DEPLOYMENT OF OUTDOOR TEST-BED WIRELESS MESH NETWORK USING D-LINK ROUTER

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Date :2 MAY 2011

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

This project is about deployment of Wireless Mesh Network (WMN) using D-links DIR 615 router is a communications network made up of radio nodes organized in a mesh topology. Usually WMN used to extend the network coverage and increase more clients that can connect to the network. This project is a bit same with Local Access Network (LAN) network but WMN have more advantages to compare with LAN. Objective of this project is to create an 802.11 mesh test-bed using off-the-shelf equipments with D-Link Router & dd-wrt firmware. Then, investigate the network performances in term of throughput and Received Signal Strength Indicator (RSSI) for outdoor scenarios. RSSI is to measured the strength of an incoming signal. The RSSI is an ability of the receiver to pick the signals that referred as the receiver sensitivity. Higher the receiver sensitivity is better. If the signal strength is good the output the throughput is higher and if the signal strength is poor its will effected the throuhgput. This project can solve the problem that usually occurred such as no self-healing network when router is brake down, and limited network coverage for big area.

ABSTRAK

Projek ini adalah berkenaan penempatan *Wireless Mesh Network (WMN)* yang menggunakan D-links DIR 615 penghala ialah satu rangkaian komunikasi membuat nodus radio tersusun dalam topologi jaring. Biasanya WMN digunakan untuk melanjutkan liputan rangkaian dan meningkatkan lebih banyak pelanggan yang boleh disambungkan kepada rangkaian. Projek ini juga lebih kurang sama dengan *Local Access Network (LAN)* tetapi WMN mempunyai lebih banyak kelebihan membanding dengan LAN. Matlamat projek ini ialah untuk mewujudkan untuk menwujudkan 802.11 jaring platform ujian dengan menggunakan peralatan-peralatan yang sedia ada seperti D-Link Router & dd-wrt perisian. Kemudian, menyiasat prestasi rangkaian dalam istilah kekuatan daya pemprosesan *(throughput)* dan isyarat yang diterima penunjuk *(RSSI)* untuk senario-senario luar. RSSI ialah untuk mengukur kekuatan satu isyarat yang diterima. RSSI ialah satu kemampuan penerima memilih isyarat-isyarat yang merujuk sebagai kepekaan penerima. Jika kekuatan isyarat baik keluaran daya pemprosesan adalah tinggi adalah dan jika kekuatan isyarat lemah, keluaran kekuatan daya pemprosesan akan terganggu . Projek ini dapat menyelesaikan masalah yang biasanya berlaku seperti tiada rangkaian sembuh sendiri apabila penghala rosak , dan mengehadkan liputan rangkaian untuk kawasan luas.

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LIST OF ABBREVIATIONS

MWN	-	Wireless Mesh Network
MANET	-	Mobile Ad hoc Networks
RSSI	-	Received Signal Strength Indicator
LAN	-	Local Area Network
WLAN	-	Wireless Local Area Network
AP	-	Access Point
FHSS	-	Frequency-Hopping Spread Spectrum
DSSS	-	Direct-Sequence Spread Spectrum
LOS	-	Line Of Sight
NLOS	-	Non Line Of Sight
IP	-	Internet Protocol
WDS	-	Wireless Distribution System
TCP	-	Transmission Control Protocol
UDP	-	User Datagram Protocol

CHAPTER I

INTRODUCTION

This chapter is briefly explained about the project description. This chapter covered about background, objective, scope problem statement and the outline of this project.

1.1 Project Background

A Wireless Mesh Network (WMN) is a communications network made up of radio nodes organized in a mesh topology. Wireless mesh networks often consist of mesh clients, mesh routers and gateways Wireless networks are great for extending network and Internet connections through buildings, campuses, and other spaces. But even though the technology frees users from needing to connect wires from their computer to the network, the wireless routers and access points must ultimately connect to the underlying network over Ethernet cables. Thus, a big challenge in any wireless deployment is running the wires to the wireless equipment, often in areas without power and certainly without Ethernet connections.

Mesh networking is a type of networking wherein each node in the network may act as an independent router, regardless of whether it is connected to another network or not. It allows for continuous connections and reconfiguration around

broken or blocked paths by "hopping" from node to node until the destination is reached. A mesh network whose nodes are all connected to each other is a fully connected network. Mesh networks differ from other networks in that the component parts can all connect to each other via multiple hops, and they generally are not mobile. Mesh networks can be seen as one type of ad hoc network. Mobile ad hoc networks (MANET) [4] and mesh networks are therefore closely related, but MANET also have to deal with the problems introduced by the mobility of the nodes. Mesh networks are self-healing therefore the network can still operate when one node breaks down or a connection goes bad. As a result, the network may typically be very reliable, as there is often more than one path between a source and a destination in the network

The WMN is one of the communication topology by using wireless as the transmission line. Previously, this communication use wired to connected each other but differ now with the WMN that use wireless to connect and to transmit the data. Advantages use the WMN because this topology is self-healing, low cost of infrastructure, self-forming and many more. This WMN is followed the IEEE 802.11 a/b/g standard that related with wireless communication network. This standard tells about the specification of the WMN such as the range of the distance, frequency use and many more. This project basically to created the test bed deployment for this wireless mesh network. The important thing is create network more effective and increase the performance of wireless communication.

1.2 Objective Project

Objective of this project is to create an 802.11 mesh test-bed using off-the-shelf equipments with D-Link and dd-wrt firmware. Then, investigate the network performances in term of throughput and Received Signal Strength Indicator (RSSI) for outdoor scenarios.

1.3 Problem Statement

Wireless Mesh Network is the network that consist the multiple hops that connection each other by using wireless medium. The main objective of mesh topology is to extend the coverage of LAN network. But extend the network using LAN is expensive because need to spent to the equipment and averhead cost such cable cost. This is not practical for long distance deployment. Before this, coverage for wireless network is limited and the signal is low for some placed.

Besides that, the test-bed made is to know the effect obstacle, interference, and distance to the network performance. Interference is the major factor the influencing the performance of throughput. Test- bed is chosen to see the effect of the interference, obstacles, and channel management. This test-bed is the plan of the network before implement in the real environment. So, the target of this mesh network deployment is to improve the wireless network performance with low cost budget.

1.4 Scope of Project

This project used type router D-link DIR- 615 and the distance of coverage up to 100 meter with 802.11n wireless clients. System requirement for configured this router is Ethernet based cable or DSL modem, Computer with Windows with an installed Ethernet adapter, Mozilla Firefox and above for configuration and Installation Wizard requires Windows 7.

This project also uses open source firmware is dd-wrt firmware. DD-WRT is a third party developed firmware released under the terms of the GPL for many IEEE802.11a/b/g/h/n wireless routers based on a Broadcom or Atheros chip reference design. After configuring the hardware, Project need to test and consider the throughput performance and Received Signal Strength Indicator (RSSI).

Then, the throughput of wireless mesh network performance and RSSI is measured by using "Ix Chariot" software and inSSIDer 2.0 software. After that, throughput and RSSI will be considered for the difference geography of outdoor topology. Location of test-bed deployment is at FKEKK building in University Teknikal Malaysia Melaka.

1.5 Methodology

This project starts with literature review about mesh topology, hardware and firmware used to measure network performance. The literature also covered about the effect of interference in the wireless communication done by study the papers, journals and books that related to this project.

Next, dd-wrt is flash into the D-link router to make the router has a mesh function. Then, the network was deployed at the FKEKK building. After done configure the network, the throughput and RSSI was measured. Then, analyze the result of measurement to know the performance of this network.

1.6 Report Outline

This report is consisting of 5 chapters. The following paragraph will elaborate briefly about the content of each chapter.

Chapter I of this report explains the project overview, problem statement, objectives, and scope of project.

Chapter II gives the literature review on the importance source that is related to the project and explanation of each software and method used in project.

Chapter III is the methodologies that describe the flow chart of the project implementation and explanation of process to measure the throughput and RSSI.

Chapter IV is the project main focus which explained and showed the project result and analysis.

Chapter V point out the conclusion of the project including the problem encountered throughout the project implementation and the future work consideration.

CHAPTER II

LITERATURE REVIEW

This chapter discuss about the all theory that need to study before deployment the network. The literature review consists of wireless mesh topology, hardware description, dd-wrt firmware and many more.

2.1 Wireless Mesh Topology

A wireless mesh network can be seen as a special type of wireless ad-hoc network. It is often assumed that all nodes in a wireless mesh network are immobile but this need not be so. The mesh routers may be highly mobile. Often the mesh routers are not limited in terms of resources compared to other nodes in the network and thus can be exploited to perform more resource intensive functions. In this way, the wireless mesh network differs from an ad-hoc network since all of these nodes are often constrained by resources. Other advantages of mesh networks are the ability to self organize, auto-conFigure and self-healing [1].Table below show the comparison between wireless mesh and Wired LAN.

Table 2.1: Comparison between Wireless mesh and wired network

	Wireless Mesh	Wired
	Wireless Communication	Wired Communication
	Infrastructure based	Infrastructure based
	Usually Mains Powered	Mains Powered
	Usually Permanent	Permanent

2.1.1 Network structure

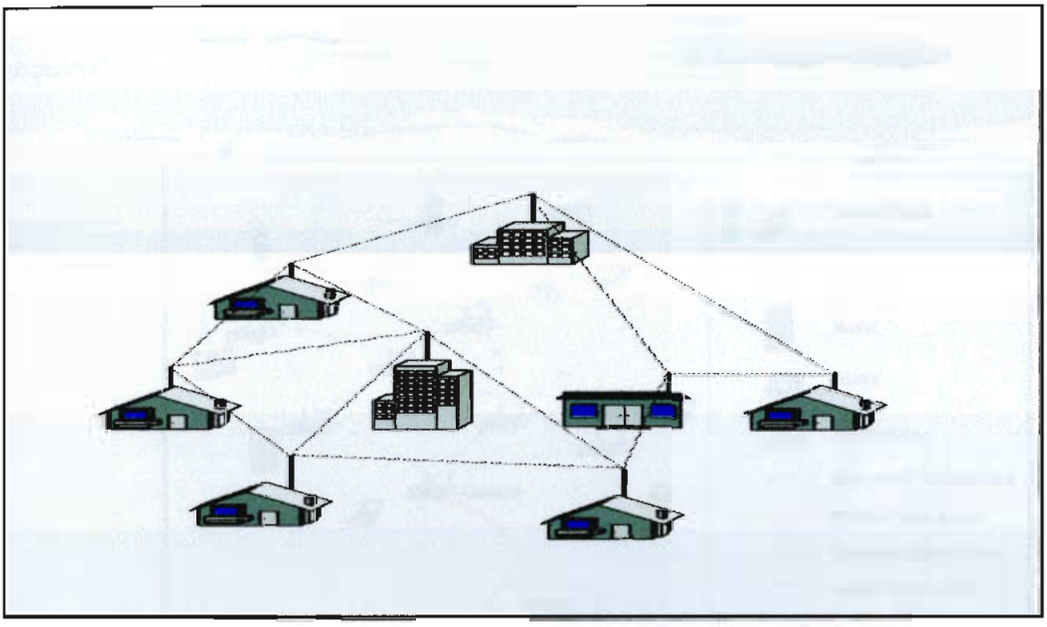

Figure 2.1: Wireless Mesh Network Topology

2.1.2 Architecture

Wireless mesh architecture show in Figure 2.1 is a first step towards providing high-bandwidth network over a specific coverage area. Wireless mesh architectures infrastructure such shown in Figure 2.2 is a router network minus the cabling between nodes. It's built of peer radio devices that don't have to be cabled to a wired port like traditional WLAN access points (AP) do. Wireless communication is without a doubt a very desirable service as emphasized by the tremendous growth

in both cellular and wireless local area networks (WLANs) (primarily, the ones that are compliant with the IEEE 802.11 family of standards, popularly known as Wi-Fi). However, these two radically different technologies address only a narrow range of connectivity needs, and there are numerous other applications that can benefit from wireless connectivity. The cellular networks offer wide area coverage, but the service is relatively expensive and offers low data rates: even the third generation of cellular networks (3G) offers low data rates up to 2Mbps compared to WLANs up to 50Mbps for IEEE 802.11a and 802.11g and approximately 100Mbps for proprietary solutions at the time of this writing. On the other hand, the WLANs have rather limited coverage and the associated reduced mobility. Furthermore, in order to increase the coverage of WLANs, a wired backbone connecting multiple access points is required.

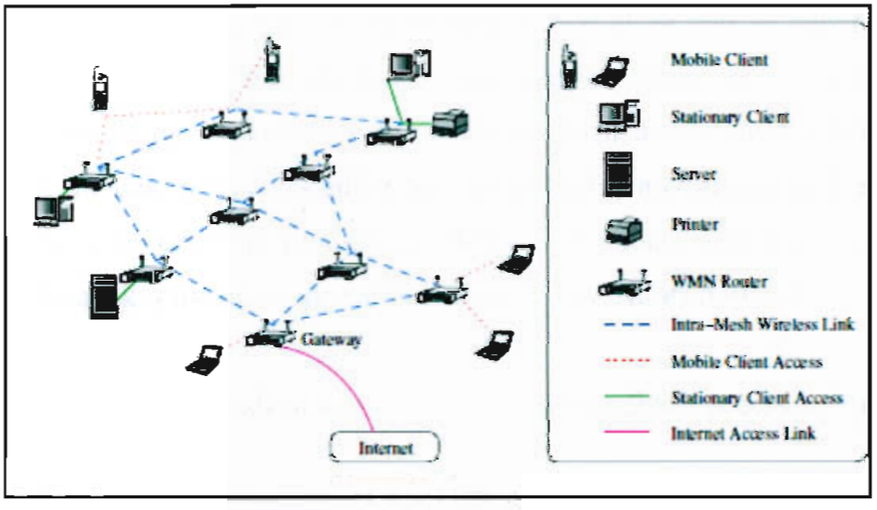

Figure 2.2: Network Architecture

Example of three types of wireless mesh network

- Infrastructure wireless mesh networks: Mesh routers form an infrastructure for clients.
- Client wireless mesh networks: Client nodes constitute the actual network to perform routing and configuration functionalities.
- Hybrid wireless mesh networks: Mesh clients can perform mesh functions with other mesh clients as well as accessing the network.

Wireless mesh networks have a relatively stable topology except for the occasional failure of nodes or addition of new nodes. The traffic, being aggregated from a large number of end users, changes infrequently. Practically all the traffic in an infrastructure mesh network is either forwarded to or from a gateway, while in ad hoc networks or client mesh networks the traffic flows between arbitrary pairs of nodes

2.1.3 Advantages of WMN

The principle is similar to the way packets travel around the wired Internet data will hop from one device to another until it reaches its destination. Dynamic routing algorithms implemented in each device allow this to happen. To implement such dynamic routing protocols, each device needs to communicate routing information to other devices in the network. Each device then determines what to do with the data it receives either pass it on to the next device or keeps it, depending on the protocol. The routing algorithm used should attempt to always ensure that the data takes the most appropriate (fastest) route to its destination.

WMNs offer considerable advantages as an Internet broadband access technology [12]:

- Extended geographic coverage.
- Easy network expansion: adding a new node to an existing network only requires line-of-sight to another node already in the network. And the new node now provides coverage for future nodes further downstream.
- Long Links: use a directional antenna to reach a far away parent. The radios come with a dual antenna port that lets you deploy a second antenna to provide access to downstream nodes.
- Automatic routing: All LAN get bridged together by the radio network. The radios autonomously route your packets to the correct destination using the minimum number of hops.