

Fiber To The Home (Ftth) Network Infrastructure Design Using Gigabyte Passive Optical Network (Gpon) Technology South Solok District

Riski Valentino^{1*}, Amelia Yolanda², Popy Maria³

^{1,2,3}State Polytechnic of Padang, Electrical Engineering Department

¹valellen311001@email.com, ²amelia@pnp.co.id, ³popy@pnp.co.id



***Corresponding Author**

Article History:

Submitted: 01-12-2024

Accepted: 03-12-2024

Published: 05-12-2024

Keywords:

Fiber Optic; FTTH; GPON;

Attenuation; Transmission.

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ABSTRACT

Fiber To The Home (FTTH) Network with Gigabit Passive Optical Network (GPON) Technology in South Solok Regency, supervised by Ibu Amelia Yolanda, ST as supervisor 1 and Ibuk Popy Maria, ST STT as supervisor 2. Development of Telecommunications technology as a necessity Currently, communication has developed rapidly, transmission media facilities are needed that are capable of transmitting information with large capacities and adequate data transfer speeds. By implementing GPON technology, FTTH services can reach users at up to speed. This research aims to design an FTTH network using GPON technology in the South Solok Regency area, obtain results of identification and analysis of communication network needs for the Nagari Lubuk Gadang Selatan community in South Solok Regency, obtain results of FTTH network infrastructure design using GPON technology for Nagari Lubuk Gadang Selatan Regency. South Solok.

INTRODUCTION

At this time, several communication systems that are often used sometimes cause various problems ranging from slow access and interference such as noise which will hinder the user, so currently users need better technology, so the technology used is technology (GPON).

This research discusses the design of the Fiber To Home design. This research discusses the quality analysis of a fiber optic network with GPON technology, by using this method the performance of a network can be determined. This is because this method can be used to see the suitability of a network for sending signals from the sender to the receiver to determine the performance of a network. This is because this method can be used to see the suitability of a network for sending signals from the sender to the receiver with the parameters of fiber optic cable types, connectors, connections, passive splitters, OLT (Optical Line Terminal) and ONT (Optical Network Terminal) specifications. The author uses 2 optical measuring instruments, namely Optical Power Meter (OPM) and Optical Time Domain Reflectometer (OTDR). The Optical Power meter is used to measure the signal strength sent from the OLT device or from the STO, while the OTDR is used to measure the distance of the fiber optic cable and see the attenuation that occurs due to the connection in the fiber optic cable. Then a solution will be taken to optimize the network if the attenuation does not comply with the specified standards.

(GPON) is an optical network technology that uses a Passive Optical Network (PON) base based on ITU-T. G.984. Service speed (GPON) reaches 2.4 Gbps Downstream and 1.2 on Upstream. The distance from (OLT) Optical Line Terminal to (ONT) Optical Network Terminal is 20 km. The uniqueness of this technology (GPON) uses distribution techniques that are carried out passively (Saifuddin & P. Sardju, 2017).

Using this optical network system allows a wider range of services to be used by customers. Fiber optic network designs are made using AutoCad software, this software can make it easier to design networks (FTTH).

The structure of a fiber optic cable generally consists of the outermost part, namely the protective jacket (coating), cladding (tube), and core (core) on the inside. The light source used is a laser, optical fiber has become the main component for the world of telecommunications. (Hanif & Arnaldy, 2017).

LITERATURE REVIEW

Based on several journals that have been read and used as references in making this proposal, in this final assignment, Our task will be to design a fiber to home (FTTH) network with (GPON) technology, so that we can understand how designing ftth networks. Based on this research, the author wants to create and develop this final project with a network that can be utilized by many people. Therefore, the title of this final assignment is "Fiber To The Home (Ftth) Network Infrastructure Design With Gigabyte Passive Optical Network (Gpon) Technology, Solok Selatan



District." By using GPON technology, it is hoped that this final assignment can be implemented and used as a development consideration. fth network within the Padang State Technical Polytechnic and Telecommunications related to the fth field.

METHOD

The stages carried out during the research are:

1. Literature Study Section
In this research, the author first conducted a literature study of the research to be researched. At this stage, a search is carried out on journals, essays. This literature study is carried out by researchers after determining the research topic and determining the formulation.
2. The FTTH network design section begins to proceed according to the topology that was created previously in the previous research stage according to the literature.
3. The data collection section for the problem under study is regarding macrobending in the feeder cable segment.
4. The data processing and analysis section analyzes the data that has been taken regarding macrobending in the feeder cable segment.
5. In this section, reports are prepared regarding the entire series of activities such as design, analysis and conclusions obtained.

The research stages can be seen in the flowchart below:

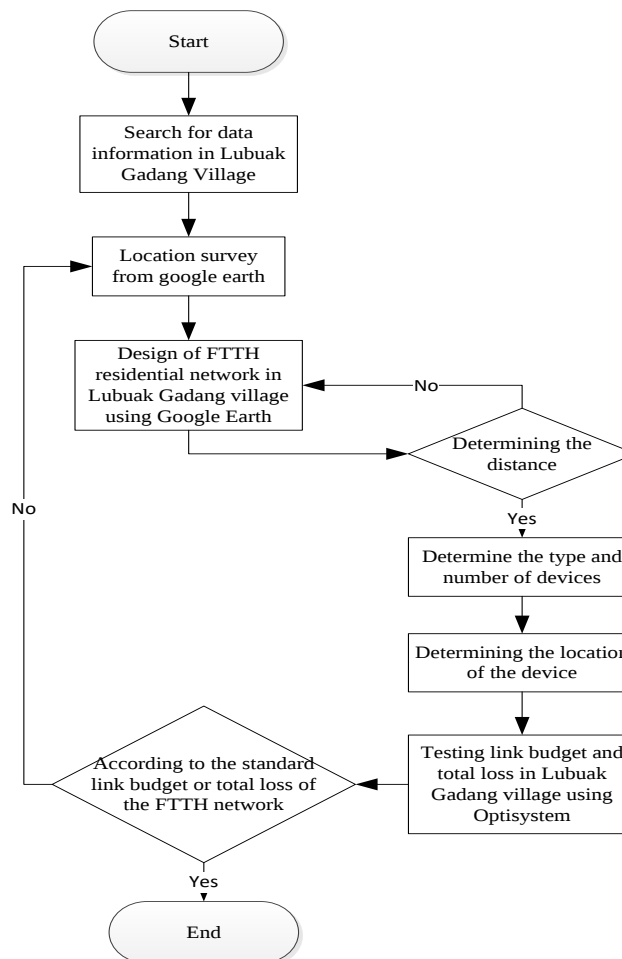


Figure 1. Flowchart

In this final project, we only design an FTTH installation using ODC, ODP, ROSET, and HSL devices as input and OPM as the output or measurement results. The fiber to the home that will be built will require several aspects to support the running of this system testing. Supporting the implementation of this design includes:

1. Search for housing information data.

2. FTTH network design using AutoCad to determine the placement and number of devices.
3. Designing the FTTH network design using Google Earth and Optisystem as a virtual simulation of the FTTH network which has been previously designed to determine the total loss along the fiber optic route.

This design begins with the design flow and checking the network tools and devices that have been created in the previous final project.

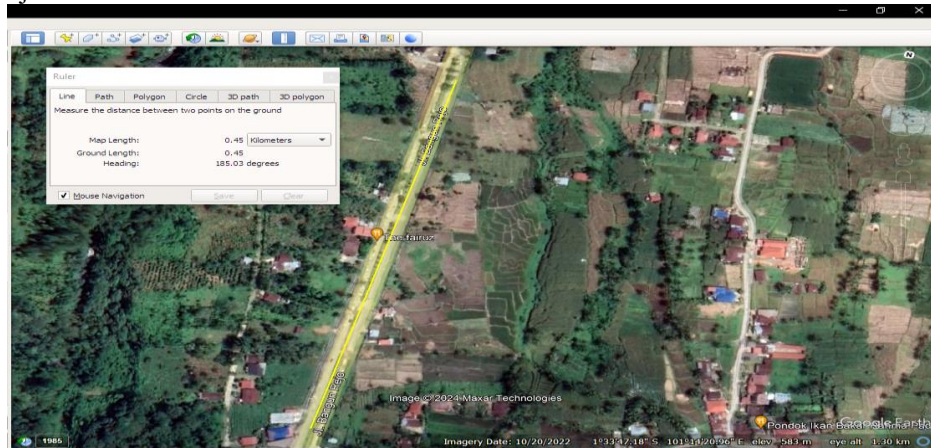


Figure 2. Using Google Earth

Calculate the number of devices needed. After obtaining the design data and knowing the number of devices needed, the next step is to design the network. Network design consists of determining the location of the device in the design area. The next stage is a feasibility analysis which consists of the following things.

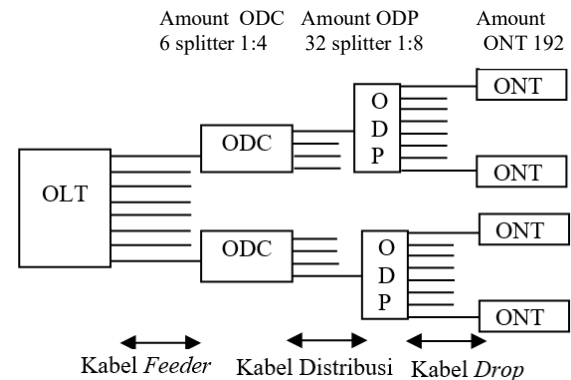
1. Analyze potential problems, impacts, and solutions.
2. Link power budget analysis, rise time budget analysis, and BER analysis. Analysis is carried out on the downlink side (OLT to ONT) and uplink side (ONT to OLT) for calculations using the farthest and closest distances of OLT to ONT in the downlink process and ONT to OLT in the uplink process. The farthest and closest distances can describe the link power budget analysis of the entire network.
3. Analysis of material and HR costs. In this analysis, the type, quantity, cost of devices and human resources costs for installing FTTH devices will be obtained.

Table 1. Network system devices

No	Name	Use	Item
1	Passive Splitter 1:8	ODP	32 pcs
2	Passive splitter 1:4	ODC	6 pcs
2	Optical Cores	Distribution Cable	32 core
3	Optical Cores	Feeder	8 core
4	Dropcore	Customer Line	6 core
5	ODC	For distribution lines	192 Port

On the other hand, the two stage category involves the use of two passive splitters, namely splitters on the ODC and ODP. Splitters in this category can be 1:2 ; 1:4 ; 1:8 ; and 1:16. At the ODC, a 1:4 passive splitter is installed which divides the signal into four cores, which are then further divided at the ODP using a 1:8 splitter, resulting in a total of eight subscribers. Thus, one core feeder can serve up to 32 customers via 1:4 and 1:8 splitters. This two stage category is highly recommended for FTTH planning because it makes it easier to divide distribution lines. Design Data Collection.

Housing consists of eleven housing complexes, namely complex A with 18 houses, complex B with 20 houses, complex C with 21 houses, complex D with 21 houses, complex E with 18 houses, complex F with 22 houses, complex G with 22 houses, complex H with 22 houses, complex I with 21 houses, complex J with 16 houses, and complex K with 28 houses. The total number of houses is 192 houses.



The next stage is calculating the needs for FTTH devices. The calculation starts from the number of ONT devices that will be used. The next stage is determining the type and number of splitters on the ODC (the basis for considering the type and number of splitters is the same as determining the type and number on the ODP). Finally, the number of feeder cable cores from the OLT is determined. The feeder cable is connected from the ODC to the OLT. In this paper, one OLT is used. FIG. 5 shows the proposed FTTH network architecture. Each customer has an ONT device. From the number of ONT devices available, the number of 1:8 splitters on the ODP was 29 splitters. From the total of 29 1:8 splitters on the ODP, the number of 1:4 splitters on the ODC was eight 1:4 splitters, so that the required number of feeder cable cores from ODC to OLT was obtained, namely eight feeder cable cores.

RESULT

The distance from STO to ODC is around 12 km with the OLT transmitter from South Solok and ODC also coded South Solok.



Figure 3. distance from STO to ODC

House Plotting, the aim is to clarify the boundaries between houses and road access in the south Solok housing complex.



Figure 4. Residential network access limits

Determining the location of the ODP and ONT points, you can see that the cable from the ODP to the ONT is around 60 meters.



Figure 5. location of the ODP and ONT

The following is the ODP used in this design of the Pole type. LPB calculations are measured on the uplink and downlink paths. With attenuation for the uplink of 0.35 dB and downlink of 0.28 dB. LPB calculations both mathematically and by simulation use power from the OLT of 5 dB.

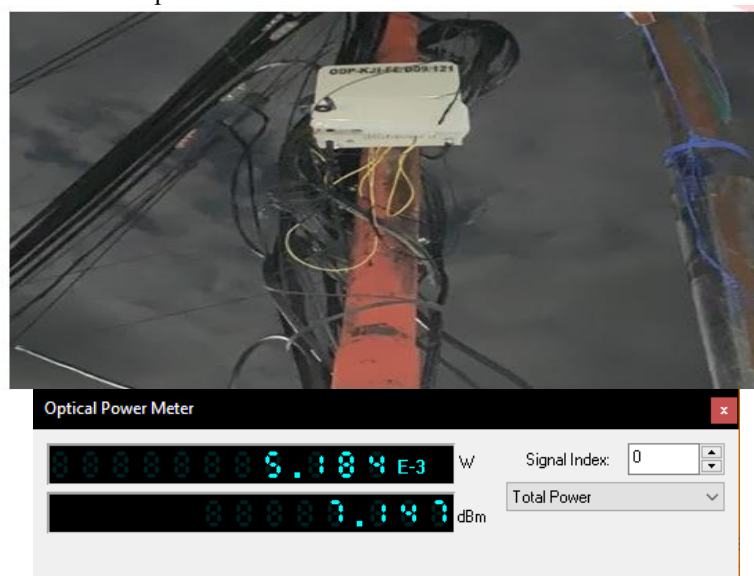


Figure 6. Network circuit on site

Table 2. Process of Entering Feeder Cable Data

Main	Disp...	PMD	Nonli...	Num...	Graphs	Simul...	Noise	Rand...	Custo...
Disp	Name		Value		Units		Mode		
☐	User defined reference wavelength		☒				Normal		
☐	Reference wavelength		1550		nm		Normal		
☒	Length		4.38		km		Normal		
☐	Attenuation effect		☒				Normal		
☐	Attenuation data type		Constant				Normal		
☒	Attenuation		0.35		dB/km		Normal		
☐	Attenuation vs. wavelength		Attenuation.dat				Normal		

Table 3. Process of Entering Distribution Cable Data

Main	Disp...	PMD	Nonli...	Num...	Graphs	Simul...	Noise	Rand...	Custo...
Disp	Name	Value	Units	Mode					
☐	User defined reference wavelength	☒		Normal					
☐	Reference wavelength	1550	nm	Normal					
☒	Length	0.8	km	Normal					
☐	Attenuation effect	☒		Normal					
☐	Attenuation data type	Constant		Normal					
☒	Attenuation	0.35	dB/km	Normal					
☐	Attenuation vs. wavelength	Attenuation.dat		Normal					

Table 4. Drop Core Data Entry Process

Main	Disp...	PMD	Nonli...	Num...	Graphs	Simul...	Noise	Rand...	Custo...
Disp	Name	Value	Units	Mode					
☐	User defined reference wavelength	☒		Normal					
☐	Reference wavelength	1550	nm	Normal					
☒	Length	0.05	km	Normal					
☐	Attenuation effect	☒		Normal					
☐	Attenuation data type	Constant		Normal					
☐	Attenuation	0.35	dB/km	Normal					
☐	Attenuation vs. wavelength	Attenuation.dat		Normal					

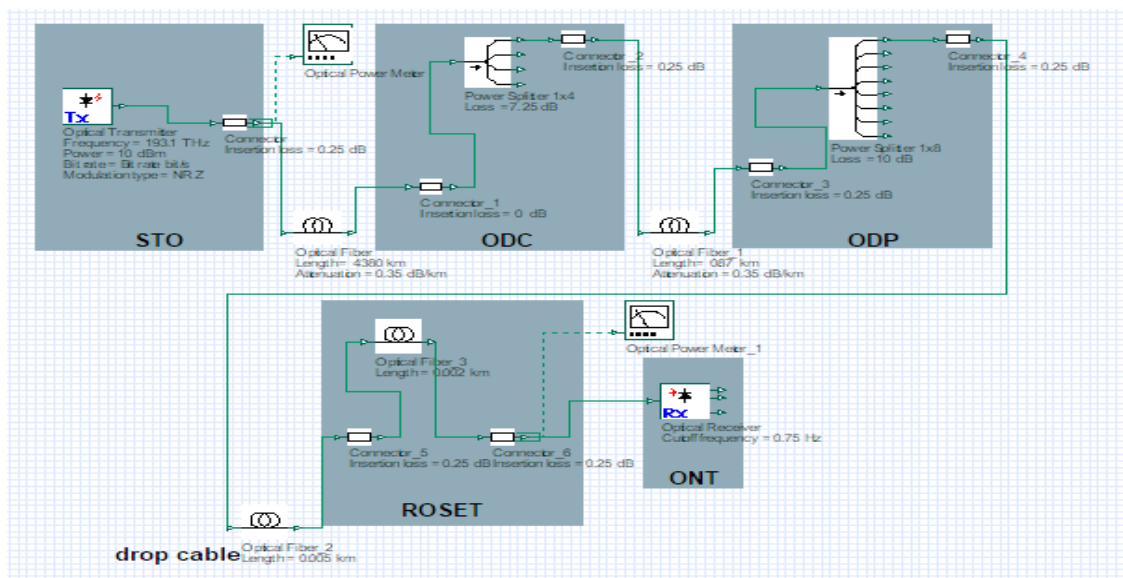


Figure 7. OPM Rosette 1 results

DISCUSSION

In general, potential problems that can occur when implementing FTTH design can be divided into problems from the managerial side and problems from the technical (engineering) side. From the managerial side, these include cost management, recruitment of quality employees, and regulatory restrictions. Meanwhile, from a technical perspective, problems that can occur include expanding to new locations, implementing new network topologies, and enlarging network operations. From a technical perspective, expansion to new locations is easier and faster than duct-aerial systems, but if a lot of aerial system cables are used and the installation is not neat enough, the view will be disturbed and re-installation will be necessary if there is damage to the aerial system cables.

When installing FTTH devices, errors in device installation and cable irregularities in the cabinet/terminal may occur due to improper placement of the device. This can be overcome by carrying out installation repairs and recruiting qualified workers and carrying out continuous work supervision. Apart from that, during installation there may also be a macro-bend or large curvature in the fiber optic cable. This could eliminate the potential for developing next generation PON technology networks using longer wavelengths, which are very sensitive to macro-bends – and could increase losses in fiber optics. If this happens, you must check the location where the macro-bend occurred using an Optical Time-Domain Reflector (OTDR), rearrange the cable to reduce bending, and re-test to ensure the problem has been

resolved.

After the drafting stage using Google Earth is complete, The results obtained are that the distance from the OLT to the ODC is ± 12 km. Distance between ODC to each ODP each path can be seen in table 5 below.

Table 5. Distance between ODC to each ODP

Parameter	Information
λ	1.310 nm dan 1.550 nm
$\Delta\sigma(\text{OLT/ONT})$	1 nm / 1 nm
$ttx(\text{OLT/ONT})$	$(160 \times 10^{-3} / 200 \times 10^{-3})$ ns
$Dm(1310/1550)$	(3,56 / 13,64) ps/nm.km
$trx(\text{OLT/ONT})$	$(160 \times 10^{-3} / 200 \times 10^{-3})$ ns
Coding	NRZ
Types of fiber optic	Single mode fiber
Refractive index of core (n_1)	1,48
Refractive index of envelope (n_2)	1,46
Core radius (a)	4,5 μm
Br (downlink/uplink)	2,4 Gbps/1,2 Gbps

LPB mathematical calculations use formulas (1) and (2), both at the farthest and closest distances. By continuing to adhere to the attenuation standards in table I. After getting the results from the two calculation methods, they can be compared clearly in table 4 below. From these two calculation methods, there are also differences in the results obtained.

Table 6. Downlink Calculation

Downlink Calculation			
Distance	Prx (dBm)	Rise Time System (ns)	BER
Farthest	-22,792	0,258	$18,58 \times 10^{-14}$

Table 7. Uplink Calculation

Uplink Calculation			
Distance	Prx (dBm)	Rise Time System (ns)	BER
Farthest	-23,120	0,256	$14,63 \times 10^{-12}$
Closest	-22,995	0,256	$30,37 \times 10^{-13}$

Be faster; the use of fiber optic cables in FTTH technology makes it more environmentally friendly compared to technology that uses copper cables; opening up business opportunities to expand the FTTH network to other residential areas; as well as enabling the creation of a smart city by enhancing FTTH services to various applications. The negative impact on FTTH implementation is increased latency when broadband is fully operational, which results in a decrease in network performance, as well as the emergence of business competition with other FTTH providers.

All tables should be numbered with Arabic numerals. Every table should have a caption. Headings should be placed above tables, left-justified. Only horizontal lines should be used within a table, to distinguish the column headings

Network System	Material Cost (Rp)	HR Costs (Rp)	Total cost (Rp)
Aerial system	281.393.905	99.832.500	381.226.405
Duct-aerial system	290.458.605	140.637.500	431.096.105

Based on the design data in Table XI, the following analysis can be carried out. The estimated material costs for the aerial network system are IDR 281,393,905 and for the duct-aerial network system IDR 290,458,605. The estimated material costs for the duct-aerial network system are more than the aerial network system, amounting to IDR 9,064,700. The estimated human resource costs for the aerial network system are IDR 99,832,500 and for the duct-aerial network system IDR 140,637,500. The estimated human resource costs for the duct-aerial network system are more than the aerial network system, amounting to IDR 40,805,000. The total estimated material costs and human resource costs for

the aerial network system are IDR 381,226,405 and for the duct-aerial network system it is IDR 431,096,105, so the total material costs and human resource costs for the duct-aerial system are more than IDR 49,869,700.

CONCLUSION

Based on the results of calculations and analysis, the power received by the detector at the farthest distance is -22,792 dBm for the downlink and -23,120 dBm for the uplink, with a total rise time uplink of 0.256 ns and downlink of 0.258 ns, and a BER value of 14.628×10^{-12} . The FTTH design carried out for the example case at Thoyibah Cibitung Islamic Housing, Bekasi Regency, using aerial and duct-aerial systems has met the requirements, namely $P_r > -28$ dBm, total rise time < maximum rise time, and BER values ranging from 10^{-9} to 10^{-12} , so that the proposed network design can be implemented. For material and human resource costs, the aerial system costs less than the duct-aerial system, with a price difference of IDR 49,869,700 or 11.56%. However, the use of a large number of aerial system cables and a lack of neatness in the installation will disrupt the view and require re-installation if there is damage to the aerial system cables. This FTTH network design is suitable for application in housing which has distances between houses that are close to each other.

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