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Attenuation Analysis on Fiber To The Home (FTTH) Network with Gigabit Passive Optical Network (GPON) at Oxygen Home Pontianak

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ABSTRACT

Optical fiber as a transmission medium that meets the needs of the internet with large bandwidth. The FTTH (Fiber To The Home) network can deliver a variety of digital information, such as voice, video and data more effectively so that it can support the Triple Play service marketed by Oxygen Home. To determine the feasibility and performance of the FTTH (Fiber To The Home) design system in the Bali Agung 2 Complex, South Pontianak, it will be assessed based on test parameters. The test parameters are Power Link Budget for system feasibility and BER (Bit Error Ratio) will be displayed with an eye diagram for system performance used using Optisystem software, Optisystem is software that can be used to simulate a fiber optic network from central to end – user. From the results of the FTTH network simulator using optical system software, it is found that the farthest user attenuation value is Prx: -16.018 dBm, 1.4804 x 10-61 and Q factor 16.5122. The results obtained are feasible because they are above the minimum FTTH network standard with GPON technology

1. INTRODUCTION

Technological developments continue to experience rapid development, humans in the present era cannot be separated from technology. Especially in terms of communication technology which is required to continue to experience changes in terms of better service quality, speed and security. Along with network users who want a development so that it can provide maximum results both in terms of efficiency and increased security of the network itself. The development of this communication technology requires a transmission medium that is capable in terms of capacity and data transfer speed. The transmission medium itself is a medium that connects the sender and receiver of information.

FTTH is a development of JARLOKAF (Local Access Fiber Network) which uses GPON (Gigabit Passive Optical Network) technology as standard device. The use of GPON technology in FTTH networks is due to the ability of this technology to support transmission at large bandwidths and can solve bandwidth access barriers for IPTV and TV broadcast services, this technology is also able to provide 3 services (data, voice and video) in one infrastructure. Another advantage of this FTTH network is the ability to transfer data faster than other network technologies and can cover long distances.[1]

Gigabit Passive Optical Network (GPON) is an access node technology required to provide multimedia services (Voice, data, video and other contents) for residential and business customers. The use of a Fiber To The Home (FTTH) network that uses Optical Fiber as a transmission medium can meet the need for large bandwidth. In addition, the FTTH Network can transmit various digital information, such as voice, video, data, and so on more effectively so that it can support the Triple Play service marketed by Oxygen Home.

Oxygen.id is one of the telecommunication service companies launched by PT Mora Telematika Indonesia (Moratelindo) in 2015. Initially it was provided to corporate services. February 2017 Oxygen.id opens retail sales which are quite affordable. Its retail services currently cover Jabodetabek, Medan, Bali, Pangkal Pinang and Pontianak. One of the advantages of the Oxygen.id network is that it uses a qualified fiber optic network called Gigabit Passive Optical Network (GPON). per second. Differences Oxygen.id compared to other providers, among others, Moratelindo has built its own fiber optic network to international coverage,

*optsystem*is a software that can be used to simulate a fiber optic network from central to end-user. The use of optisystem was chosen because it is easier to obtain so that it can simulate and calculate loss on optical devices without incurring high costs, and obtain a high level of accuracy in calculations.

To determine the feasibility and performance of the FTTH design system, in this study a calculation was carried out on the feasibility and performance test parameters of the Fiber To The Home (FTTH) network applied in one of the areas of Pontianak City. These parameters are the Power Link Budget and BER for system performance which will be obtained from the simulation results using the Optisystem software.

2. LITERATURE REVIEWS

With regard to the importance of the GPON (Gigabit Passive Optical Network) system with the right method of use in terms of attenuation on FTTH (Fiber To The Home) networks, the researcher is interested in conducting research in assessing the feasibility of a network with the title "DAMPING ANALYSIS OF FIBER TO THE HOME NETWORKS (FTTH) WITH GIGABIT PASSIVE OPTICAL NETWORK (GPON) TECHNOLOGY AT OXYGEN HOME PONTIANAK" with the aim of knowing the quality of service received by Oxygen Home Pontianak customers. In previous research regarding attenuation analysis on Fiber To The Home (FTTH) networks, namely:

Research conducted by Adian Kurniawan, in 2019 with the title "The Influence of Product Quality, Service Quality and Price on Indihome Customer Satisfaction in Tarakan City"This study discusses partial hypothesis testing. It can be concluded that product quality and service quality have no significant effect on Indihome customer satisfaction in Tarakan City. Meanwhile, the price variable has a significant effect on Indihome customer satisfaction in Tarakan City.[2]

Research conducted by Andi Nurul Ulfawaty Z, Fausiah, in 2018 with the title "Analysis of Attenuation in Fiber To The Home (FTTH) Networks Using Gigabit Passive Optical Network (GPON) Technology at PT Telkom Makassar" in fiber optic cables such as the number of splices/connections on each cable, and the occurrence of cable bends above 45°.[3]

Research conducted by Astrid Harera Royani Hsb, M. Zulfin, in 2012 with the title "Modernization of Copper Access Networks with Optical Fiber to Customers" This research discusses the modernization of copper access networks into fiber optics, fiber optics can meet customer needs with increased service quality. After Modernization the bandwidth is bigger and the speed is high 4 Mbps to 100 Mbps. The applications customers get also vary. Fiber optic installation is easier, on fiber optics the need for measuring instruments uses only 2 types of measuring instruments.[4]

Research conducted by AS Lestari, 2013 with the title "Design of Fiber To The Home (FTTH) Access Network for Gunung Batu Housing Case Study" This study discusses the results of a FTTH network design located in Gunung Batu Housing.[5]

Research conducted byBayu Heri Prabowo, 2015 with the title "Design of Fiber To The Home (FTTH) Network in Taman Kopo Indah 5 Housing, Bandung." This research discusses the results of a FTTH network design in Taman Kopo Indah 5 Housing, Bandung.[6]

Research conducted by Delima Saptun Susilawati Sinaga, Fitri Imansyah, F. Trias Pontia W. in 2020, with the title "Optisystem Implementation on Fiber To The Home (FTTH) Networks with Gigabit Passive Optical Network (GPON) Technology." This study discusses the Analysis of FTTH Networks with GPON Technology Using the Optisystem Application. With the aim of calculating the quality of the Power Link Budget and Rise Time Budget on Fiber To the Home (FTTH) networks with Gigabit Passive Optical Network (GPON) Technology using the help of Optisystem.[7]

Research conducted by Desianty Fithri Wahyuni, 2017 with the title "The Influence of Indihome Service and Product Quality on Customer Satisfaction and Loyalty" This research discusses the large number of subscription television stations, so customers will be more selective in choosing and using products according to their wants and needs. The number of products with their respective advantages is the main attraction for customers.[8]

Research conducted by Dewi Aniizah Arham, Nurul Amirah Syarif, in 2018 with the title "Optical Distribution Cabinet (ODC) Attenuation Analysis Toward Optical Distribution Point (ODP) Using the Link Power Budget Method". This study measures the amount of attenuation in the Optical Distribution Cabinet (ODC) network to the Optical Distribution Point (ODP) on optical fiber transmission using a Power Meter and using the Link Power Budget method.[9]

Research conducted by Ignatius Gita, 2015 with the title ". 2015. Design of a Fiber To The Home (FTTH) Access Network with Gigabit Passive Optical Network (GPON) Technology in Private Village, Cikoneng." This research discusses the design of an FTTH network located in Private Village, Cikoneng.[10]

Research conducted by Muhammad Alfarizi, in 2015 with the title "Creating an FTTH (Fiber To The Home) Network Design in the Buah Batu Square Housing Complex, Bandung." This research discusses the results of making a design for the FTTH network in the Buah Batu Square Housing Complex, Bandung.[11]

Research conducted by Novermy Triyandari Nugroho, 2015 with the title "The Influence of Service Quality on Customer Satisfaction and Loyalty (Survey of Speedy Telkom Customers in Surakarta City)" This study discusses testing the effect of service quality on customer satisfaction and loyalty using multiple linear regression analysis.[12]

Research conducted by Okta Nur Theo Yuwana, 2017 with the title "Designing a Fiber To The Home (FTTH) Network Using GPON Technology in Cibeber District, Cilegon City." This research discusses the results of an FTTH network design in Cibeber District, Cilegon City.[13]

Research conducted by Raka Marinda Dewi, Yus Natalia, in 2017 with the title "Simulation of Feeder Network Design for Fiber To The Home (FTTH) at PT. Indosat" This study discusses the simulation results of feeder network design for FTTH at PT. Indosat.[14]

Research conducted by Yusfiana Anggreani, 2017with the title "Analysis of FTTH Networks with GPON Technology Using the Optisystem Application." This study discusses testing the design forms and values of the components that make up the Fiber To The Home network using the optisystem application.[15]

3. RESEARCH METHODOLOGY

3.1 Location and Time of Research

This research will be conducted at the Bali Agung 2 Complex, South Pontianak. The research will be conducted in February – March 2023.

3.2 Tools and materials

The tools and materials used in this study are as follows:

a) ASUS Vivobook laptop to save data
b) OPM (Optical Power Meter) is a tool used to measure the attenuation of an optical cable
c) *OptiSystem software*7.0, is used to simulate a fiber to the home access network from the center to the user from the results of the design that has been done. This optisystem is used to perform loss budget calculations on real fiber optic networks. In testing network performance using optical power meter and BER analyzer components.

3.3 Research methods

The following are the research methods used:

a. Study of literature
   Searching for sources of data or materials needed to complete the final assignment from related books and journals and also to look for materials related to fiber to the home, GPON, optisystem and all matters relating to the final project. will be done.
b. Field observation
   Direct observation of the research location to determine the model of the network.
c. Consultation and Discussion
   Conduct consultations and discussions with supervisors regarding the research to be carried out. As well as having discussions with friends who are conducting similar research to exchange opinions and get maximum results.
d. Design Simulation
   Designing an FTTH access network with GPON technology at research locations using Optisystem software.
e. Conclusion Drawing
   Make conclusions from the results of design simulations that have been carried out.

The research method used in this study is described in a flowchart as outlined in Figure 1 as follows:

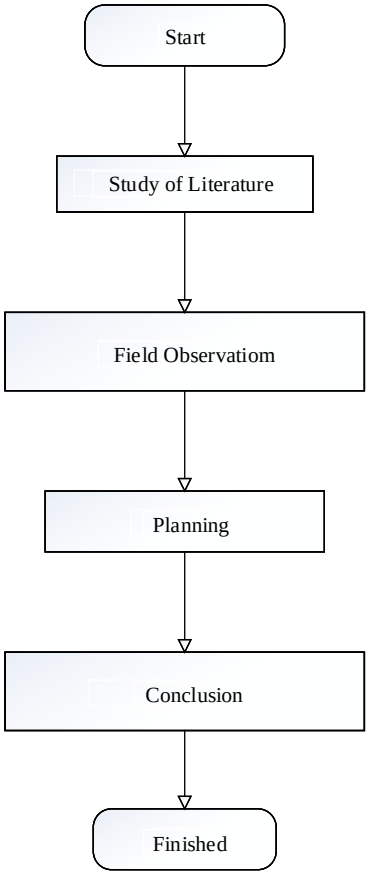

Figure 1. Figure Research Flowchart in General

3.4 Research Steps

The following are the steps in conducting research.

a. Design Location Determination
   After making observations, the authors chose a fiber optic network located on Jalan Perdana Komplek Bali Agung 2, South Pontianak.
b. Data collection
   The data at this stage is in the form of network architecture and the value of the fiber optic devices used at the research location. The value of the device used is based on the results of observations and measurements in the field.
c. BER Analysis and Power Link Budget Calculation
   Analyze the BER (Bit Error Rate) value and power link budget based on the data that has been obtained using predetermined formulas.

The following is a flow chart of the research steps to be carried out:

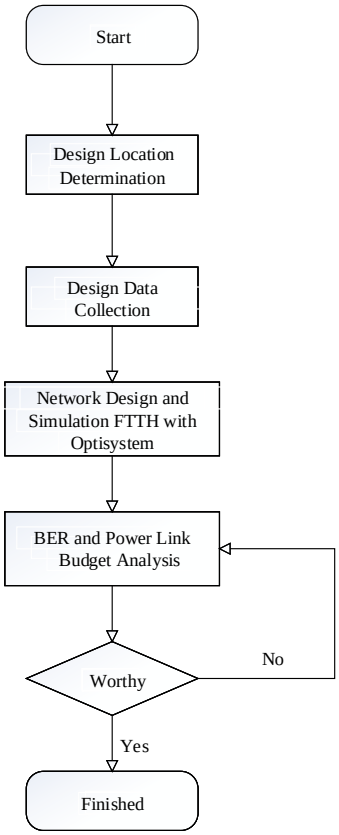

Figure 2. Specifically Research Flowchart

4. RESULTS AND ANALYSIS

4.1 Fiber To The Home (FTTH) Access Network Design

The initial step of a network is to create a scheme of Fiber To The Home (FTTH) networking which is useful for identifying a network with good quality and stable speed.

The following is a fiber optic cable pulling scheme for the Bali Agung 2 Complex area on Jalan Perdana, South Pontianak.

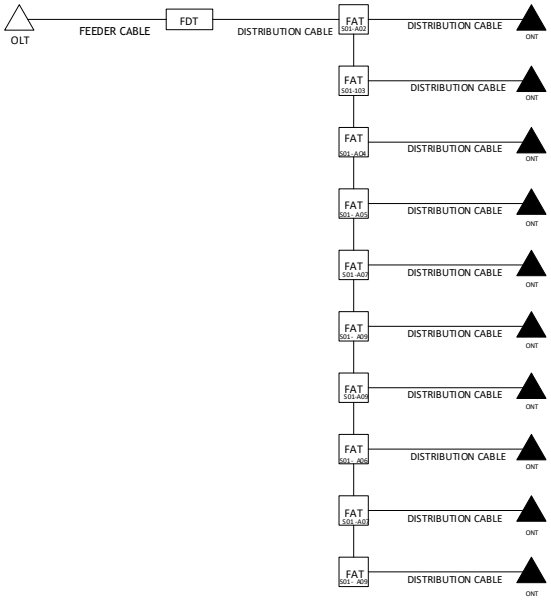

Figure 3. Fiber To The Home (FTTH) cable withdrawal scheme in the Bali Agung 2 Pontianak area

In this study the distance from OLT/STO to FDT is 1.2 km with the cable route passing through the Perdana road to the Bali Agung Complex 2.

4.2 Simulation of Design Results Using Optisystem

At this stage, a simulation was carried out using the Optisystem application, the design simulation was carried out after obtaining the value of each device by conducting a field survey. This simulation refers to the screening scheme in the field. Simulation of the design results will be carried out using optisystem software with configurations from OLT to ONT.

The simulation will be carried out with 10 FAT samples from the center (OLT) to the user (ONT) with the furthest distance.

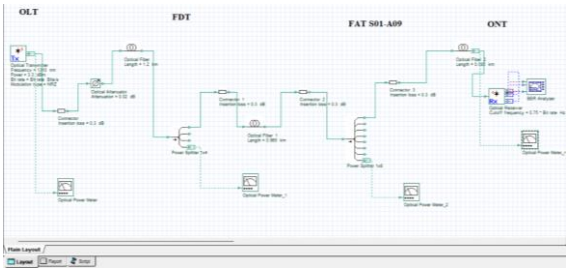

Figure 4.FTTH Device Simulation on FAT S01-A09

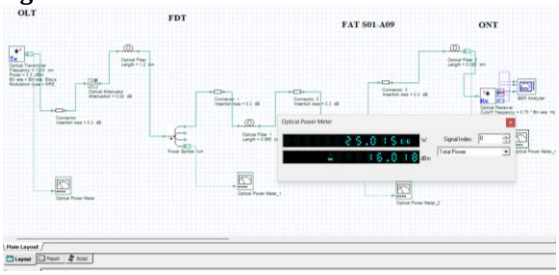

Figure 5.FAT S01-A09 Simulation Damping Results

After making a simulation of the design results based on the device to be used using the downlink optisystem. Then the Prx value (attenuation received by the device) will be obtained. In Table 1. will display the results of the optisystem simulation based on 10 samples of FAT devices with the farthest distance from the central to the user.

Table 1. Attenuation Value Results from Optisystem Simulation on 10 FAT Devices

FAT devices	Prx value
FAT S01-A02	-15,986 dBm
FAT S01-A03	-15,877 dBm
FAT S01-A04	-15,901 dBm
FAT S01-A05	-15,924 dBm
FAT S01-A07	-15,986 dBm
FAT S01-A08	-16,007 dBm
FAT S01-A09	-16,018 dBm
FAT S02-C01 A06	-15,893 dBm
FAT S02-C01-A07	-15,926 dBm
FAT S02-C01-A09	-15,896 dBm

From the table above the value of the design results generated from the simulation using the downlink optisystem can be stated that the design is feasible. Where in FAT S01-A09 which is the farthest point of the device from the central to the user, namely 2,250 km, the device attenuation value (Prx) is -16,018 dBm. In the simulation, the average attenuation value is -15 dBm to -16 dBm at the FAT position so that it still meets the

maximum attenuation standard because the value obtained is below the received power sensitivity standard (Rx), which is -28 dBm.

4.3 BER (Bit Error Ratio) Analysis

BER (Bit Error Rate) is a way to determine the quality of the signal sent on a fiber optic communication system. In this design, the BER value will be known from the simulation using the optisystem on the BER Analyzer. In the optisystem, the BER value will be displayed with a graph of the Q factor and an eye diagram. The BER value will appear after all devices are given the appropriate value and then calculated.

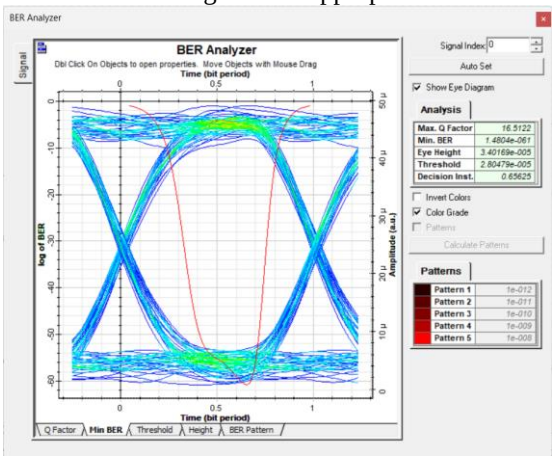

Figure 6.BER value on BER Analyzer on FAT S01-A09

In Figure 6. states the BER graph resulting from a feasible design and is in accordance with the BER standard, where the maximum standard BER value is 10-9. In this design, the BER value generated on the farthest device is 1.4808 x 10-61 which is on FAT S01-A09.

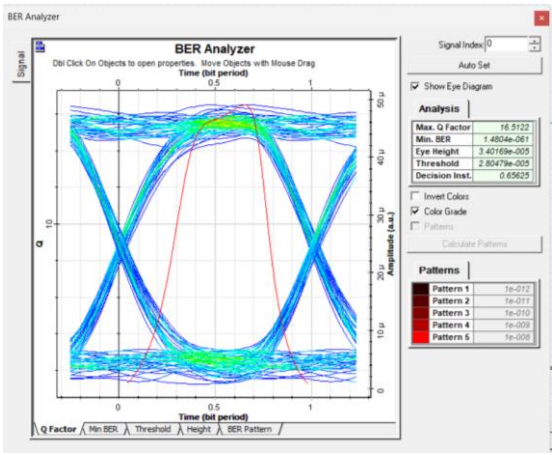

Figure 7.Q Factor Graph on FAT S01-A09

Figure 7 displays the Q factor graph with the resulting value above the specified minimum standard. A design will be said to be feasible if the resulting Q factor value is greater than the optical communication standard, namely 6. Where in the design that has been carried out the Q factor value obtained is 16.5122 at the farthest point of the device, namely FAT S01-A09.

Table 2 will display the results of the BER and Q Factor values from the optisystem simulation based on 10 samples of FAT devices with the farthest distance from the center to the user.

Table 2.BER and Q Factor Value Results from Optisystem Simulation on 10 FAT Devices

FAT devices	BER value	Q Factor value
FAT S01-A02	$5.99658x10^{-66}$	17.1117
FAT S01-A03	$2.95903x10^{-65}$	17.0185
FAT S01-A04	$1.46911x10^{-64}$	16.9244
FAT S01-A05	$5.45073x10^{-64}$	16,847
FAT S01-A07	$2.17153x10^{-62}$	16.6276
FAT S01-A08	$8.29959x10^{-62}$	16.5471
FAT S01-A09	$1.4804x10^{-61}$	16.5122
FAT S02-C01-A06	$8.08696x10^{-65}$	16.9595
FAT S02-C01-A07	$6.14148x10^{-64}$	16.8399
FAT S02-C02-A09	$9.76488x10^{-65}$	16.9484

4.4 Calculation of Power Link Budget

The farthest FAT is FAT S01-A09 with an OLT distance of 2,250 km to the user.

The following is the calculation of the power link budget based on the furthest distance:

- Total Damping

  αtotal = (L x αf) + (Nc x αc) + (NS x αs) + αsplitter

  = (2.250 x 0.35) + (4 x 0.3) + (1 x 0.1) + (7.25+10.38)

  = 0.7875 + 1.2 + 0.1 + 17.63

  = 19.7175 dBm

- *PowerLinkBudget*

  Prx = Ptx – αtotal

  = 3.89 – 19.7175

  = -15.8275 dBm

- Power Margin

  M = (Ptx-Prx(sensitivity)) – αtotal - SM

  = (3.89- (-28)) – 19.7175 – 7

  = 5.1725 dB

The calculation of the power link budget at the farthest distance of the device from the center to the users who are on FAT S01-A09 can be declared feasible, because the received attenuation value obtained is still below the specified maximum standard, which is -28 dBm.

The calculation results obtained are not much different from the simulation results using optisystem. Differences in the value of the results obtained can occur because each device in its specifications has a different attenuation range in its use.

In Table 3. will display the results of measurements in the field with 10 samples of FAT devices:

Table 3. Measurement Results in the Field

Device	α_{total} (dBm)
FAT S01-A02	−19.96 dBm
FAT S01-A03	−21.63 dBm
FAT S01-A04	−20.21 dBm
FAT S01-A05	−20.09 dBm
FAT S01-A07	−20.04 dBm
FAT S01-A08	−20.56 dBm
FAT S01-A09	−22.21 dBm
FAT S02-C01-A06	−22.47 dBm
FAT S02-C01-A07	−21.50 dBm
FAT S02-C02-A09	−20.74 dBm

From the measurement results in the field there are differences from the simulation results. The difference in this value is caused by not including the attenuation value and the number of cable connection points in the

simulation. This results in the total damping value on the measurement results being different from the total damping from the simulation results. The total attenuation value affects the power link budget value.

5. CONCLUSION

After doing the research, it can be concluded; In the simulation of devices generated using optisystem, the network simulation results are said to be feasible. The farthest path from the center to the user is 2,250 km, namely on FAT S01-A09. Where the value obtained on FAT S01-A09 obtained a BER value of 1.4804 x 10-61, a device attenuation value (Prx) of -16.018 dBm, and a Q factor value of 16.5122. From the calculation of the power link budget which was carried out with a sample size of 10 FAT with the distance from the center to the furthest user. Where the farthest FAT distance from the central to the user is on FAT S01-A09, namely with a distance of 2,250 km and a power link budget value of -15,8275 dBm, it is said to be feasible because the value obtained is below the standard of receiving power sensitivity (Rx), which is -28 dBm. The shape of the design and the value of the components forming the network affect the value of the total attenuation. The attenuation value at the receiver obtained in the simulation is not the same as the attenuation value obtained from the measurement results on 10 FAT samples in the field. Based on the measurement and calculation results, the total attenuation value affects the power link budget value.

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