Analysis and Implementation of Grid Antennas with varied Center Beam Antennas performance

Daniel Silli Bataona[1], Jemsrado Sine[1], Gloria Christiana Manulangga[1]

{danielbataona@pnk.ac.id, jemsradosine@pnk.ac.id. gloriamanulangga@pnk.ac.id}
State Polytechnic of Kupang[1]

Abstract. Problems of network expansion between campuses at State Polytechnic of Kupang are still an obstacle. The problem of research needs to be done early research so that the results of this study can be implementing in internet network systems between Campus A and Campus B. This Research use Research and Development methods to guarantee the accuracy in the results of research and implementation of the desired Antenna Grid devices. Testing results are looking at the effect of shift *Center Beam Antenna* on the size of the *throughput* and *alignment* antenna based on the principle of *Line Of Sight (LOS)*. The results of the study were also able to provide results in the form of the size of the Antenna Grid signal presentation to the shift *Center Beam* antenna according to the location of the Building and location contours at State Polytechnic of Kupang. Performing three stages of LOS Grid antenna testing with a test distance of 100 meters, 125 meters, and 200 meters, the transmit average value is 101.923 kbps, and the average receive value is 890.591 kbps. The next stage of testing is Grid antenna testing with the unidirectional placement of the antenna between the Sending and Receiving Antennas with a 200-meter test distance, and the transmit average value is 1.4826 kbps, and the average receive value is 2.2679 kbps.

Keywords: Grid Antenna, Center Beam, Hotspot, Internet, Client-Server

1 Introduction

The Department of Electrical Engineering is one of the departments in Kupang State Polytechnic. With a reasonably large building area, which consists of lecture buildings and computer labs filled with students. *The internet* has become one of the basic needs every day to work on information. Therefore, The Institution has provided *HotSpot* [1]–[4]for students to access the *internet*. However, the existing network *internet* at the Kupang State Polytechnic, especially in the computer lab and Multimedia Room, the Department of Electrical Engineering to access and work on information and material is still minimal, both from the number of *clients*, the distance between each room and the distance of each building. Considering the number of students (*clients*) in the New Building of Campus B of the Kupang State Polytechnic who want to be connecting in accessing the *internet*, it is necessary to have a device that can provide convenience in supporting connectivity between *client* and *server*.

The problem in question is when it will expand the network between Campus A and Campus B buildings of the Kupang State Polytechnic. The solution needs to be done to increase the network coverage needed. How to increase the coverage of a Wifi network, an external antenna with a high gain is needed compared to the standard antenna used. One of

ICESC 2019, October 18-19, Indonesia

DOI 10.4108/eai.18-10-2019.2289919

them is a directional antenna that is used on the client-side, for example, a parabolic reflector [5]–[7].

For this reason, in this research, we choose the Antenna Grid device to help solve these problems so that the internet network can be used by other buildings that are located quite far away. In a considerable distance, it is not possible to use cable transmissions except for Optical Fiber, but due to problems in the availability of devices and readiness for application, the use of Grid Antennas was chosen. In addition to implementation, it will also be seen the measurement of *Alignment* Antenna and *Throughput* Antenna from position *LOS* with shift pattern *Center Variable* beams so that comparative data and research results can be used as a reference in the placement and pointing of the antenna grid for other buildings both in Campus A and Campus B or between Campus A and Campus B.

2 Related Works

According to Nugraha Yurandi et al., [8], currently, wifi has been widely applied in various strategic locations. In these places, users are usually free to use internet access. For those who live near the access point is an advantage, for those who live far away can access the access point by building antennas with high gain as a receiver, because with high gain the range increases, for example, there is a directional antenna with a parabolic reflector. In this study, the antenna was designed and implemented using a reflector with wok and wire. The design is based on theoretical calculations of the reflector and waveguide focal points and is tested with conditions indoors and outdoors. From the results of measurements and analysis, obtained wajanbolic and gridbolic gain equal to 17.065 dBi, while the theoretical gain was 17.18 dBi. The wajanbolic signal level of -40.94 dBm (indoor) and -75.38 dBm (outdoor) is higher than the gridbolic signal level of -47.02 dBm (indoor) and -83 dBm (outdoor). Wajanbolic captures 16 access points while gridbolic 14 access points. Thus wajanbolic is superior to gridbolic.

In the research of Iqbal Maulana Mustaqim [9], the WMAN network design in BAPUSIPDA began with problems to make efficient use of the internet and funds spent to subscribe to the internet. While the use of funds to use internet access provided by the central office is limited and the separation of the two buildings between BAPUSIPDA West Java and BAPUSIPDA Bandung, it is planned to build a WMAN network to replace the network lines that have been installed by the provider. The WMAN network was chosen as access because the costs incurred would not be continuous only during the design and implementation.

The method used is a point to point WMAN network design between West Java BAPUSIPDA building and BAPUSIPDA Bandung. The device used in the design and implementation of the WMAN uses a grid antenna as a transmitter and a sectoral antenna on the receiver. Point to point communication between the two antennas is made in the line of sight without any obstacle. In the design and implementation of this WMAN get good Quality of Service measurement results. This can be seen from the value of the test results of several parameters, namely an average delay of 15.67ms, an average packet loss of 0.67%, and a throughput of 0.110MBit / sec which is done by accessing several server locations to international locations. So that when compared with the quality of the ITU-T G.114 Quality of

Service, the scores are following these standards, it can be concluded that the design and implementation of the WMAN are quite good.

The purpose of this study [10] is to build a point to point wireless network between Campus A and Campus B, Jakarta State University. This research uses research and development methods which include analysis, design, and implementation activities. The communication channel to connect Campus A and Campus B of Jakarta State University uses Telkom's cable line, and the line is used as the main backbone. Because there is no application of fault tolerance in the pathway, point to point wireless networks need to be prepared as an alternative in the event of failure. Analysis of wireless installation location conditions, namely the height of the 42 m Certification Building and 17 m Student Flat Building, two locations are 911 m with a significant free space loss of 99.24 dB - 99.49 dB, line of sight free from obstructions, and radius of zone fresnel 4 , 27 m - 4.33 m (Telkom BTS) and 5.24 m - 5.32 m (Gedung Rabbani) in unobstructed conditions. Network design planning in the bridge - station bridge mode, using 30 dBm Microtic Metal 2SHPn hardware, 24 dBi Grid Antenna, LMR-400 pigtail cable, and tower triangle. Point to point wireless network was successfully implemented with the test results that there was much interference from other wireless access points, and the connection was successfully made with 0% packet loss, signal strength -64.75 dBm, SNR 41.25 dB, CCQ 86.14%, and 11.15 Mbps throughput.

GSM communication technology (Global System for Mobile Communication) is a cellular communication technology that allows users to access communications based on the coverage of the nearest BTS (Base Transceiver Station), but in certain areas, especially in mountainous areas, there are still areas that have signals with low power levels because of its location far from the GSM transmitter. One solution to overcome this problem is to add an antenna on the user's side (mobile station), to increase the reception of GSM signals in areas that have low power level signals. In this research, Helix antenna has been designed with variations of the number of windings, five windings, eight windings and ten windings which can be used to increase the reception of GSM signals. Antennas are tested on a laboratory scale, and the results are compared with simulation results using 4NEC2 software. As for the parameters analysed are working frequency, bandwidth, VSWR, amplification, radiation pattern and HPBW. To find out the performance of the helix antenna, the antenna is connected to a GSM modem, and the received value of the GSM signal is observed using the software. Based on the test results obtained Helix 5 coil antenna results: working at a frequency = 900MHz, VSWR = 1.09, bandwidth = 50 MHz, HPBW = 400, gain = 5 dB, Helix antenna 8 turns: working at a frequency = 900MHz, VSWR = 1.09, bandwidth = 50 MHz, HPBW = 490, gain = 6 dB, Helix antenna 10 turns: work at frequency = 935MHz, VSWR = 1.12, bandwidth = 35 MHz, HPBW = 350, gain = 7 dB [11] .

Research on the analysis of 2.4 GHz Semi Parabolic Grid antennas for Wireless LAN networks is motivated by many lay people who do not understand the use of wireless LAN technology. With this research [12], it is expected to be able to assist the general public in utilising wireless antennas and Wireless LAN network technology. This research can also be used to provide convenience in obtaining information about Wireless LAN antennas. This research is using the experimental method. The author conducted several research steps, namely literature review, feasibility study consisting of site survey and site survey documentation, the analysis which includes analysing available networks and analysing the use of areas and towers, installation, testing and implementation, evaluation, documentation and compiling a final project report book. The author also experienced several obstacles in the study including the great distance between the Grid antenna and Access Point, the configuration that often experienced errors and the weaknesses found in the Grid antenna which made the link quality decrease. There are several things that affect the quality of the signal emitted by the Access Point, among others: the distance and placement of the Access Point and Grid antenna, the focal point and the corner point between the Access Point and the Grid antenna, whether there is a barrier or interference and the type or brand of the Access Point. Also, the link budget and fade margin greatly affect the reliability of wireless links. 2.4 GHz Semi Parabolic Grid Antennas can be connected to Access Points at a certain distance with a signal strength that is directly proportional to distance.

According to [13], the internet cannot be separated from everyday life. This can be seen from the many free hotspots that have been built. For people who live far away from the free hotspot area, bolic pans and canned antennas are inexpensive solutions for wireless LAN networks. This Final Project focuses on making and comparing the performance of bolic griddle and an antenna that operates at 2.4 GHz frequency for wireless LAN networks, analysing signal strength, decreasing the signal when encountering tree obstacles, and calculating the gain values of the two antennas. As the name implies, this Bolic Skill Antenna uses a reflector from a griddle, with a waveguide from a paralon pipe coated with aluminium tape, and a wireless USB adapter as a signal receiver.

Meanwhile, canned antennas only use waveguides originating from used cans and wireless USB adapters as signal receivers. This research uses Prolink WN2000 Software as a wireless USB installation, Cantennator Software as a calculation for making antenna cans, and WirelessMon Software as a signal strength research. The results of measurements and analysis showed that the pan antenna and tin antenna have the same signal average of -60 dB at a distance of 100 meters. However, Bolic pan is more stable in signal capture. The signal decrease when meeting tree barriers from the two antennas is also the same that is equal to 13 dB at a distance of 100 meters. Bolic skillet gain and can antenna also get the same result, which is 12.15 dB. The recommendation from the author himself is to use a can antenna if the distance of the signal to be captured is not too far if the distance of the signal to be captured is far or the signal that is captured is less stable then it is recommended to use a bolic pan.

In a study of Budi Pratama et.al [14], explained that the use of communication technology using cables has now been replaced by wireless communication technology, where most users use access point devices that have a limited beam coverage due to omnidirectional radiation patterns, so we need an antenna that has directional radiation patterns for a more directional beam range. The Yagi antenna is one that can be used to overcome this problem. In this study, the designed Yagi antenna can be applied to WLAN systems. The results of the implementation found that the Yagi antenna can work at 2.4 GHz WLAN working frequency. Moreover, besides getting a level of field strength with an average increase in the gain of the yagi antenna to the Omni antenna by 12.1 dB. Besides that Yagi antenna gain is 16 dB while the simulation results are 10 dB, vertical beamwidth 250 and horizontal 260, and antenna bandwidth 150 MHz. In this study, the results obtained are compared with the results of vistumbler software and SuperNEC 2.9.

Based on research Nugraha Yurandi et al.,[8], currently wifi has been widely applied in various strategic locations. In these places, users are usually free to use internet access. For those who live near the access point is an advantage, for those who live far away can access the access point by building antennas with high gain as a receiver, because with high gain the range increases, for example, there is a directional antenna with a parabolic reflector. In this study, the antenna was designed and implemented using a reflector with wok and wire. The design is based on theoretical calculations of the reflector and waveguide focal points and is tested with conditions indoors and outdoors. From the results of measurements and analysis, obtained wajanbolic and gridbolic gain equal to 17.065 dBi, while the theoretical gain was

17.18 dBi. The wajanbolic signal level of -40.94 dBm (indoor) and -75.38 dBm (outdoor) is higher than the gridbolic signal level of -47.02 dBm (indoor) and -83 dBm (outdoor). Wajanbolic captures 16 access points while gridbolic 14 access points. Thus wajanbolic is superior to gridbolic.

3 Network Topology and Configuration Process

3.1 Network Topology

Implementing and expanding WLAN networks using Grid Antennas with Bridge Mode. The location is in the Electrical Engineering Department of the State Polytechnic of Kupang. Where the Bridge Mode is a network component used to expand a network or create a network segment, the function bridge most important in a network is to forward data based on addresses MAC (Media Access Control) from the sending device to the receiving device.

The results of the design of the placement of the Antenna, Switch and Access Point on the network WLAN Multimedia Building, Electrical Engineering Department of the State Polytechnic of Kupang can be seen in figure 1.

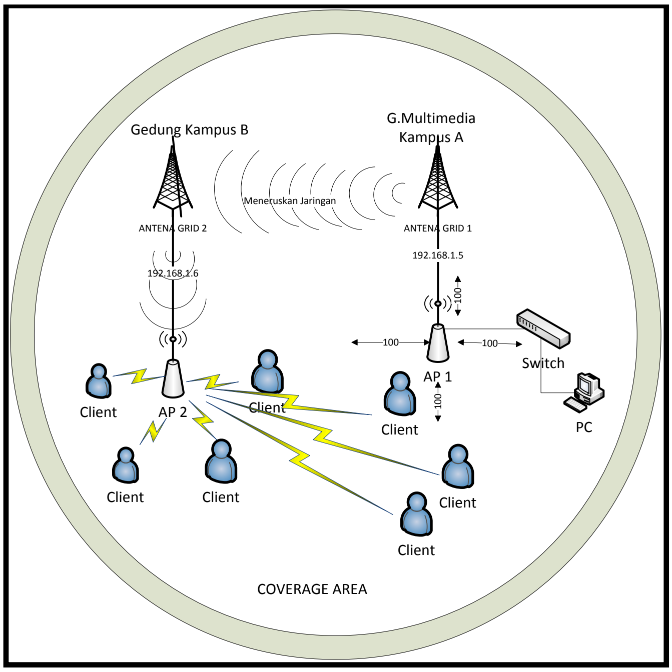

Fig. 1. Network Topology Model

3.2 Configuration

In the configuration of the access point, used two the access point models of TP-Link TL WA701ND wherein the first access point as the sender and the second access point as a receiver.

- Connect the Tp Link Tl Wa701nd power cable to the power source and connect the default UTP Tp-Link T70 WaL1nd cable to the laptop that we will use for configuration. Open a browser and type the default IP Tl Wa701nd in Web Browser 192.168.0.254.
- On the configuration, page network selects LAN, enter Ip Address: 192.168.100.10, Subnet Mask: 255.255 .255.0, Default gateway: 192.168.100.1 then click save.
- Ip Address 192.168.100.10 functions as the Access point IP address. Subnet Mask 255.255.255.0 functions as a differentiator between network ID and Host ID. Gateway 192.168.100.1 functions as the IP Address of the TLWA701ND TP-Link.
- Configuration DHCP select DHCP Settings to select DHCP Server, and then Start Ip Address: 192.168 .100.100, End Ip Address: 192.168.100.199, Default Gateway: 192.168.100.10, Primary DNS: 202.134.1.10;
- DHCP Server: Enable aims to activate the DHCP Server, start IP address for the division of IP addresses from 192.168.100.100 to 192.168.100.199, Default Gateway: 192.168.100.10 is an IP address that functions to connect devices to the network. Primary DNS: 202.134.1.10 is Server IP address.

4 Testing and Analysis

After completing the setup process access point, the next step is to do antenna testing. Testing is done in order to get data from the system so that with this data can find out the performance of the antenna. The test results can be used as a reference in device analysis.

In this testing grid antenna, we use two grid antennas, one of which functions as a sender (Master-AP) and one antenna as a receiver (Master AP-Extend). The following are some of the stages of testing that have been done to find out the best signal strength in using this grid antenna:

- Testing with a default Access Point antenna, both the sender (Master-AP) and receiver (Master AP-Extend);
- Testing where the Master-AP uses a grid antenna, and The AP-extend master uses the built-in antenna;
- Testing Between Master-AP and Master AP-Extend uses a grid antenna.

This test aims to determine the distance and strength of the smallest signal sent from the AP (as a sender) and will receive the access point of the receiver (AP-Extend Master).

Results test can be proved that with a distance of two kilometres, the smallest signal condition in the Master-AP can be received and continued by the Master AP-Extend with an excellent signal magnitude. Testing and measuring the strength of the signal obtained by each access point both the sender and receiver.

The distance of two kilometres, the signal sent by the Master AP with a power of -88 dBm can be received by the Master AP Extend with a signal strength of -38 dBm. The above test proves that the Master AP antenna with a weak signal condition can still be received and emitted by the Master Ap Extend.

This test aims to determine the distance and strength of the smallest signal sent from the Master-AP (as a sender) using the antenna grid and will be forwarded to the receiving Access Point (Master AP-Extend) using the default antenna Access point.

As we can see in Fig.2 with a distance of two kilometres [15], the signal sent by the AP Master using a grid antenna with a strength of -72 dBm can be received by the Master AP Extend with a signal strength of -44 dBm [16]. The above test proves that the Master AP antenna with a weak signal condition can still be received and emitted by the Master Ap Extend.

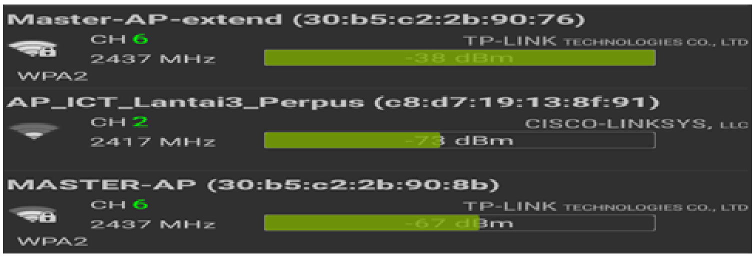

Fig. 2. Testing between Grid Antenna and the AP-Extend Master

Fig.3 gives us information about Throughput monitor. It can be explained even with Run time in 172 seconds. Transmit indicator : Current 29,3808 kbps, Max 429,5468 kbps, Min 11,843 kbps and Average 77,2347 kbps. While Receive indicator : Current 27,22285 kbps, Max 416,2187 kbps, Min 5,1406 kbps and Average 63,6681 kbps.

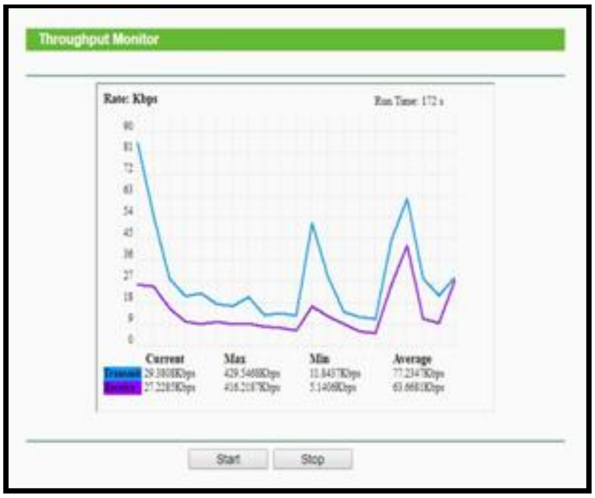

Fig. 3. Throughput Monitor 172s View

At Fig 4. Throughput monitor can be explained even by Run time: 80 s Transmit/ Sender with Current 15.5136 kbps, Max 429.5468 kbps, Min 12.6835 kbps and Average 132.2325 kbps. While Receive/ Receiver with Current 9.5917 kbps, Max 416.2187 kbps, Min 5.3886 kbps and Average 120. 9051 kbps.

Fig. 4. Throughput Monitor 80s View

As we can see in Fig. 5, the Throughput Monitor explained that with Run time: 124 s **Transmit/ Sender** with Current 13.457 kbps, Max 429.5468 kbps, Min 12.6835 kbps and Average 96.3018 kbps. While **Receive/ Receiver** with Current is 7.8164 kbps, Max 416.2187 kbps, Min 5.3886 kbps and Average 82.6043kbps.

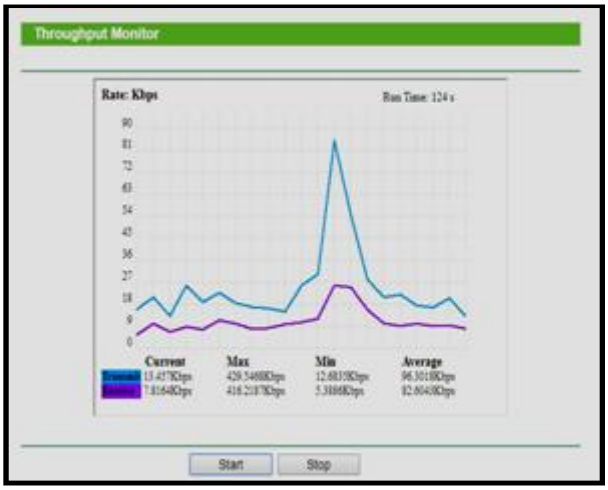

Fig. 5. Throughput Monitor 124s View

Based on the test, it can be explained that the data can be through several stages of testing and placement of different positions and transmit distances between Antennas that function as transmitter/ sender or receiver/ receiver. Where the average value transmitter 101.923 kbps and an average receive 890.591 kbps. The result analysis we can see in Table 1

Table 1. Table title. Table captions Testing Results Transmittance of unidirectional transmittance between Sender and Receiver Antenna

NO	Transmiter				Receiver			
	Current (kbps)	*Max (kbps)*	*Min (kbps)*	*Average (kbps)*	*Current (kbps)*	*Max (kbps)*	*Min (kbps)*	*Average (kbps)*
1	29.3808	429.5468	11.8437	77.2347	27.2285	416.2187	5.1406	63.6681
2	15.5136	429.5468	12.6835	132.2325	9.5917	416.2187	5.3886	120.9051
3	13.457	429.5468	12.6835	96.3018	7.8164	416.2187	5.3886	82.6043
Averages	**19.4504**	**429.5468**	**12.4035**	**101.923**	**148,788**	**4,162,187**	**5.3059**	**890,591**

5 Conclusions

Based on the test results, the authors conclude several conclusions that can be drawn from the testing and use of Grid Antennas for Wireless LANs, among others, Placement of the antenna (Antenna Alignment) will affect throughput the obtained; Whether there is a barrier between the grid antennas there will be changes and the difference in throughput obtained; In testing the grid antenna (Antenna Alignment) a parallel position (Point to Point) the better the results of the Throughput obtained; The higher the barrier, the smaller the results throughput obtained; Three times stages of testing the antenna Grid with straight position unhindered by distance test of 100 meters, 125 meters and 200 meters to the average value transmitter 101, 923 kbps and an average receive 890.591 kbps while out of 4 times stages of testing the antenna Grid with antenna placement position offs between Sender and Receiver antennas with a distance of 200 meters can test average value transmitter 1.4826 kbps and an average receive 2.2679 kbps.

6 Future Works

For the development of Wireless LAN Networks, it is expected to use an antenna that can be used for Point to Multipoint (for example Omni, Sectoral antennas); Due to location limitations, it is recommended that in the future this grid antenna can be tested/implemented at a greater distance or location; Placement between grid antennas is as far as possible located at a parallel and focal point, without obstructions (walls or buildings or trees) and cannot be intervened so that the signal quality is more leverage.

References

[1] J. Jamaluddin, M. Doherty, R. Edwards, and P. Coulton, “A Hybrid Operating Model for Wireless Hotspot Businesses,” pp. 611–615, 2007.

[2] A. Roos, M. H. Amirsalari, S. Wieland, and A. Schwarzbacher, “Barcode Initiated

Hotspot Auto-login Mechanism For WLAN-Based Access Networks,” 2014.
[3] L. K. Raju and R. Nair, “Secure Hotspot,” no. November, pp. 642–646, 2015.
[4] W. Xu, W. Shi, F. Lyu, H. Zhou, N. Cheng, and X. Shen, “Throughput Analysis of Vehicular Internet Access via Roadside WiFi Hotspot,” no. 1, pp. 1–12.
[5] P. Telagarapu, “Design and Analysis of Parabolic Reflector with High Gain Pencil Beam and Low side lobes by Varying feed,” vol. 1115, pp. 1105–1115, 2011.
[6] D. Li, “A Novel and Versatile Parabolic Reflector that Significantly Improves Wi-Fi Reception at Different Distances and Angles,” vol. 3, no. 2, pp. 13–17, 2013.
[7] I. Engineering, “Design and Analysis of Parabolic Reflector Using MATLAB,” pp. 1367–1373, 2015.
[8] N. Yurandi, L. Jambola, and A. R. Darlis, “Perancangan dan Implementasi Reflector Antena Wifi dengan Frekuensi 2 , 4 GHz,” vol. 1, no. 3, 2013.
[9] I. M. Mustaqim, F. I. Terapan, and U. Telkom, “PERANCANGAN DAN IMPLEMENTASI JARINGAN WMAN,” vol. 2, no. 3, pp. 1413–1421, 2016.
[10] M. F. Duskarnaen, F. Nurfalah, and U. N. Jakarta, “ANALISIS , PERANCANGAN , DAN IMPLEMENTASI JARINGAN WIRELESS POINT TO POINT ANTARA KAMPUS A DAN KAMPUS B UNIVERSITAS NEGERI JAKARTA,” vol. 1, no. 2, pp. 134–141, 2017.
[11] F. M. Dwijayatno, Y. Christyono, and I. Santoso, “PERANCANGAN ANTENA HELIX UNTUK MENINGKATKAN DAYA TERIMA SINYAL GSM 900 YANG MEMILIKI LEVEL DAYA RENDAH,” 2014.
[12] T. U. Hasanah, “ANALISIS ANTENA SEMI PARABOLIK GRID 2,4 GHz UNTUK JARINGAN WIRELESS LAN,” UIN Sunan Kalijaga, 2010.
[13] P. Studi, T. Informatika, and B. N. Huda, “Pembuatan dan analisis perbandingan kinerja wajan bolic dan antena kaleng dalam menangkap sinyal wifi,” 2014.
[14] A. R. Budi Pratama, Lita Lidiawati, “Perancangan Dan Implementasi Antena Yagi 2 . 4 GHz Pada Aplikasi WIFI (Wireless Fidelity),” no. June, 2013.
[15] Z. Wani, M. P. Abegaonkar, and S. K. Koul, “Dual-Beam Antenna for Millimeter Wave MIMO Applications,” *2018 IEEE Indian Conf. Antennas Propogation*, pp. 1–3, 2018.
[16] A. Taeb, H. Al-saedi, S. Gigoyan, M. Basha, G. Z. Rafi, and S. K. Chaudhuri, “A Silicon-Based Beam-Steering Tapered Antenna Array for W-Band Applications,” pp. 1455–1456, 2018.