part is to make sure the configuration that does at previous step is done properly. Finally, the 3rd phase of this project is to do investigation of network performance which is covering about the distance, signal propagation and also comparing some protocol services TCP and UDP.

1.7 Report Outline

In this project, there are 5 chapters that need to complete. Firstly, as usual the project is requiring for some introduction, and then it will be located at Chapter 1. In this chapter will briefly explain regarding project overview, objective of the project, problem statement, scope of project, the methodology outline which explain about steps of project and the last one is about application of project to the current environment. After that, research and literature review will be discussed in Chapter 2. The D-link DIR 615 architecture and requirement was state in this chapter. After

that, the methodology of this project will be discussed in Chapter 3 and results will be discussed in Chapter 4. Finally, some conclusion and future work in Chapter 5.

1.8 Project Application

The project that was developed has particular application such as;

i. Home network

This application is known as indoor network. It contains the components for WMN architecture, such as network gateway (internet), access point (router) and mobile node (client) that are located in the indoor area. Apart from that, data sharing can only be done in the indoor area, cannot be shared with outdoor area.

ii. Community network

This network is also known as outdoor network, whereas the routers (access point) are located in the outdoor area (home). The access point needs to be communicated with the nearest access point (router) to ensure the connection is Mesh with each other.

iii. Enterprise network.

Enterprise network is a combination between indoor and outdoor network. It requires WMN architecture elements such as network gateway (internet), access point (router) and mobile node (client) placed in indoor and outdoor areas.

CHAPTER II

LITERATURE REVIEW

This chapter presents about several review paper of wireless mesh network projects and the guidelines in developing of network performance of indoor test bed deployment for mesh wireless. There have 5 review paper of wireless mesh network technology, whereby the papers has been describe about mesh network architecture, protocol and also about the IEEE standard that use in mesh networking. It also describes regarding the user capacity that mesh network can support. Other than that, the paper had made researched on the throughput received power relationship for file transfer protocol (FTP) services in wireless mesh network. Besides that, there are several theories that should be taken into consideration in developing this project, such as test bed rural area where it's a common element in wireless mesh network. Test bed area is some method of measurement throughput of wireless mesh, which is consist of several study node. Others, the D-link Router is use as major mesh hardware component, which is use to extend the coverage in expected area. The software that being use in this project is DD-WRT firmware, where it provide the easiest possible handling while at the same time supporting a great number of functionalities. Lastly, transmission control protocol and user datagram protocol has been use to investigate the network performance, and also investigate which protocol is better

2.1 Review Paper Wireless Mesh Network (WMN)

2.1.1 Wireless Mesh Networking: Architecture, Protocol and Standards

A wireless mesh network (WMN) consists of mesh nodes that form the backbone of the network. [1] The nodes are able to configure automatically and re-configure dynamically to maintain the mesh connectivity. Wireless Mesh Network is defined by dynamic self-organization, self-configuration and self-healing to enable quick deployment, easy maintenance, low cost, high scalability and reliable services, as well as enhancing network capacity, connectivity and flexible. By definition WMN is any wireless network having a network topology of either a partial or full mesh topology, practical WMNs are characterized by static wireless relay nodes providing a distributed infrastructure for mobile client nodes over a partial mesh topology

Table 2.0 shows the different issues between Ad hoc Network and Wireless Mesh Network. This table also stated that wireless mesh network is better than ad hoc network in term of application characteristics which offer for permanent connection. [1]

Table 2.0: Differences between Ad Hoc Wireless Networks and Wireless Mesh Networks [1]

Issue	Wireless Ad Hoc Networks	Wireless Mesh Networks
Network topology	Highly dynamic	Relatively static
Mobility of relay nodes	Medium to high	Low
Energy constraint	High	Low
Application characteristics	Temporary	Semi permanent or permanent
Infrastructure requirement	Infrastructure less	Partial or full fixed

		infrastructure
Relaying	Relaying by mobile nodes	Relaying by fixed nodes
Routing performance	Fully distributed on-demand routing preferred	Fully distributed or partially distributed with table-driven or hierarchical routing preferred
Deployment	Easy to deploy	Some planning required
Traffic characteristics	Typically user traffic	Typically user and sensor traffic
Popular application scenario	Tactical communication	Tactical and civilian communication

2.1.2 Capacity of Wireless Mesh Networks - Understanding Single Radio, Dual Radio and Multi-Radio Wireless Mesh Networks

The wireless mesh infrastructure systems used for creating large Wi-Fi access networks, and examined three different approaches currently available for implementing them.[5] They also stated that mesh networks are different which is the full physical layer connectivity is not required. Mesh network also can be wired or wireless which are all of these approaches had their own advantage and advantages. Those can be used in any application and different stages of network. The wireless link work well when there is no disturb between communication stations. Capacity in a wireless mesh infrastructure is affected by the mesh forwarding performance, shared network contention and self interference of the mesh access points.

Single radio wireless mesh, gave the lowest cost entry point in the operation of a mesh network. It is low capacity and will not effectively scale to implement a complete large network. The dual-radio mesh architecture represents the logical evolution in the growth of a mesh network. Multi-radio mesh systems separate wireless access and backhaul, and use dedicated point-to-point links to form the