Performance Analysis Of BTS (Base Transceiver Station) Viewed From The Influence Of Large Diameter Microwave Antenna

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Abstract

Microwave is an electromagnetic wave which is a form of radio emission that is transmitted through the air and received using a circular antenna mounted on a tower. The microwave antenna functions to receive and distribute radio waves, either from BTS to BTS or from BTS to BSC. BTS performance itself is influenced by the size of the diameter of the microwave antenna. The purpose of this research was to determine the effect of the diameter of a microwave antenna on BTS performance by comparing the diameter at several different locations with the same type of provider. As for the signal parameter values, they are adjusted to the link budget calculation, which will later be compared with the data monitored via StarWeb LCT, so that the data or signal can be transmitted optimally. Based on the results of the analysis, the diameter of the microwave antenna affects the RSL value, frequency, and transmitting distance of the signal. A microwave antenna with a diameter of 0.3 m can transmit signals as far as 1-2 km, a diameter of 0.6 m can transmit signals as far as 3-4 km, a diameter of 0.9 m can transmit signals as far as 9-12 km, and a diameter of 1.8 m can transmit signals as far as 17-19 km, which means that the larger the size of the microwave antenna used, the farther the signal transmission distance will be.

KATA KUNCI: Diameter Antena Microwave, Link Budget, StarWeb LCT

Abstrak

Microwave atau gelombang mikro merupakan gelombang elektromagnetik yang merupakan bentuk dari pancaran radio yang ditransmisikan melalui udara dan diterima dengan menggunakan antena yang berbentuk bundar yang dipasang di atas tower. Antena microwave berfungsi untuk menerima dan menyalurkan gelombang radio, bisa dari BTS ke BTS atau pun dari BTS ke BSC. Kinerja BTS sendiri sangat dipengaruhi oleh ukuran diameter antena microwave. Tujuan penelitian ini adalah untuk mengetahui pengaruh besar diameter antena microwave terhadap kinerja BTS dengan membandingkan besar diameter di beberapa lokasi yang berbeda dengan jenis provider yang sama. Adapun untuk nilai parameter sinyal disesuaikan dengan perhitungan link budget yang nantinya akan dibandingkan dengan data yang dimonitoring melalui StarWeb LCT, agar data atau sinyal tersebut dapat ditransmisikan dengan maksimal. Berdasarkan hasil analisa, besar diameter antena microwave berpengaruh terhadap nilai RSL, frekuensi, dan jarak pancar sinyal. Antena microwave yang memiliki diameter 0.3 m mampu memancarkan sinyal sejauh 1-2 Km, diameter 0.6 m mampu memancarkan sinyal sejauh 3-4 Km, diameter 0.9 m mampu memancarkan sinyal sejauh 9-12 Km, dan diameter 1.8 m mampu memancarkan sinyal sejauh 17-19 Km yang artinya semakin besar ukuran antena microwave yang digunakan, maka jarak pancar sinyal akan semakin jauh.
I. Preliminary

The rapid development of science and technology has had major repercussions on human life. In the field of telecommunications technology, the need for telecommunications itself has now become one of the basic needs for all levels of society. In its development, currently telecommunication technology has reached 4G LTE technology, and there are even providers that apply 5G technology.

One of the mainstays of telecommunication systems is the telecommunication system using microwaves. Microwaves are transmitted through the air and received using a device such as an antenna known as a microwave antenna. A microwave antenna or microwave antenna is a device that is used to transmit and receive signals between sites so that all sites will be connected and connected to a central server [1]. This microwave antenna has a different performance power depending on the size of the diameter of the microwave antenna, the location where the microwave antenna is placed, to the interference that may occur around the location where the microwave antenna is placed [2] [3].

Because each microwave antenna has a different diameter which will affect signal quality, in this study a comparison of the size of the diameter microwave antennas at several different locations in Pontianak City was carried out and monitoring signal parameters using a software and later on compared to the calculation of the link budget [4] [5] [6].

This monitoring is carried out as an initial identification step in comparing signal parameters. Monitoring at PT. Infratech Indonesia Ao Pontianak is implemented using StarWeb LCT. StarWeb LCT is a network monitoring website of the Huawei company that functions to monitor the alarm condition of microwave radio devices, microwave antennas, RSL values, configurations, topologies, and others [7] [8] [9].

II. Literature Reviews

The previous research used as a reference in this study is as follows:

1. “Analisis Kinerja Transmisi Microwave Link End Site Pada Monitoring Menggunakan iMaster NCE”. This study contains the performance of microwave link end site transmission using the iMaster NCE website”. [10]
2. “Perencanaan dan Analisis Fronthaul Microwave Menggunakan Spektrum Frekuensi 71 GHz untuk Radio Access Network dengan Metode Drive Test 4G LTE di Kota Purwotorto”. This research is about designing the addition of a new eNodeB using the fronthaul microwave 4G LTE method to improve bad coverage of an area by increasing network coverage and capacity”. [11]
3. “Analisis Perencanaan Transmisi Microwave Link antara Semarang-Magelang untuk Radio Access Long Term Evolution (LTE)”. This research concerns the planning of a simulated microwave link network using Pathloss 5.0 software. Planning is carried out by theoretical calculation of end-to-end performance for communication lines under a certain set of regional conditions. The important parameter that is tathan into account in this simulation is the link budget, where this parameter will be used to predict link performance before it is used to communicate”. [6]
4. “Nur Mufid (2020) in his research entitled “Analisis Link Budget Pada Antena Radio Gelombang Mikro Menggunakan Topologi Point to Point di PT. Blue Bird”. This study analyzes the link budget on microwave radio antennas in Indosat BTS development using point to point topology”. [7]

II.1 Base Transceiver Station

The Base Transceiver Station is a transmitting station whose function is to receive radio waves and send them back. All communication devices require radio waves to be connected to one another. However, these radio waves are not directly connected to one another. Therefore, it requires BTS. BTS is a very important element for the continuity of the communication process. The main task of BTS is to send and receive radio signals to communication devices such as landline phones, cell phones and other similar gadgets. Then the radio signal will be converted into a digital signal which is then sent to the other terminal as a message or data. From several BTS, it is controlled or controlled by a Base Station Controller (BSC) which is connected to a microwave or optical fiber connection. [12]

II.2 Components on the BTS Tower

1. Microwave Antennas

A microwave antenna is a drum-shaped device that is used to send and receive signals between sites so that all sites will be connected and connected to a central server. This antenna is also called a parabolic antenna [13].
Microwave antenna supports point to point microwave communication. This antenna has various diameter sizes, ranging from 30 cm, 60 cm, 90 cm, 120 cm, up to 450 cm. In a microwave antenna, there is an antenna cover which function to protect the antenna component from wind loads and changes in the surrounding weather, which is called a radome. The function of the microwave antenna is to receive and transmit radio waves, either from BTS to BTS or from BTS to BSC.

2. Microwave Systems

There are 2 parts inside and outside of this microwave system. The outer or outdoor part is called the ODU (Outdoor Unit) which is directly connected and installed with the microwave antenna on the BTS tower. ODU is a device that has an important role in the transmission process where the ODU specification is adjusted to the type of the IDU and the use of ODU is adjusted to the frequency used. Meanwhile, those that are inside or indoor are known as IDUs (Indoor Units) which are directly connected to the outdoor system. The IDU function is to superimpose the information signal on the carrier signal, then it is forwarded to the ODU and the antenna for further radiation, or vice versa.

II.3 StarWeb LCT

StarWeb LCT is a software or software under the control of PT. Huawei is used to monitor various matters related to BTS towers, including disturbances or troubleshooting that occurs, maintenance, alarms when damage occurs to BTS towers, and others. This software is also capable of monitoring microwave antenna specifications on a BTS tower and monitoring signal parameters that have previously been adjusted to the link budget.

This software is one of the software that can be operated directly at the location because it is connected to the BTS device using a special USB cable. StarWeb LCT has several configuration menus displays, including Link Configuration, Microwave Link Configuration, Microwave Link Alarm, and Microwave Link Performance. In addition to the configuration menu, there is also a Diagnosis & Maintenance menu which includes ODU Frequency Scan [14].

II.4 Link Budget

Link budget is a way to calculate the receiving power level that is greater than or equal to the transmitted power level with the aim of maintaining a balance between the gain of the transmitting antenna (Tx) to the receiving antenna (Rx). This link budget can be calculated based of the distance between the transmitter (Tx) and receiver (Rx) or by looking at the specifications on the antenna. The link budget calculation determines the level of success of a communication that is carried out. In determining the link budget for a microwave access network, the parameters that can be used include the following [15]:

1. Antenna Gain

The gain is a parameter that measures the ability of the antenna to transmit the desired wave to the destination. The gain value is used to find the RSL value of each antenna. The data needed to calculate the antenna gain is the diameter of the microwave antenna and the frequency of the antenna used. The following is as the equation used to calculate the gain.

\[
G \text{ (dBi)} = 17.8 + 20 \log \varnothing + 20 \log f
\]

Where:
- \( \varnothing \) = microwave antenna diameter (meter)
- \( f \) = microwave antenna frequency (GHz)

2. Free Space Loss (FSL)

Free Space Loss is a function of distance and frequency. Free Space Loss is the attenuation that occurs along the space between the transmitting and receiving antennas. In this space, no obstructions are allowed, because the transmission it has LOS character. To find out the condition of point to point with the transmission line, the free space attenuation calculation uses the following equation.

\[
\text{FSL (dB)} = 20 \log (D) + 20 \log (f) + 92.45
\]

Where:
- \( D \) = The distance between the transmitting and receiving antennas (km)
- \( f \) = microwave antenna frequency (MHz)

3. Received Signal Level (RSL)

Received Signal Level (RSL) is the power level received by the decoding processing device. The purpose of calculating the RSL is to estimate the results to be obtained, namely in the form of received power and to determine whether the results are as desired. The data used in the RSL calculation are the gain values of the two antennas and the given transmitter power. The calculation of the RSL value is very important because it shows the service quality of a
telecommunication operator. To get the RSL value, it can be done by 2 methods, namely:

a. The Automatic method, that is with an application installed on a device. One android-based application that can be used is the RF Signal Tractor.

b. The manual method, namely by using the theory of formula calculations by entering the necessary parameters or data

The following is the equation used to calculate the RSL.

\[ \text{RSL} = \text{PTX} + \text{GTX} + \text{GRX} - \text{FSL} \]

Where:

- PTX = transmit power (dBm)
- GTX = transmit antenna gain (dBi)
- GRX = receive antenna gain (dBi)
- FSL = free space loss (dB)

2.4 Transmission

In general, transmission means sending a signal or information from one place to another. In transmitting, of course there are obstacles that can cause the transmission process to be disrupted so that information delivery activities are disrupted. Line of Sight (LOS) radio telecommunication system is a signal transmission technique in which there are absolutely no obstacles between two interconnected terminals, so that the signal from the sender can be directly directed to and received by the receiving system. The LOS system is usually used in microwave transmission systems which are free space wave propagation with respect to direct waves and reflected waves. Transmission performance is a measure of a transmission process that is carried out, which indicates whether the transmission process is good or not. Therefore, better transmission performance is a condition that must be met and really needs to be considered so that the purpose of communication can be achieved [16].

Apart from LOS, it is also known as Non-Line of Sight or NLOS which is used to describe radio transmission over a partially blocked or obstructed path, usually a physical object (tall buildings or trees) within the Fresnel zone.

III. Research Methodology

III.1 Research Sites

The location as a place of research where to collect data regarding the size specifications and diameter of the microwave antenna and also the parameters that affect the signal quality at the base stations carried out at PT Infratech Indonesia Ao which is located on Jl. Prime, Mr. Setia No.8A, Parit Tokaya, South Pontianak, West Kalimantan 78115.

III.2 Required Equipment

In this study used supporting equipment and is already available on PT. Infratech Indonesia to carry out a comparative analysis of the large diameter microwave antennas as follows:

1. Software StarWeb LCT
   StarWeb LCT software is a type of software released by Huawei that can monitor microwave antenna specifications and parameters that affect signal quality at base stations.

2. Software Open Camera
   The Open Camera Software is a type of software used to obtain microwave antenna location data in the form of coordinates, location photos and situation photos.

3. Wi-Fi Device
   The Wi-Fi device in this study is used to provide stable internet access in order to be able to access the StarWeb LCT software without a time limit on a laptop.

III.3 Research Methods

1. Literature Study
   Literature study in this research was conducted to find and collect theories regarding microwaves. Literature studies are carried out through journals, internet media and other references

2. Qualitative Method
   The qualitative method was carried out to analyze the effect of the diameter of the microwave antenna on the BTS performance.

3. Quantitative Method
   The quantitative method is used to determine the signal parameters by calculating the link budget which will then be compared with the data on the StarWeb LCT.

4. Conclusion
   Conclusions made after conducting data collection and analysis.

III.4 Monitoring Steps Using StarWeb LCT software

1. Set the IP address corresponding to data from Huawei.
2. Open the software by double-clicking the StarWeb LCT icon.

![Figure 1. Icon view or shortcut StarWeb LCT](image)

3. Perform the login process using a valid username and password and have connected to the Wi-Fi network.

![Figure 2. Login View](image)

4. Select the site to be monitored

![Figure 3. View of Various Site Location](image)

5. Select the Microwave Link configuration menu to monitor site name and ID, configuration type on ODU, frequency, actual Rx power, and Tx Power.

![Figure 4. First Display of Microwave Link Configuration Menu](image)

**III.5 Flow Chart of Research**

The flowchart in the research can be shown in the following figure.

![Figure 5. Flow Chart of Research](image)
IV. Analysis of the Effect of Microwave Antenna Diameter on BTS (Base Transceiver Station) Performance

IV.1 Data dan Site Location

Below is the attached site data from each site analyzed for further comparison of the diameters of the microwave antennas.

### Table 1. Data site Tebu to Mitra Anda

<table>
<thead>
<tr>
<th>No</th>
<th>Site ID</th>
<th>Longitude (UTM)</th>
<th>Latitude (UTM)</th>
<th>Tower Type</th>
<th>Tower Height</th>
<th>Distance</th>
<th>Microwave Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140344</td>
<td>-0.024916</td>
<td>109.326570</td>
<td>Greenfield</td>
<td>42 m</td>
<td>3.5 km</td>
<td>0.6 m</td>
</tr>
<tr>
<td>2</td>
<td>140069</td>
<td>-0.018641</td>
<td>109.327014</td>
<td>Rooftop</td>
<td>30 m</td>
<td></td>
<td>0.6 m</td>
</tr>
</tbody>
</table>

### Table 2. Data site Mitra Anda to Gertak

<table>
<thead>
<tr>
<th>No</th>
<th>Site ID</th>
<th>Longitude (UTM)</th>
<th>Latitude (UTM)</th>
<th>Tower Type</th>
<th>Tower Height</th>
<th>Distance</th>
<th>Microwave Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140069</td>
<td>-0.017503</td>
<td>109.327014</td>
<td>Rooftop</td>
<td>52 m</td>
<td>1.2 km</td>
<td>0.3 m</td>
</tr>
<tr>
<td>2</td>
<td>140079</td>
<td>-0.017503</td>
<td>109.32637</td>
<td>Greenfield</td>
<td>40 m</td>
<td></td>
<td>0.3 m</td>
</tr>
</tbody>
</table>

### Table 3. Data site Mitra Anda to New Site

<table>
<thead>
<tr>
<th>No</th>
<th>Site ID</th>
<th>Longitude (UTM)</th>
<th>Microwave Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140069</td>
<td>-0.018641</td>
<td>0.3 m</td>
</tr>
<tr>
<td>2</td>
<td>140915</td>
<td>-0.024916</td>
<td>0.3 m</td>
</tr>
</tbody>
</table>

### Table 4. Data site Gertak to Grand Mahkota

<table>
<thead>
<tr>
<th>No</th>
<th>Site ID</th>
<th>Longitude (UTM)</th>
<th>Latitude (UTM)</th>
<th>Tower Type</th>
<th>Tower Height</th>
<th>Distance</th>
<th>Microwave Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140079</td>
<td>-0.017503</td>
<td>109.332637</td>
<td>Rooftop</td>
<td>52 m</td>
<td>1.2 km</td>
<td>0.3 m</td>
</tr>
<tr>
<td>2</td>
<td>1401203</td>
<td>-0.021823</td>
<td>109.335495</td>
<td>Greenfield</td>
<td>40 m</td>
<td></td>
<td>0.3 m</td>
</tr>
</tbody>
</table>

### Table 5. Data site Merdeka Barat to Siantan Tengah

<table>
<thead>
<tr>
<th>No</th>
<th>Site ID</th>
<th>Longitude (UTM)</th>
<th>Latitude (UTM)</th>
<th>Tower Type</th>
<th>Tower Height</th>
<th>Distance</th>
<th>Microwave Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140089</td>
<td>-0.025008</td>
<td>109.330384</td>
<td>Rooftop</td>
<td>52 m</td>
<td>9 km</td>
<td>0.9 m</td>
</tr>
<tr>
<td>2</td>
<td>140378</td>
<td>-0.006590</td>
<td>109.346040</td>
<td>Greenfield</td>
<td>42 m</td>
<td></td>
<td>0.9 m</td>
</tr>
</tbody>
</table>

### Table 6. Data site Mercure to Supadio

<table>
<thead>
<tr>
<th>No</th>
<th>Site ID</th>
<th>Longitude (UTM)</th>
<th>Microwave Antenna Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140069</td>
<td>-0.018641</td>
<td>0.3 m</td>
</tr>
<tr>
<td>2</td>
<td>140915</td>
<td>-0.024916</td>
<td>0.3 m</td>
</tr>
<tr>
<td>No</td>
<td>Site ID</td>
<td>Wonoyoso</td>
<td>Kuala Dua</td>
</tr>
<tr>
<td>----</td>
<td>---------</td>
<td>----------</td>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
<td>149201</td>
<td>140103</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-0.047824</td>
<td>-0.155425</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>109.324316</td>
<td>109.423615</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Greenfield</td>
<td>Greenfield</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>72 m</td>
<td>42 m</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>17.3 km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1.8 m</td>
<td>1.8 m</td>
<td></td>
</tr>
</tbody>
</table>

**Table 7.** Data site Wonoyoso to Kuala Dua

**IV.2 Microwave Antenna Parameter Monitoring with StarWeb LCT**

Below is the capture result from the StarWeb LCT software which displays the data or parameters of the microwave antenna and the antenna parameter table which will be used for calculating the link budget at each site.

1. **Site Tebu to Mitra Anda**

**Figure 6.** The First display of Microwave Antenna Parameters at the Tebu Site

**Figure 7.** The Second Display of Microwave Antenna Parameters at the Tebu Site

**Table 8.** Microwave Antenna Parameters at Tebu site to Mitra Anda site

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tebu to Mitra Anda</td>
<td>Frequency</td>
<td>23 GHz</td>
</tr>
<tr>
<td></td>
<td>Actual RX Power</td>
<td>-41.8 dBm</td>
</tr>
<tr>
<td></td>
<td>TX Power</td>
<td>17.5 dBm</td>
</tr>
</tbody>
</table>

a) Calculation of FSL from Tebu site to Mitra Anda site

Based on existing data, the distance between Tebu site to Mitra Anda site is 3.5 km in a straight line and the frequency at the receiver is 23 GHz.

\[
FSL (dB) = 20 \log (D) + 20 \log (f) + 92.45
\]

\[
= 20 \log (3.5) + 20 \log (23) + 92.45
\]

\[
= 10.88 + 27.23 + 92.45
\]

\[
= 130.56 \text{ dB}
\]

b) Calculation of antenna gain from Tebu site to Mitra Anda site

Based on existing data, the diameter of the receiver antenna at site Tebu to site Mitra Anda is 0.6 m and the frequency at the receiver is 23 GHz.
c) RSL Calculation from Tebu site to Mitra Anda site

Based on existing data, the Tx Power is 17.5 dBm, the antenna gain is 40.59 dB and the FSL value is 130.56 dB.

\[
\text{RSL} = \text{PRX} = \text{PTX} + \text{GTX} + \text{GRX} - \text{FSL}
\]
\[
= 17.5 + 40.59 + 40.59 - 130.56
\]
\[
= -31.88 \text{ dBm}
\]

2. Mitra Anda site to Gertak site

Based on existing data, the distance between Mitra Anda site to the Gertak site is 1.5 km in a straight line and the frequency on the receiver is 23 GHz.

\[
\text{FSL (dB)} = 20 \log (D) + 20 \log (f) + 92.45
\]
\[
= 20 \log (1.5) + 20 \log (23) + 92.45
\]
\[
= 3.52 + 27.23 + 92.45
\]
\[
= 123.2 \text{ dB}
\]

b) Calculation of antenna gain from Mitra Anda site to Gertak site

Based on existing data, the diameter of the receiver antenna at the Mitra Anda site to the Gertak site is 0.3 m and the frequency at the receiver is 23 GHz.

\[
G = 17.8 + 20 \log \varnothing + 20 \log f
\]
\[
= 17.8 + 20 \log (0.3) + 20 \log (23)
\]
\[
= 17.8 + (-10.46) + 27.23
\]
\[
= 34.57 \text{ dBi}
\]

c) RSL Calculation from Mitra Anda site to Gertak site

Based on existing data, the Tx Power is 22.0 dBm, the antenna gain is 34.57 dB and the FSL value is 123.20 dB.

\[
\text{RSL} = \text{PRX} = \text{PTX} + \text{GTX} + \text{GRX} - \text{FSL}
\]
\[
= 22.0 + 34.57 + 34.57 - 123.20
\]
\[
= -32.06 \text{ dBm}
\]

3. Site Mitra Anda to New Site

Based on existing data, the distance between Mitra Anda site to the Gertak site is 1.5 km in a straight line and the frequency on the receiver is 23 GHz.

\[
\text{FSL (dB)} = 20 \log (D) + 20 \log (f) + 92.45
\]
\[
= 20 \log (1.5) + 20 \log (23) + 92.45
\]
\[
= 3.52 + 27.23 + 92.45
\]
\[
= 123.2 \text{ dB}
\]

b) Calculation of antenna gain from Mitra Anda site to Gertak site

Based on existing data, the diameter of the receiver antenna at the Mitra Anda site to the Gertak site is 0.3 m and the frequency at the receiver is 23 GHz.

\[
G = 17.8 + 20 \log \varnothing + 20 \log f
\]
\[
= 17.8 + 20 \log (0.3) + 20 \log (23)
\]
\[
= 17.8 + (-10.46) + 27.23
\]
\[
= 34.57 \text{ dBi}
\]

c) RSL Calculation from Mitra Anda site to Gertak site

Based on existing data, the Tx Power is 22.0 dBm, the antenna gain is 34.57 dB and the FSL value is 123.20 dB.

\[
\text{RSL} = \text{PRX} = \text{PTX} + \text{GTX} + \text{GRX} - \text{FSL}
\]
\[
= 22.0 + 34.57 + 34.57 - 123.20
\]
\[
= -32.06 \text{ dBm}
\]
a) Calculation of FSL from Mitra Anda site to New Site

Based on existing data, the distance between your Mitra Anda site and New Site Gertak is 0.8 km in a straight line and the frequency on the receiver is 23 GHz.

FSL (dB) = 20 log (D) + 20 log (f) + 92.45
= 20 log (0.8) + 20 log (23) + 92.45
= 117.74 dB

b) Calculation of antenna gain from Mitra Anda site to New Site

Based on existing data, the diameter of the receiver antenna at the Mitra Anda site to the new site is 0.3 m and the frequency at the receiver is 23 GHz.

G = 17.8 + 20 log Ø + 20 log f
= 17.8 + 20 log (0.3) + 20 log (23)
= 17.8 + 34.57 = 34.57 dBi

c) RSL Calculation from Mitra Anda site to New Site

Based on existing data, the Tx Power is 12 dBm, the antenna gain is 34.57 dB and the FSL value is 117.74 dB.

RSL = PRX = PTX + GTX + GRX – FSL
= 12 + 34.57 + 34.57 – 117.74
= -36.6 dBm

4. Gertak site to Grand Mahkota site

a) Calculation of FSL from Gertak site to Grand Mahkota site

Based on existing data, the distance between the Gertak site to the Grand Mahkota site is 1.2 km in a straight line and the frequency on the receiver is 23 GHz.

FSL (dB) = 20 log (D) + 20 log (f) + 92.45
= 20 log (1.2) + 20 log (23) + 92.45
= 121.26 dB

b) Calculation of antenna gain from Gertak to Grand Mahkota site

Based on existing data, the diameter of the receiver antenna at the Gertak site to the Grand Mahkota site is 0.3 m and the frequency at the receiver is 23 GHz.

G = 17.8 + 20 log Ø + 20 log f
= 17.8 + 20 log (0.3) + 20 log (23)
= 17.8 + 34.57 = 34.57 dBi
c) RSL Calculation from Gertak site to Grand Mahkota site
Based on existing data, the Tx Power is 19 dBm, the antenna gain is 34.57 dB and the FSL value is 121.26 dB.
RSL = PRX = PTX + GTX + GRX – FSL
= 19 + 34.57 + 34.57 – 121.26
= -33.12 dBm

5. Merdeka Barat site to Siantan Tengah site

![Image](image1.png)

Figure 14. The First display of Microwave Antenna Parameters at Siantan Tengah site

![Image](image2.png)

Figure 15. The Second Display of Microwave Antenna Parameters at Siantan Tengah site

Table 12. Microwave Antenna Parameters at Gertak site to Siantan Tengah site

<table>
<thead>
<tr>
<th>Name Site</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merdeka Barat to Siantan Tengah</td>
<td>Frequency</td>
<td>23 GHz</td>
</tr>
<tr>
<td></td>
<td>Actual RX Power</td>
<td>-30.8 dBm</td>
</tr>
<tr>
<td></td>
<td>TX Power</td>
<td>19.5 dBm</td>
</tr>
</tbody>
</table>

a) Calculation of FSL from Merdeka Barat site to Siantan Tengah site
Based on existing data, the distance between the Merdeka Barat site and the Siantan Tengah site is 10 km in a straight line and the frequency on the receiver is 23 GHz.
FSL (dB) = 20 log (D) + 20 log (f) + 92.45
= 20 log (10) + 20 log (23) + 92.45
= 19.08 + 27.23 + 92.45
= 139.68 dB

b) Calculation of antenna gain from Merdeka Barat site to Siantan Tengah site
Based on existing data, the diameter of the receiver antenna at the Gertak site to the Grand Mahkota site is 0.9 m and the frequency at the receiver is 23 GHz.
G = 17.8 + 20 log Ø + 20 log f
= 17.8 + 20 log (0.9) + 20 log (23)
= 17.8 + (-0.9151) + 27.23
= 44.11 dBi

So, the obtained FSL value is calculated by changing parameter D, namely the distance between one site and another. The change that occurs in the FSL calculation is that the greater the distance between sites, the greater the FSL value. The gain value of the antenna is calculated by changing the variable diameter of the microwave antenna, where the larger the diameter of the antenna, the greater the gain value. The effect of the antenna diameter on the gain value is that the larger the diameter used, the greater the receiving power from the transmitting antenna due to the wider antenna coverage.

IV.3 The Effect of Microwave Antenna Diameter on Receiving Power in StarWeb LCT and Link Budget Calculation

The data being compared is the RSL value. Figure 16 shows a comparison of the RSL values contained in the StarWeb LCT software and in the calculations of the link budget.
The RSL value between the data in the StarWeb LCT software and the link budget calculation has a slight difference. This is because there are several values in the different link budget calculation parameters, such as rounding off numbers that affect the final calculation result. In addition, the RSL values are also different because the signal waves propagate in free space at short or long distances with LOS conditions or without obstacles without any attenuation on the transmission line.

The receiving power parameter used as a benchmark in determining the transmission performance of microwave antennas at base stations is adjusted to the standard provisions according to the International Telecommunication Union (ITU) as follows:

Table 13. Acceptability Rated Standard Based on ITU-D

<table>
<thead>
<tr>
<th>No.</th>
<th>Power Reception</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; -50 dBm</td>
<td>Very Good</td>
</tr>
<tr>
<td>2</td>
<td>-50 dBm s/d -88 dBm</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>&lt; -88 dBm</td>
<td>Bad</td>
</tr>
</tbody>
</table>

(Source: International Telecommunication Union For Development)

IV.4 Comparison of Microwave Antenna Diameter Against Signal Emitting Distance

In this study, the diameter sizes of the microwave antennas compared were 0.3 m, 0.6 m, 0.9 m and 1.8 m at the New site, Mitra Anda site, Siantan Tengah site and Kuala Dua site. At the New site, the diameter of the microwave antenna is 0.3 m which is the receiver from your Mitra site which is 0.8 km away. For the Mitra Anda site, the diameter of the microwave antenna is 0.6 m which is the receiver from the Tebu site which is 3.5 km away and the Siantan Tengah site has a microwave antenna with a diameter of 0.9 m which is the receiver from the Merdeka Barat site which is 9 km away. Whereas the Kuala Dua site has a microwave antenna diameter of 1.8 m which is a receiver from the Wonyoso site which is 17.3 km away.

IV.5 The Comparison Simulation of Microwave Antenna Diameter Against Signal Emitting Distance

In diameter of 0.3 m, the distance of the transmitted signal is 1 km to 2 km and at a diameter of 0.6 m, the distance of the transmitted signal is 3 km to 4 km. For a diameter of 0.9 m, the distance of the transmitted signal is 9 to 12 km. Meanwhile, for a microwave antenna with a diameter of 1.8 m, the distance of the transmitted signal is 17 to 19 km. The installation of the diameter size of the microwave antenna varies depending on the location of the BTS placement and the needs around the location. For example, a microwave antenna with a large diameter is used in densely populated residential locations because there will be many users or users around the placement of the BTS.

Table 14. Comparison of Microwave Antenna Diameters

<table>
<thead>
<tr>
<th>No.</th>
<th>Microwave Antenna Diameter</th>
<th>Signal Transmission Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.8 m</td>
<td>17 – 19 km</td>
</tr>
<tr>
<td>2</td>
<td>0.9 m</td>
<td>9 – 12 km</td>
</tr>
<tr>
<td>3</td>
<td>0.6 m</td>
<td>3 – 4 km</td>
</tr>
<tr>
<td>4</td>
<td>0.3 m</td>
<td>1 – 2 km</td>
</tr>
</tbody>
</table>

The ODU frequency is also related to the distance of the signal transmission power, where the smaller the frequency used, the farther the distance of the signal transmission power.

Table 15. The Effect of Microwave Antenna Diameter of ODU Frequency

<table>
<thead>
<tr>
<th>No.</th>
<th>Microwave Antenna Diameter</th>
<th>ODU Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.8 m</td>
<td>7 GHz</td>
</tr>
<tr>
<td>2</td>
<td>0.9 m</td>
<td>23 GHz</td>
</tr>
<tr>
<td>3</td>
<td>0.6 m</td>
<td>23 GHz</td>
</tr>
<tr>
<td>4</td>
<td>0.3 m</td>
<td>23 GHz</td>
</tr>
</tbody>
</table>
V. Conclusions

The diameter of the microwave antenna affects the RSL (Received Signal Level) and the signal transmission distance. As for the comparison of the RSL value on the StarWeb LCT with the RSL value in the link budget calculation, this is due to the signal wave propagating in free space at short and long distances with LOS conditions without any attenuation on the transmission line. The larger the diameter of the microwave antenna used, the farther the signal transmission distance will be. On the BTS New Site, the microwave antenna has a diameter of 0.3 m which means it can transmit signals as far as approximately 1-2 km from the Tx in your Partner BTS. Your Partner BTS which has a microwave antenna diameter of 0.6 m with a signal transmission distance of 3-4 km from Tx on Tebu BTS, Siantan Tengah BTS which has a microwave antenna with a diameter of 0.9 m and can reach signals approximately 9-12 km from Tx which is on Merdeka Barat BTS. Finally, the Kuala Dua BTS which has a microwave antenna with a diameter of 1.8 m can transmit signals as far as 17-19 km from Tx which is on the Wonoyoso BTS. From these data, it can be concluded that the larger the diameter of the microwave antenna used, the farther the signal transmission distance will be.

Bibliography


