

Microwave Link Design, Survey and Installation In Pyay Technological University

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Abstract Nowadays, microwave link has become an indispensable form of communication networks around the world. This research project describes design and installation of remote desktop connection from one computer to another computer by using 5GHz Cambium ePMP Force 180 TDD license exempt microwave link. The require components are two computers, two antennas, two POE (Power Over Ethernet) splitters, RJ 45 Ethernet cables and power supply cords. In this research, the two locations are 400 meters far away each other. The latitude and longitude of these points are used to design with the link planner software. As the system is point to point microwave system, line of sight must be between two locations. The softwares that we used in this research are Google earth and Cambium Link Planner. This research involves an iterative technique to explain the sequential communication of signal transmission for short distance radio communication through microwave link with best efficiency.

Index Terms- Microwave Radio, Cambium, Link Planner, Link Budget

I. INTRODUCTION

Microwave technology is used to transmit or receive the signals in the form of radio wave from one place to another. From the frequency perspective, there are two types of microwave called Licensed and License exempt bands. Licensing is a way of ensuring that wireless operators do not interfere with each other's radio frequencies. Licensed band is individual companies pay a licensing fee for the exclusive right to transmit on assigned channels within that band in a given geographic area or nationwide assignment. The

license microwave frequencies are normally 6-42 GHz and products are produced with frequency division duplex system (FDD).

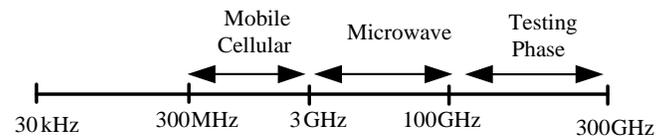


Figure 1. Radio spectrum (From 30 kHz to 300GHz)

To radiate RF frequencies from the antenna, the necessary things are power supply, radio unit (outdoor unit), IF cable (in our case is Cat5-e cable). Radio frequency (RF) is a measurement representing the oscillation rate of electromagnetic radiation spectrum, or electromagnetic radio waves, from frequencies ranging from 300GHz to as low as 30kHz. It can be categorized microwave systems to two based on their product architectures. They are split mount microwave system and full outdoor system. Split mount system consists of indoor unit (IDU) + outdoor unit (ODU) + Antenna while full outdoor system combines IDU and ODU as one. So full outdoor system consists of ODU +Antenna only. (In this research project, ePMP Force 180 5GHz is full outdoor system, so there is no IDU.) The function of IDU is to accept baseband signals, digitized and convert to intermediate frequency (IF signal) via the IF cables (Cat5-e cables or Coax cables).The function of ODU is to modulate IF signal to radio frequency (RF signal) and amplify the power of the signal. ODU is power supplied by IF cables together with IF signal mostly or power supplied

with separate cables rarely. The function of the antenna is to do the directivity of RF signal to the desired direction.

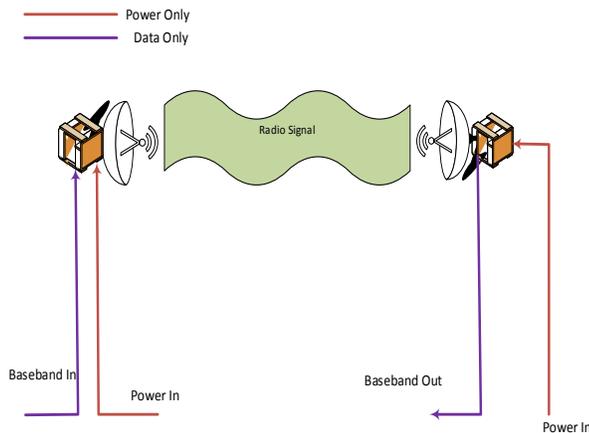


Figure 2. Typical Full Outdoor Microwave System

II. PROPOSED SYSTEM

This research project consists of two computers, one microwave hop, two POE splitters, RJ 45 Ethernet cables and power supply cord. In these installation, the microwave hop product is ePMP Force 180 5GHz. The ePMP Force 180 5GHz subscriber module is the next generation of the ePMP 5GHz integrated radio offering a higher-gain, integrated 16 dBi patch antenna. Installation and alignment are easy with the adjustable mounting bracket and the Force 180 is small, sleek and equipped with Gigabit Ethernet port to deliver the maximum throughput. POE (splitter) which is supplied together with ePMP has two ports which are Gigabit data port and Gigabit data + Power port. Data + Power slot is connected to the equipment by using RJ 45 Ethernet cable to provide power and data while another port is connected to the computer to configure in the beginning stage and to do access in the later stage.

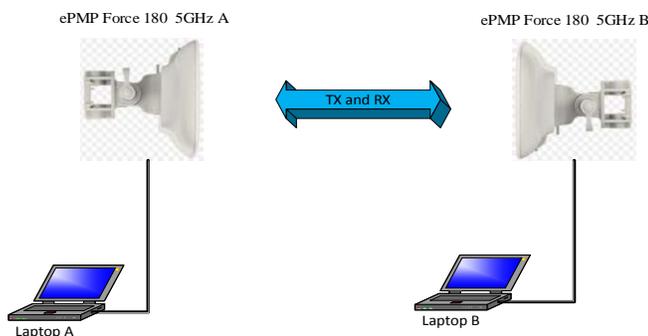


Figure 3. Block Diagram of Proposed System

III. MICROWAVE LINK DESIGN

The goal of this research project is to access remote desktop connection to another computer via 5GHz ePMP Force 180. This research operates with two sections, which are:

- Hardware (Equipment)
- Software

3.1 Hardware (Equipment)

This involves two antennas (ePMP Force 180 5GHz), two computers, two POE (power over Ethernet), four RJ 45 and power supply. At first, two antennas must be placed into line of sight. POE (splitter) has two slots which are Gigabit data and Gigabit data + Power. Data + Power slot is connected to the antenna slot by using RJ 45 and another slot is connected to the computer to configure the parameters. And then, POE is supplied to the DC input power.

3.1.1 ePMP Force 180 5GHz

The ePMP Force 180 5GHz subscriber module is 5GHz Integrated Radio offering a higher-gain, integrated 16 dBi patch antenna. Installation and alignment are easy with the adjustable mounting bracket and the Force 180 is small, sleek and equipped with Gigabit Ethernet port to deliver the maximum throughput. It has the exceptional reliability and quality that users have come to expect from the ePMP product line and adds some significant performance enhancements. This radio comes in a small, sleek form factor but delivers high performance. The antenna gain is increased by 3 dB to 16 dBi which will provide a 40% increase in range. It comes equipped with a Gigabit Ethernet port so that nothing will limit this product in delivering the maximum throughput. The radio module is powered by POE and the Ethernet port has the unique capability of being powered from a POE injector that conforms to standard pin outs or from a POE injector that conforms to Cambium pin outs. This makes it possible to upgrade

existing radio locations to the Force 180 without changing the POE injector. It also includes an adjustable mounting bracket that eases the task of installing and properly aligning the radio.



Figure 4. ePMP Force 180 5GHz

3.2 Software

In this research, the software that used are Google earth and Link planner. The desired points are measured with GPS and compare on the map by using Google earth software. The latitude and longitude of these points are used to design with the link planner software. When design the position of antennas, need to change the value of band, product, ePMP PTP mode, bandwidth and modulation to get best result of availability and capacity.

3.2.1 Link Planner

Calculating the achievable availability of a microwave link is carried out on the basis of statistical methods. Currently there are now available software solutions from a number of companies which enable the microwave link planner to calculate and configure rapidly and effectively the microwave link. All of this software is based on uniform guidelines of the International Telecommunication Union (ITU). Cambium link planner is free software provided by Cambium and it is easy to use. In this research, Link Budget is calculated by the followings equations:

The received power of antenna 2 can be calculated by using link planner equation.

$$R_x \text{ power } 2 = \text{EIRP}_1 - \text{Free space loss} + \text{Antenna gain}_2 \quad (1)$$

$$\text{EIRP}_1 = \text{Tx power } 1 + \text{Antenna gain } 1 \quad (2)$$

where,

$$R_x \text{ power } 2 = \text{received power of antenna } 2$$

$$\text{Tx power } 1 = \text{transmitted power of antenna } 1$$

$$\text{EIRP} = \text{Effective Isotropic Radiated Power}$$

For one microwave link, availability and the capacity of the link are the most important factors. So these two factors need to meet the target since the design stage. Availability is a function of fade margin and fade margin is the difference of sensitivity and received power. Capacity of the microwave link is directly proportional to the channel spacing and modulation schemes. To provide faster capacity, channel spacing need to be wide as well as need to use higher modulation schemes. In our project, availability target is 99.99% and capacity target is 50 Mbps.

$$\text{Fade Margin} = \text{Received signal} - \text{Sensitivity of the radio} \quad (3)$$

The received power depends upon free space loss and effective isotropic radiated power (EIRP). EIRP is the addition of transmitted power and antenna gain. The transmitted power depends on the product type and brand while antenna gain can be controlled by changing antenna size. Free space loss depends on frequency and the distance between two antennas.

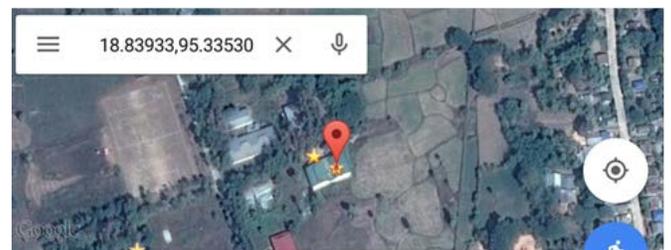
$$\text{Freespace Loss} = (4\pi df/c)^2 \quad (4)$$

where, d is the distance between two antennas in miles.

IV. SURVEY, DESIGN AND CONFIGURATION

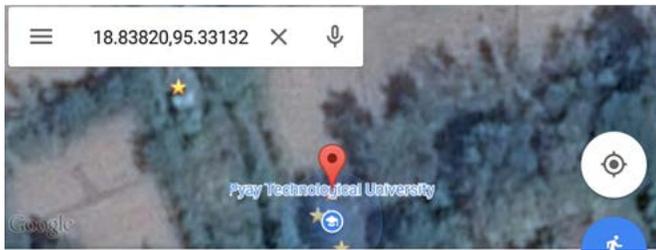
4.1 Site Survey

In our project, we located latitude and longitude of point 1 and point 2 using Google Earth and installed hardware equipment step by step. Latitude and Longitude of point 1 and Latitude and Longitude of point 2 are shown in Figure 5. and Figure 6.



18850921.60N 95820907.10E

Figure 5. Latitude and Longitude of point 1



18850917.50N 95819952.80

Figure 6. Latitude and Longitude of point 2

4.2 Design Criteria

After site survey, we design the microwave link by using cambium network link planner step by step.

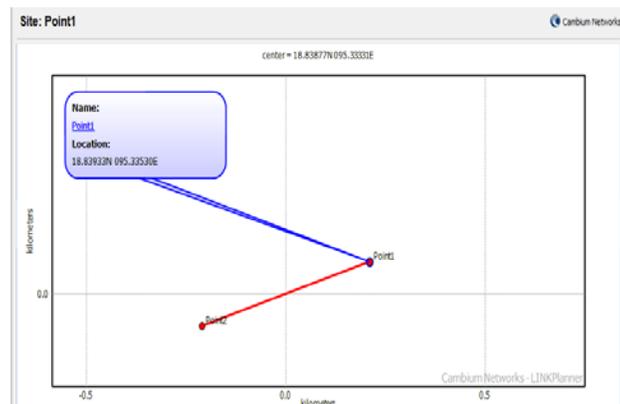


Figure 7. Site of point 1

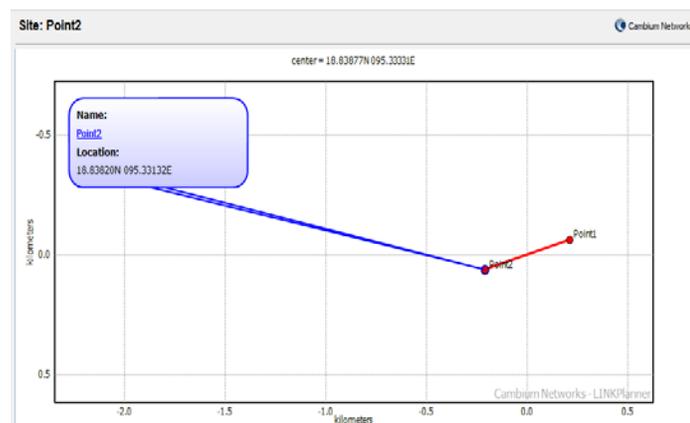


Figure 8. Site of point 2

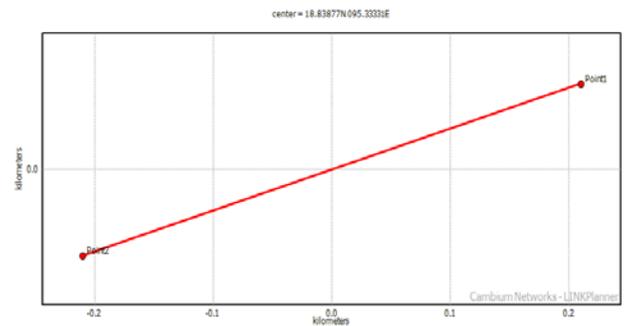


Figure 9. Microwave Link between Two Points

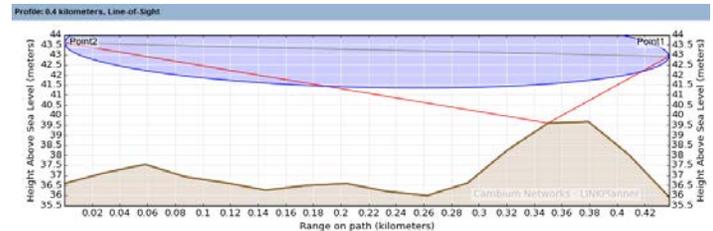


Figure 10. Path Profile between Point 1 and Point 2

Check that the profile is accurate and identify any obstructions that may affect signal quality. The profile can be verified using Google Earth(TM), maps, GPS data and site visits. It is particularly important to verify the antenna heights, to measure interference and to identify obstructions near both ends of the Fresnel zone. The following Table shows the design parameter of the research project.

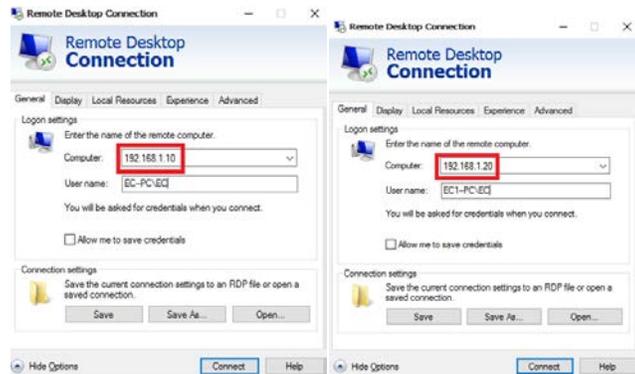
Table 1. Result of Design Parameter

| Summary | |
|--|---|
| Link Name | Point2 to Point1 |
| Profile Type | Line-of-Sight |
| Equipment Type | ePMP Force 180 |
| Maximum Obstruction | 0 meters |
| Link Distance | 0.438 kilometers |
| Free Space Path Loss | 100.23 dB |
| Excess Path Loss | 0.00 dB |
| User IP Throughput Expectation Aggregate | Aggregate 102.41 Mbps assuming ePMP Force 180 Series running the 3.4.1 software |
| RF Frequency Band | 5.4 GHz (5470 to 5725 MHz) |
| RF Channel Bandwidth | 20 MHz |

V. TESTS AND RESULTS

In this research project, we want to send the data between two computers and control the remote desktop connection from other computer. So, we want to access remote desktop connection. Figure11 shows remote desktop connection between two computers. In Figure 12, wireless in monitor will be up so that the project would be operated. In Figure 13, the eAlign in tools change if the interference have between point 1 and point 2 antennas. If the value of

RSSI is fewer, the result of the project is better. Figure 14 shows that the two computers have connected by using microwave link. In this condition, we can sent (data, video, photo, audio, etc.) of one computer to other computer by using microwave link.



Point 1 (Master) Desktop

Point 2 (Slave)

Figure 14. Final Result of Research Project

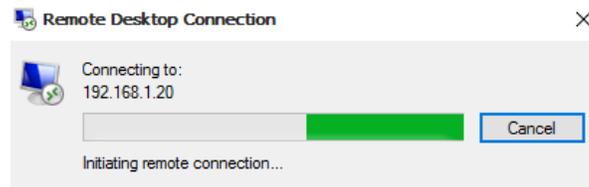


Figure 11. Remote Desktop Connection

VI. CONCLUSION

This research project is tested in Pyay Technological University. We located two points, the first point is placed in front of Civil Department and the second point is placed in front of Academy Hall. The distance between two points is 400 meters long and two antennas must be line of sight. We designed the location of latitude and longitude in the link planner software. By using this software, we know the result of availability and capacity of our project. In this project, we can send the data between two computers and control the remote desktop connection with microwave link from other computer effectively.

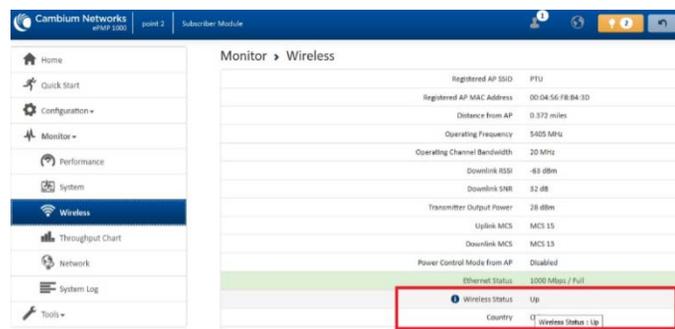


Figure 12. Wireless Status Up



Figure 13. eAlign Cambium Networks

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