PROPAGATION COVERAGE FOR FLAT HOUSE AREA USING RAY TRACING TECHNIQUE

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This Report Is Submitted In Partial Fulfilment of Requirements for the Bachelor Degree of Electronic Engineering (Wireless Communication)

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Universiti Teknikal Malaysia Melaka

May 2011

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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DEDICATION

This thesis is dedicated to my mother, who taught me that the best kind of knowledge to have is that which is learned for its own sake and taught me that even the largest task can be accomplished if it is done one step at a time.

AKNOWLEGEMENT

Alhamdullillah, I am grateful to ALLAH SWT on His blessing in completing this project.

I would like to express my gratitude to my supervisor, Puan Juwita Mohd Sultan for giving her support and good information when doing this project. Under her supervision, many aspects regarding on this project has been explored, and with the knowledge, idea and support received from her, this thesis can be presented in the time given.

Finally, I would like to dedicate my gratitude to my parents, my family and friends who helped me directly or indirectly in the completion of this project. Their encouragement and guidance mean a lot to me. Their sharing and experience foster my belief in overcoming every obstacle encountered in this project.

ABSTRACT

Propagation prediction plays an important role in the design and implementation of wireless local area network (WLAN) application. For indoor propagation, it is important to consider reflection, refraction and diffraction during the transmission. When a ray is launched from transmitter to receiver, the ray will hit the obstacles before reach the receiver. In this project, Ray Tracing Technique is used to predict the power received at receiver. The coverage prediction will be done in the flat house with 100 meter distance. The objective of this project is to predict the coverage signal when it travels using line of signal and effect of the obstacle. Using Ray Tracing Technique, the simulation will be done to predict how much power received at receiver. In order to show the propagation of signal, the simulation code will be visualized using Matlab.

ABSTRAK

Ramalan Perambatan memainkan peranan penting didalam rekabentuk dan pemasangan aplikasi WLAN. Semasa perambatan di dalam bilik pantulan, pembiasan dan difraksi adalah penting untuk dipertimbangkan selama penghantaran isyarat. Apabila isyarat dilancarkan dari pemancar ke penerima, isyarat akan melanggar halangan sebelum sampai kepada penerima. Dalam projek ini, Teknik Ray tracing digunakan untuk meramalkan kuasa yang diterima oleh penerima. Ramalan perambatan akan dilakukan di rumah flat dalam jarak 100 meter. Tujuan projek ini adalah untuk meramalkan liputan isyarat apabila isyarat melalui tempat yang tiada halangan dan halangan. Menggunakan Teknik Ray Tracing, simulasi akan dilakukan untuk meramalkan berapa banyak isyarat yang diterima oleh penerima. Keputusan ramalan rambatan dipaparkan mengunakan Matlab.

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INTRODUCTION

1.1 Background study

Wireless communications has resulted in new technologies and new applications for the personal use of radio frequencies. It cover a wide variety of situations ranging from communication with individuals walking in residential or office buildings, hospitals, factories, etc. There is certain place that cannot receive the signal or only get only lower signal. When transmitter launches a ray, it will hit some obstacle before reach to the receiver resulting reflection, transmission and diffraction. Power received at receiver will decrease as the ray hits more obstacles. There will be a lot of scenarios, but the project will be focusing on the flat houses area. The technique that will use in predicting the coverage is Ray Tracing Technique. This is the latest technique that being used this day. This technique will be applied using the MATLAB to determine how much the transmitted power can be propagated and reach to the receiver.

1.2 Objective

The objective of this project included:

1. To predict the coverage of Wireless Mesh Network for Flat house based on terms of the maximum distances and obstacles.
2. To use Ray Tracing Technique to predict the propagation coverage.

1.3 Problem statement

A network with several transmitters and receivers that communicate to each other will form a mesh network topology. For the indoor propagation, the wave propagation will travel around the room and hit the obstacle such as the concrete wall. Once a transmitter launches a ray, it will be reflected, refracted or diffracted to any kind of surfaces. That process will decrease the received signal strength at the receiver. In this project, prediction coverage will be done at different distance and angle.

1.4 Scopes

The development of the project may include:

1. Research
    - Gather material about to Wireless Mesh Network and Ray Tracing Technique.
    - Figure out the coefficient used for the indoor propagation

2. Literature Review
    - Understand about Wireless Mesh Network and how to use ray tracing technique to predict the coverage.

- Understand how basic mechanism propagation affects the received power.

3. Simulation
    - Apply the equation for free path loss, reflection, transmission and diffraction into MATLAB version7.10.0

1.5 Methodology

Phase 1: Research

The project will be focusing on Ray Tracing Technique. Before start the project, the research will be done first to find more idea about Wireless Mesh Network, Ray Tracing Technique and basic wave propagation.

Phase 2: Study of the Project

After collecting the data, then the project can be started by understanding what the concept for both Wireless Mesh Network (WMN) and Ray Tracing Technique. Ray Tracing Technique can be divided into two, which is image method and Brute force method. For this project, brute force method will be used.

Phase 3: Literature Review

Understand what the purpose of using Ray Tracing Technique. Ray Tracing Technique is used to predict the propagation coverage between transmitter and receiver. A way will be find to propagate the signal to the maximum distance so that the cost of using router and base station can be reduced.

Phase 4: Simulation and Testing

Based on the Ray Tracing Algorithm, the formula will be applied into MATLAB to predict the result. The Algorithm has four coefficients that included in it which are free path loss, reflection, transmission and diffraction. Diffraction is included because the project is focusing in indoor environment.

1.6 Report Structure

Chapter 1 is briefly introduces this project by elaborating on the project overview, objectives, and scope of project. Problem statement is also included in this chapter where it explains why the project is chosen. Methodology of the project is also briefly explained in this chapter.

Chapter 2 is written based on the findings from the literature. For this chapter, Wireless Mesh Network, radio propagation and Ray Tracing Technique has been discussed. Other than that, basic propagation mechanism that effects the radio propagation also had been included in this chapter.

Chapter 3 contains the methodology process for the propagation prediction and simulation by showing up the detailed diagram of the project methodology. Every step how to meet the objectives of this project is explained.

Chapter 4 discusses about the result and discussion. Each result for free space loss, reflection, transmission and diffraction is been analyzed based on the simulation that have been done.

Chapter 5 concludes the topics and suggests recommendation for future works.

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CHAPTER 2

LITERATURE REVIEW

2.1 Wireless Mesh Network

Wireless mesh networks (WMNs) have a lot of potential by offering low cost, wireless broadband Internet access both for fixed and mobile users. A wireless mesh network (WMN) interconnects stationary and/or mobile clients and optionally provides access to the Internet. The defining characteristic of a WMN is that the nodes at the core of the network are forwarding the data to and from the clients in a multihop fashion, thus forming a ad hoc network. Beyond the multihop requirement, there are no other restrictions on the design of a WMN, resulting in considerable flexibility and versatility. This versatility allowed many players to enter the mesh networking arena with different products and applications. [4]

Some WMN technologies are designed for high speed mobility (100mph), some for casual roaming in a building, while others are only meant to be used by stationary clients. The wireless links used to connect the mobile clients can be of the same type as the intra-mesh wireless links or can be a completely different technology. Many implementations allow mobile nodes to connect to the WMN while in its range. Their packets are forwarded in the same multihop manner as the ones of the stationary nodes.

Not all nodes have to support client nodes, the service provider can employ several relay nodes to increase the coverage of the network. [2]

The advantages of Wireless Mesh Network (WMN)

- WMNs support ad hoc networking, and have the capability of self-forming, self-healing, and self-organization.
- WMNs are multi-hop wireless networks, but with a wireless infrastructure/backbone provided by mesh routers.
- Mesh routers have minimal mobility and perform dedicated routing and configuration, which significantly decreases the load of mesh clients and other end nodes.
- Mobility of end nodes is supported easily through the wireless infrastructure.
- Mesh routers integrate heterogeneous networks, including both wired and wireless. Thus, multiple types of network access exist in WMNs.
- Power-consumption constraints are different for mesh routers and mesh clients.
- WMNs are not stand-alone and need to be compatible and interoperable with other wireless networks.

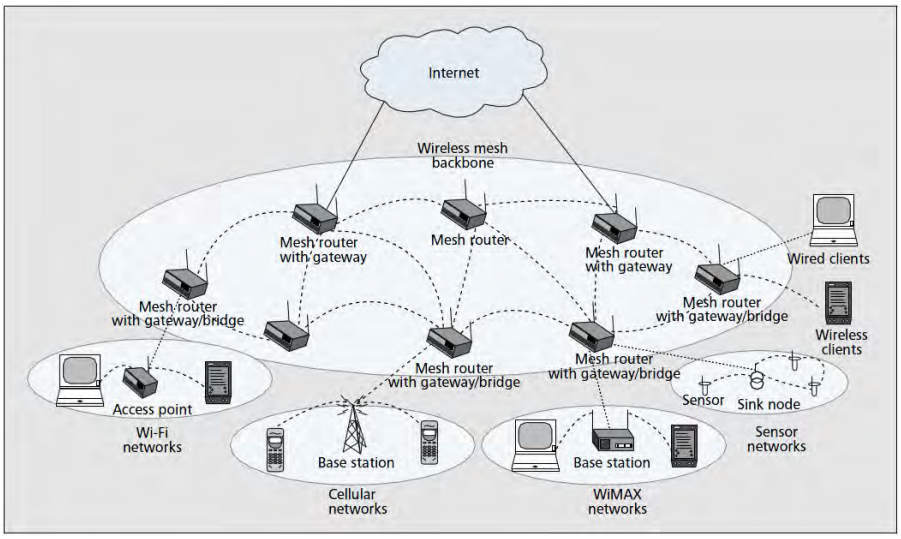

Figure 2.1: Infrastructure of Wireless Mesh Network (WMN)[1]

2.2 Radio propagation

An understanding of radio propagation is essential for coming up with appropriate design, deployment, and management strategies for any wireless network. In effect, it is the nature of the radio channel that makes wireless networks far more complicated than their wired counterparts. Radio propagation is heavily site-specific and can vary significantly depending on the terrain, frequency of operation, velocity of the mobile terminal, interface sources, and other dynamic factors. Accurate the characterization of the radio channel through key parameters and a mathematical model is important for predicting signal coverage, achievable data, specific performance attributes of alternative signaling and reception schemes, analysis of interference from different systems, and determining the optimum location for installing base station antennas.

2.2.1 Outdoor propagation

Transmission range is an important consideration when judging wireless technology. Frequency is one of the important things that have to be considered in radio propagation. With all other things being equal, as frequency increases, range decreases. Higher the frequency is used, and then the wavelength of the signal become shorter and caused higher attenuation by atmosphere. Higher-frequency waves are also more vulnerable to absorption by building materials, such as drywall and concrete.

Outdoor radio transmission in an open field is usually referred to as line-of-sight propagation. Signals propagate from the transmitter to the receiver over only two possible paths: a direct ray and one reflected from the ground. The transmitter and receiver are both close to the ground, the difference in arrival time of the two rays is smaller than the data's chip time. The propagation model is simple under these conditions, and the power arriving at the receiver falls off proportionally to the square of the distance between the transmitter and the receiver.[2]

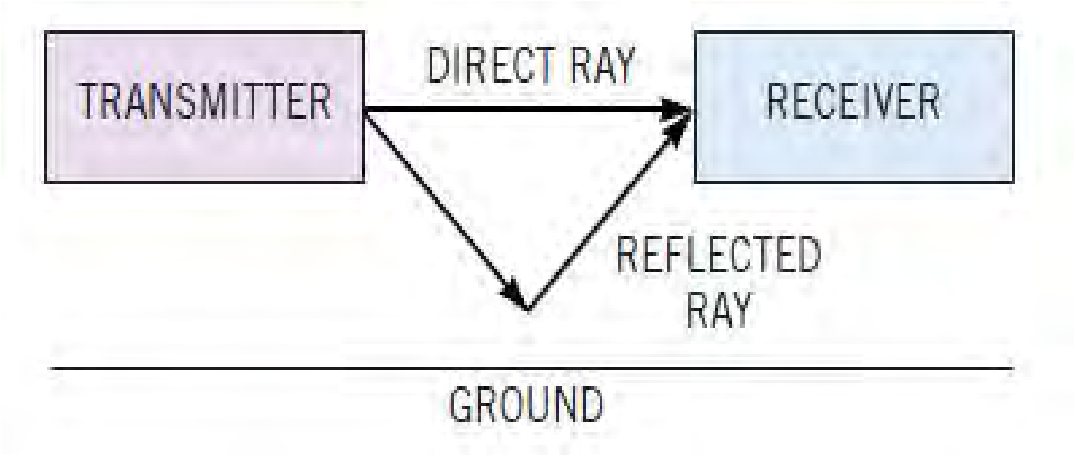

Figure 2.2.1: reflected ray between transmitter and receiver [2]

Outdoor Radio Frequency (RF) links have different propagation characteristics than indoors. Calculations can provide accurate information on possible performance and distance. The following are included in calculations for determining outdoor coverage performance:

- Antenna gain
- Transmitter power
- Receiver performance
- Cable losses
- Environmental structures

All of these parameters are known values and are easily determined. However, environmental structures, such as buildings, trees, and anything in the line of sight between one antenna and the other, can cause major issues for outdoor RF links. For long-distance communications using WLAN frequencies, a line of sight between the antennas is necessary to maintain quality Radio Frequency (RF) links.[3]

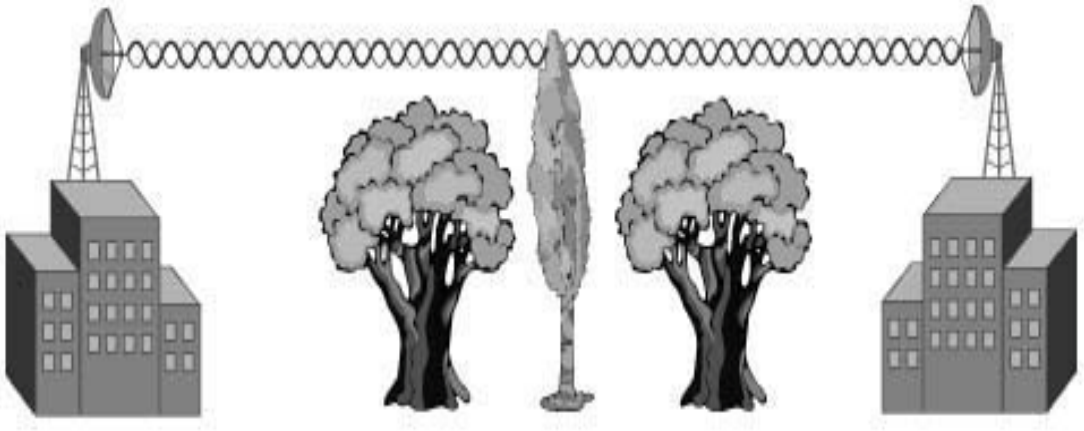

Figure 2.2.1.1: Line of sight for outdoor propagation [3]

Two other factors that affect outdoor links are the Fresnel zone and Earth bulge. It is important to make sure the antennas have proper height to maintain line of sight. Fresnel zone is an elliptical area immediately surrounding the visual path. It varies depending on the length of the signal path and the frequency of the signal. The Fresnel zone can be calculated, and it must be taken into account when designing a wireless link. If the Fresnel zone is obstructed, required line of sight is not clear and the link may be unreliable.[3]

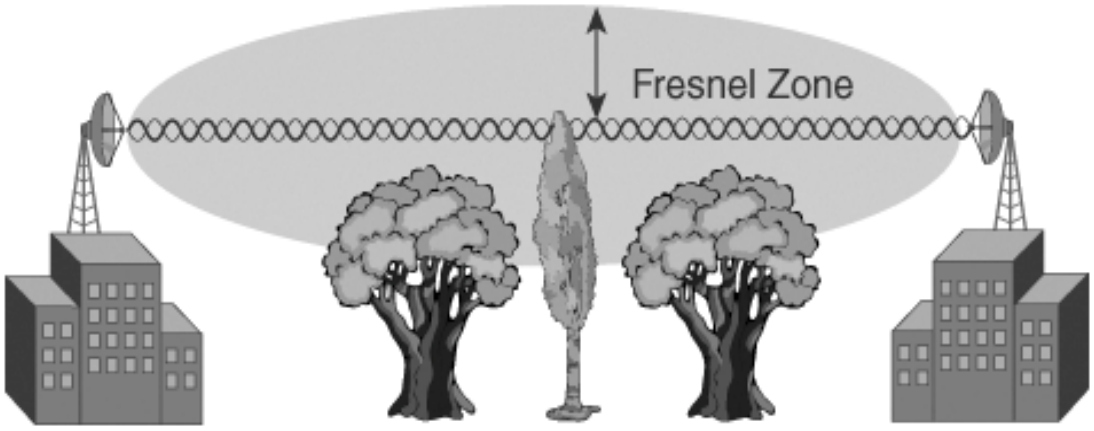

Figure 2.2.1.2: Fresnel Zone [3]

2.2.2 Indoor Propagation

It is important to characterize the indoor radio propagation channel to ensure satisfactory performance of a wireless communication system. Indoor propagation covers a wide variety of situations ranging from communication with individuals walking in residential or office buildings, hospitals, factories, etc. Indoor radio channels do not suffer from the environmental effects of snow, rain, hail, clouds or temperature inversion as do outdoor radio channels but because of the variation of building size, shape, structure, layout of rooms and, most importantly, the type of construction materials, electromagnetic-wave propagation inside a building.

The indoor environment is prone to interference where resulted from reflection, refraction and scattering of radio waves by structures inside a building. The transmitted signal most often reaches the receiver by more than one path, resulting in a phenomenon known as multipath fading. Multipath causes deep fading and pulse spreading of the signal and hence intersymbol interference can be caused in a digital radio system. Dominant propagation phenomena inside buildings are:[4]

- the shadowing of walls
- wave guiding effects in corridors due to multiple reflections
- Diffractions around vertical wedges.

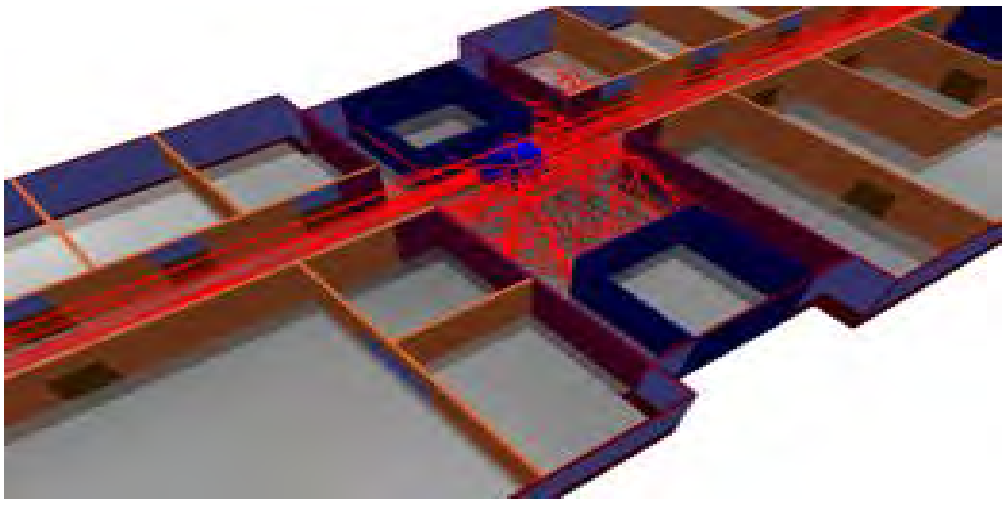

Figure 2.2.2: Propagation paths in an indoor scenario[4]