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# Long Term Evolution Network Planning Using The Backhaul Microwave Link in The Village Wangunharja Lembang District

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**ABSTRACT**

Wangunharja village has an area of 832 ha and a population of 8256. In this village, 4G LTE network coverage still does not reach the entire region. Therefore, LTE network planning is needed to expand coverage in the area. This study was carried out by analyzing and planning LTE networks use microwave backhaul in Wangunharja Village. The first step is to check the quality of the signal along the main line of the village. Then, plan for capacity and LTE network coverage to determine the number of sites needed. Next, microwave backhaul planning is carried out with work frequency based on the distance of the backhaul link. Based on the LTE network planning the calculations show that two sites are required to cover the Wangunharja Village area. Furthermore, planning simulations are carried out using simulation software, and the values of the three parameters measured have met the operator's KPI standards. With a microwave link distance of 2.87 km, the operating frequency of the microwave antenna operates at 11 GHz.The results of microwave link calculations and simulations for the value of the received power level are -18.95 dBm, with a gain antenna of 45.8 dBi obtained fading margin of 49.04 dBm so that the availability value or level of availability in one year is 99.999%.



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## 1. INTRODUCTION

Wangunharja village is one of the village located in Lembang District, West Bandung Regency. This village has area 832 Ha with a population of 8256 souls [1]. However, there are still many areas in this village that has not been reached by the 4G network. The solution that can be done is to expand scope by augmenting eNodeB with use microwave backhaul for easy installation. This type of backhaul also very suitable to be applied to this village. There are several studies related to this final project. That is on research [2] raised the topic of planning LTE network coverage and capacity for deep fading area. Then, on research [3], which describes LTE network planning using microwave backhaul in central Sumba District. Then in research [4] explains regarding LTE network planning using microwave backhaul on the island G(Golf) Reclamation. In this research, planning is carried out LTE network with microwave backhaul on Wangunharja Village uses software simulation. Before planning network, this research was conducted initial drive test along the main road of Wangunharja Village use a special handset drive test for see the signal quality in the village. This planning is done on the frequency band 1850MHz. parameters used for data comparator is Signal to Interference plus Noise Ratio (SINR), Reference Signal Level (RSL) [7], and Throughput [8].

## 2. METHOD

### 2.1. Flow diagram

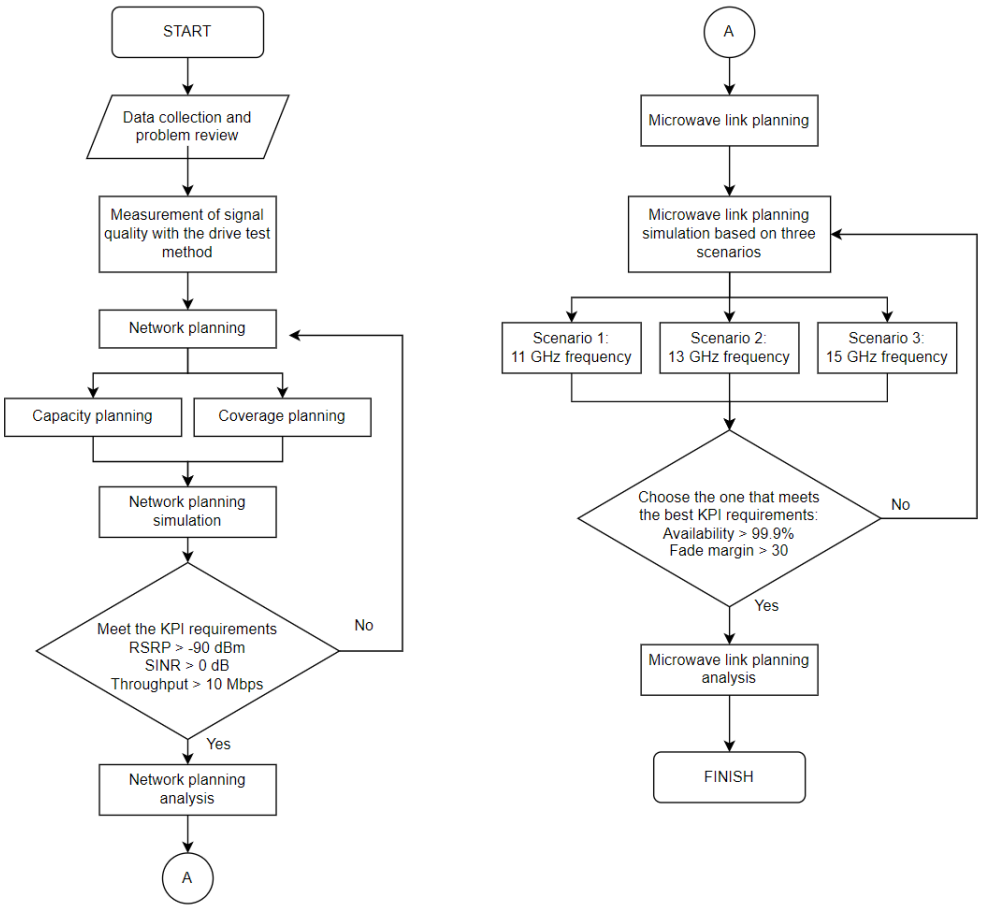


Figure 1. The research flow chart

In this study, the outline is divided into three structured stages as shows in figure 1, aim to get the final result accordingly hope. The first stage is to collect data from Wangunharja Village. Collected data is the existing condition of the village Wangunharja and also looking for information about how the condition of the internet network in The village uses the drive test method. The second stage is planning LTE network [5] as in research [2] and [4] based on capacity calculations and coverage. For capacity calculations, population data is required current and perform approximate calculations population in the next five years then do the calculations to find the minimum number of sites required based on total population. For coverage calculation, required data parameter type of propagation Cost-231 for determine the cell radius, then look for the number minimum sites required [6]. After searching number of sites on planning and capacity network, then determine the number of sites the most of the two plans that Then proceed with the planning simulation using simulation software. After determine the coordinates of the latest site, next measurements of the microwave backhaul link were carried out as in the study [4] using three scenarios with frequency different. By way of link measurement budget on the microwave backhaul link in order get RSL > -79 dBm and availability > 99.99%.

### 2.2. Data collection and initial drive test

In this research, the first thing to do is collect data in the form of information about the area to be planning such as village coverage, population and find out the standards KPIs on carriers that will come in handy when conducted an initial drive test in the village of Wangunharja. Wangunharja Village is a village in Lembang District West Bandung Regency. This village has area of 832 hectares filled by 8256 resident souls [1]. There is no 4G service in this village yet evenly because in this village only has one eNodeB site from an operator located on the outskirts of the village. By because of that the author did a drivetest with the following results:

1. RSRP Parameter Value

Signal strength gain on the main road still far from normal category because there are still 31.4% areas with poor category and 55.2% area is included in the category of very poor with an average value of -102.39 dBm.

2. SINR Parameter Value
The acquisition of SINR values on the main roads is still far from normal category because there is still 56.2% region has a SINR value < 0 dB with poor category with an average value of SINR on the main road of 0.45 dB.

3. Throughput Value
Acquisition of throughput values on the main one is still far away from the normal category because of the average value the throughput obtained is 109.6 Kbps, while the throughput value is said to be feasible if the throughput value is greater than 10 Mbps.

### 2.3. Capacity planning

At this stage, network planning prioritizes user traffic needs by calculating the quality and capacity of a network to determine the number of eNodeB sites needed based on user capacity. The number of eNodeB sites obtained from capacity planning calculations is calculated using an equation with an estimated number of sites which can be obtained by comparing the values the highest number of antennas between uplink and downlink. Table 1 shows the results of calculating the number of sites using capacity planning.

Table 1. Total site calculation capacity planning.

| Total Site Calculation | | |
|---|---|---|
| Parameter | Uplink Value | Downlink Value |
| Total Area ($Km^2$) | 08.38 | |
| Target User | 2268 | |
| Network TP (MAC) (Mbps) | 6.669 | 15.626 |
| Cell Avg TP (Mbps) | 40.895 | 34.087 |
| Site Capacity (Mbps) | 122.680 | 102.239 |
| Site Number | 1 | 1 |
| LTE Users per Site | 2262 | 2262 |
| Coverage per Site ($Km^2$) | 8.380 | 8.380 |
| Coverage per Cell ($Km^2$) | 2.793 | 2.793 |
| Cell Radius (Km) | 1.196 | 1.196 |

### 2.4. Coverage planning

At this stage, network planning is reviewed through the area to be covered in an area by calculating the required MAPL (Maximum Allowable Path Loss) to obtain the cell radius, then calculations are carried out to determine the number of sites required.

Table 2. Total site calculation coverage planning.

| Total Site Calculation | |
|---|---|
| Parameter | Value |
| Total Area ($Km^2$) | 08.38 |
| Coverage per Site (3-sectoral) ($Km^2$) | 0,23125 |
| Total Site (3-sectoral) | 2 |

In table 2 it can be concluded that the number of sites used to carry out the coverage design is two sites. After obtaining the results of calculations from coverage and capacity planning, LTE network planning is then carried out using simulation software. This simulation takes the results from the highest number of sites between coverage and capacity planning.

### 2.5. Microwave Link Planning

An analysis of the link budget calculation is needed to calculate the receiving power on the receiver side [9]. The link budget parameter is determined from the total addition and reduction of the gain and loss that occurs on the microwave link path [10]. The parameters used by the link budget use the specifications of the microwave antenna device, then proceed with the calculation of the link budget and fade margin with the following results:

Table 3. Link budget microwave link.

| Link Budget Microwave Link | | | |
|---|---|---|---|
| 11 GHz | Transmit Power (Ptx) | 22 | dBm |
| | Antenna Gain (Tx/Rx) | 45.8 | dBi |
| | Rx Sensitivity | -68 | dBm |
| | Loss Feeder (Ltx/Lrx) | 5.04 | dB |
| | Free Space Loss | 122.43 | dB |
| | Receptive Power (Prx) | -18.95 | dB |
| | Fade Margin | 49.04 | dB |
| 13 GHz | Transmit Power (Ptx) | 29 | dBm |
| | Antenna Gain (Tx/Rx) | 41.8 | dBi |
| | Rx Sensitivity | -69 | dBm |
| | Loss Feeder (Ltx/Lrx) | 5.45 | dB |
| | Free Space Loss | 123.88 | dB |
| | Receptive Power (Prx) | -22.25 | dB |
| | Fade Margin | 466.74 | dB |
| 15 GHz | Transmit Power (Ptx) | 18 | dBm |
| | Antenna Gain (Tx/Rx) | 48.7 | dBi |
| | Rx Sensitivity | -67.5 | dBm |
| | Loss Feeder (Ltx/Lrx) | 6.69 | dB |
| | Free Space Loss | 125.12 | dB |
| | Receptive Power (Prx) | -23.22 | dB |
| | Fade Margin | 44.27 | dB |

## 3. RESULTS AND DISCUSSION

### 3.1. LTE Planning Results

After obtaining the required number of sites, planning simulations were then carried out in Wangunharja Village using the required simulation software with the eNodeB data site in chapter 3 and the configuration used was the Tri-sector antenna where each site has three sectoral antennas where each antenna it can transmit signals farther than omnidirectional antenna models. In addition, the height of the antenna at New_Site is also determined as high as 40 m with various azimuth and downtilt angles. as well as the maximum transmit power of the sender of 46 dBm on each antenna. The planning position for each antenna can be seen in Figure 2:

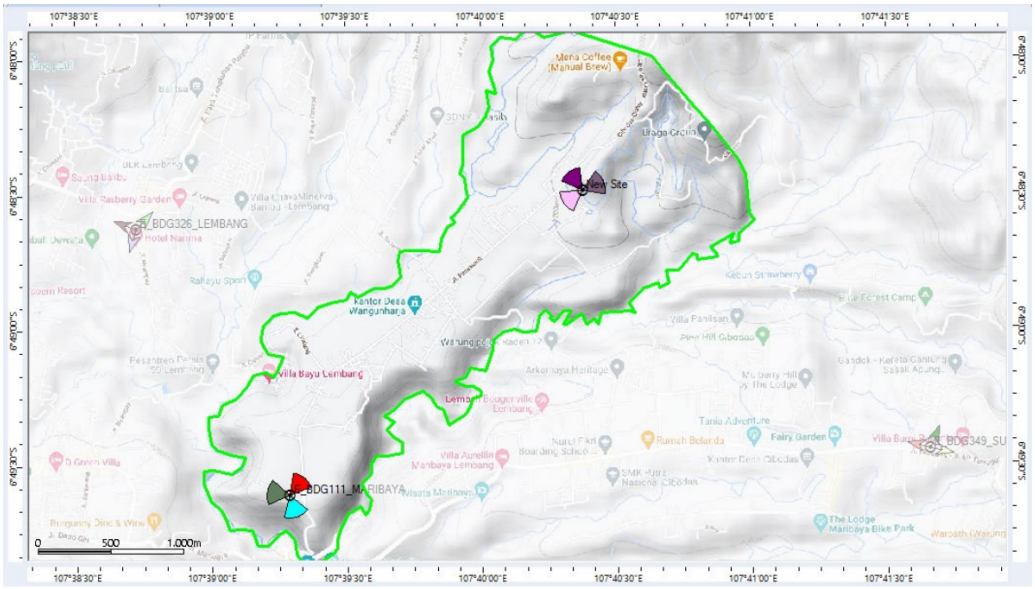


Figure 2. LTE Planning for Wangunharja Village.

Table 4 is a comparison of each parameter from the results obtained using the drive test method, LTE simulation before planning using one site, and simulating LTE after the planning has been done using two sites. The data obtained from the drive test is data that taken directly on the main road of Wangunharja Village, so the value is obtained is different from the simulation before planning using software. The table also explains that after planning LTE, the three parameters used have increased, so that it can be it is said that LTE planning in Wangunharja Village is feasible to implement.

Table 4. Comparison of LTE planning simulation results.

| Parameter | Drive Test | Before LTE Planning | After LTE Planning |
|---|---|---|---|
| RSRP (dBm) | -102,39 | -98,3 | -75,86 |
| SINR (dB) | 0,45 | 4,48 | 8,16 |
| Throughput (Kbps) | 109,6 | 9570 | 39420 |

### 3.2. Microwave link planning analysis

Things to consider in planning a microwave link are: determine the frequency and type of polarization, in order to maintain the quality of the link on each hops from interference. The frequency used must comply with that standard has been determined by the Ministry of KOMINFO No. 2 of 2019, work frequency used by the microwave antenna is determined based on the distance between transmitting antenna and receiving antenna. The farther the link distance, the frequency used will be smaller. In this planning, the link distance between the existing site and the new site located in Wangunjarja Village, 2.87 Km away. The required working frequency at the link distance is 11 GHz with a microwave link bandwidth used of 40 MHz and type the polarization used is vertical in order to get the spread of the signal closer.

In this simulation, the microwave link parameter calculation results are obtained where the availability value or availability level is as expected, namely > 99.9%. In addition, the value of the minimum received power level is -70.5 dBm at 11 GHz frequency, and the achievement of Line-of-Sight propagation. So it can be concluded that the simulation results of the parameter values carried out can be seen in Table 5 below.

Table 5. Planning recapitulation results.

| Site A | Site B | Distance (Km) | Prx (dBm) | Fading Margin (dBm) | Availability (%) | Conclusion |
|---|---|---|---|---|---|---|
| Existing Site | New Site | 2.87 | -18.95 | 51.54 | 99.99 | Achieved |

It can be seen that the microwave link produces a value of the received power level (Prx) which has met the achievement where the minimum received power level (Rx Threshold) is -70.5 dBm with the resulting

received power level in this plan of -18.95 dBm. By calculating the link budget on the existing parameters, a fading margin value of 51.54 dBm is obtained, so an availability of 99.999% is obtained. So it can be concluded that the microwave link planning in Wangunharja Village is feasible to implement.

## 4. CONCLUSION

Based on the LTE network planning the calculations show that two sites are required to cover the Wangunharja Village area. Furthermore, planning simulations are carried out using simulation software, and the values of the three parameters measured have met the operator's KPI standards. With a microwave link distance of 2.87 km, the operating frequency of the microwave antenna operates at 11 GHz. The results of microwave link calculations and simulations for the value of the received power level are -18.95 dBm, with a gain antenna of 45.8 dBi obtained fading margin of 49.04 dBm so that the availability value or level of availability in one year is 99.999%.

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