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Fiber to the home (FTTH) activation system and analysis of dropcore cable connection losses on optical network performance

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ABSTRACT

The FTTH network is currently a reliable network concept used in an era where very fast access to information is needed as it is today, but several problems arise in the FTTH network, for example, reduced data transmission speed due to losses in the transmission cable connection or drop core. In this study, activation of the FTTH network will be carried out so that it can function for internet data transmission and observations will also be made of the connection losses on the 10-meter dropcore cable with the number of connections respectively, namely no connection, 1 connection, and 2 connections, where each connection obtains connection losses from 0.00 to 0.02 dB which will affect the total attenuation obtained in the activated FTTH network. Standard attenuation for fiber optic network activation starting from OLT to ONT according to IEEE Std 802.3ah states that the permissible attenuation / loss tolerance is between 20-24 to 29 dB. Splicing losses are caused by errors in the process of joining the fiber optic cable cores. The number of connections in a fiber optic cable can affect the attenuation value in the fiber optic cable. The more connections, the higher the attenuation in the fiber optic cable.

INTRODUCTION

It should be noted that in this digital age, people need fast internet access, so network technology is needed that is capable of meeting the need for fast and stable internet. Fiber To The Home (FTTH) is a network concept that uses fiber optic cable as a transmission medium or package conductor which has a large bandwidth so that it can provide reliable, fast and stable telecommunications services. At this time, fiber optic cable competence is very necessary in the era of information and communication technology (S. D. Kussoy, J. Prasetyo, and S. Widodo,2021)

In its implementation, the FTTH network does not always run smoothly as it should, sometimes there is a reduction in internet access speed due to problems or errors either in the ODP (Optical Distribution Point) or in the features on the customer's side.

An obstacle that often occurs in fiber optic networks is the reduction in light energy in the fiber optic cable core which results in disruption of the data transmission process, so that data transmission via optical cables causes high attenuation. Attenuation in fiber optic cables is mainly caused by poor splicing, unconnected cables, and poor cable quality, which results in attenuation and data transmission losses during data transmission (R. E. N. Iswan Umaternate, M. Zen Saifuddin, Hidayat Saman, 2016)

When an optical cable breaks, the Dropcore cable fusion splicing method can be used to overcome network loss (S. Tarsem Lal,2016). The device used is an Optical Fiber Fusion Splicer or better known as a Fusion Splicer. This device connects optical fibers between one core and another.

Connecting a dropcore cable can affect the performance of the FTTH network. If the connection you make gets good results, it will make FTTH performance when sending data easier and faster and vice versa. Based on research (Y. Wismaya and L. Jambola ,2018) it shows that the permissible attenuation when connecting optical cable cores is 0.03dB in order to produce connection results that comply with standards.

Based on research by Khairunnisa Mardhatillah entitled "Fiber to the home (FTTH) Network Design and Loss Analysis of Drop Core Cable Connections on Optical Network Performance" where in previous research the FTTH network design was carried out starting from ODC to ONT in the fiber optic communications laboratory Padang State Polytechnic campus which then carried out an analysis of the connection results in terms of the connection losses of the FTTH network, especially losses in the drop core cable, attenuation and also the influence of the many connections used in the drop core cable on transmission loss. on the FTTH network.

This research refers to previous research conducted by Khairunnisa Mardhatillah where in the previous research the Fiber to the Home (FTTH) network that was created only started from ODC to ONT, in this current research the aim is to perfect or add to the FTTH network that was previously created starting from OLT to the ONT while simultaneously activating the FTTH network and also analyzing the connection losses of the FTTH network, especially

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losses on the drop core cable and also the effect of the many connections used on the drop core cable on transmission loss on the FTTH network.

LITERATURE REVIEW

Fiber To The Home (FTTH)

FTTH (Fiber To The Home) is a fiber optic network architecture technology that can carry signals from providers using fiber optic as a carrier medium to the user. The architecture of the FTTH network can be seen in the picture

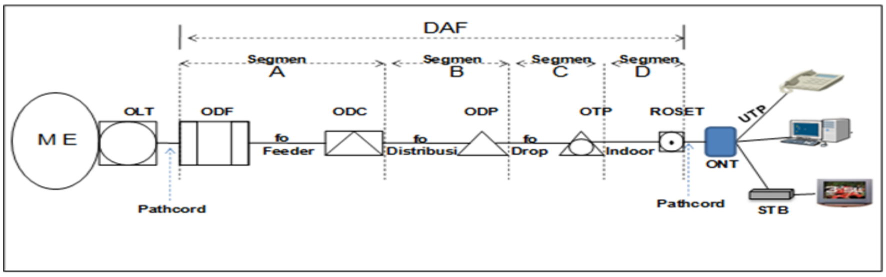

Figure 1. FTTH technology architecture

In general, the FTTH network is divided into 4 cable segment supplies in addition to active devices such as OLT and ONU/ONT, including the following:

1. Segment A: Feeder Cable Supply
2. Segment B: Distribution Cable Supply
3. Segment C: Penanggal / Drop Cable Supply
4. Segment D: House/Building Cable Supply

FTTH Network device

a. Metro E

Metro E/ Metro ethernet is a data communications network that covers urban or large-scale areas using ethernet technology.


Figure 2. Metro Ethernet

b. Optical Line Terminal (OLT)

OLT is a terminal device connected to the fiber optic network backbone. OLT sends ethernet data to the ONU/ONT, monitors and controls the start-up process, and records the start-up process (Wibisono Gunawan, Hantoro Dwi Gunadi, 2020). This device has two main functions, namely converting electrical signals and optical signals. Coordinating multiplexing on other devices at the end of the network which is usually called the Optical Network Terminal (ONT) or Optical Network Unit (ONU).

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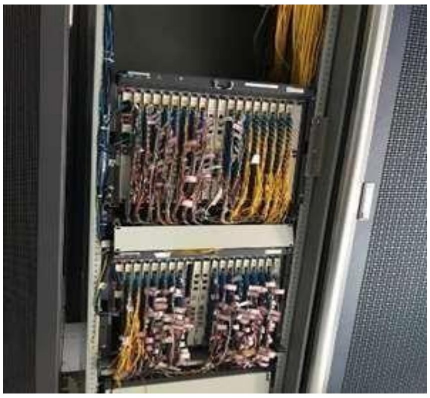

Figure 3. Optical Line Terminal

c. Optical Distribution Frame (ODF)

It is the termination point for fiber cables transitioning from outdoor fiber optic cables to indoor fiber optic cables and vice versa.

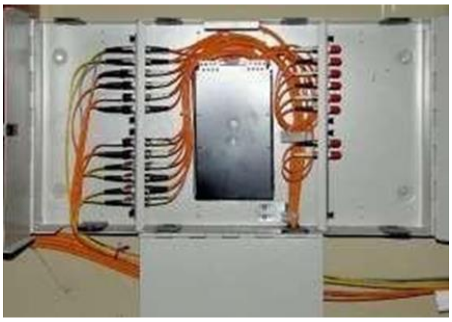

Figure 4. Optical Distribution Frame

d. Frame Termination Management (FTM)

It is a fiber optic based access network infrastructure, especially the FTTH access network located in the central office position. The FTM device functions as optical cable termination management in access and crossconnect networks as well as patchcord interconnections between O-Akses, E-Akses.

Figure 5. Frame Termination Management

e. Optical Distribution Cabinet (ODC)

ODC is a special place in the form of a box or dome made of special materials which functions as a place for installing single-mode optical network connections, which contains connectors, splicers and splitters and is equipped with a fiber management room with a certain capacity on passive optical access networks. (Passive Optical Network / PON).

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Figure 6. Optical Distribution Cabinet

f. Join Closure
A Joint Closure is a box or place to store the connection results from a fiber optic cable.

Figure 7. Join Closure

g. Optical Distribution Point (ODP)
ODP is the initial termination device for using a drop cable, before it enters the customer's home. The ODP device components consist of an optical pigtail, adapter connector, splitter room, fiber optic management room with a certain capacity and equipped with places for cable entry and exit (distribution cables and drop cables).

Figure 8. Optical Distribution Point

h. ROSETTE
ROSET is a passive device placed in the customer's home, which is the final termination point of the indoor/drop core fiber optic cable

Figure 9. Rosette

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i. Optical Network Terminal (ONT) / Optical Network Unit (ONU)

ONU/ONT is a general term denoting a device that terminates one of the ends of a fiber optic network to a receiver, implements a passive optical network (PON) protocol, and adapts the PON to a customer service interface. In some contexts, ONU implies a multi-subscriber device. Optical Network Terminal (ONT) is a special case of ONU that serves one customer (Wibisono Gunawan, Hantoro Dwi Gunadi, 2020).

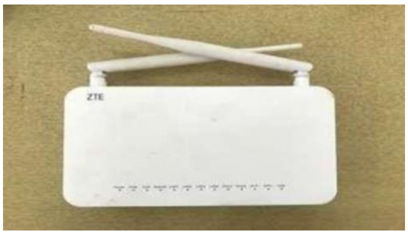

Figure 10. Optical Network Terminal

METHODS

Design flow

The first flow of designing an FTTH network activation system is to conduct a literature study regarding FTTH network activation which is appointed as a final assignment. After that, design a schematic or block diagram of the FTTH network activation design. Then, checks and repairs are carried out on damaged segments and adding new segments or installing additional segments on the FTTH network that was created in the previous final project. After that, initial data is collected before activating the FTTH network, then activation is carried out on the FTTH network. If the activation is successful, namely when the network attenuation complies with the IEEE Std 802.3ah standard, namely between 20-24 to 29 dB and you can access the internet using the FTTH network, then after that it will Testing and data collection is carried out on the FTTH network to see whether it is working as it should. Data collection is carried out to see whether the power value and attenuation value produced by the device and network are in accordance with the power link budget calculation. After collecting attenuation data, we will continue collecting connection loss data and analyzing problems with FTTH network activation. The FTTH network activation flow can be seen in Figure 11 below:

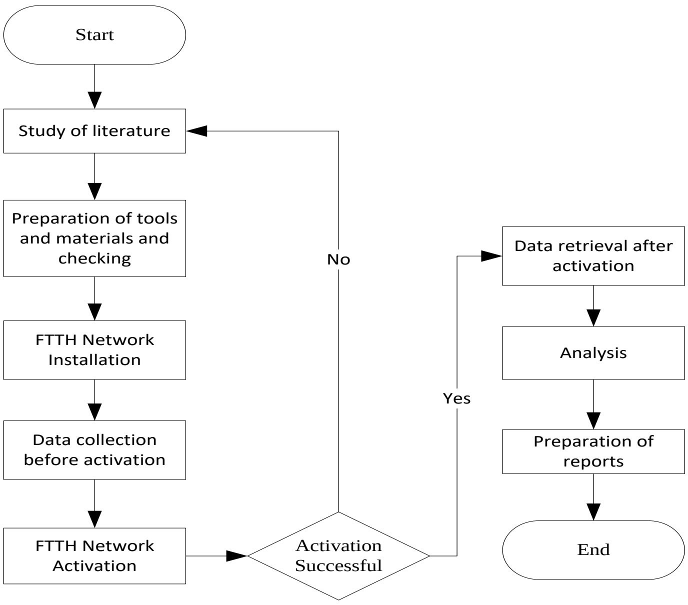

Figure 11. Final task flow

In this FTTH network activation design, losses are analyzed on the drop core cable, where the connection is carried out on the drop core cable in three conditions, namely no connection, one connection, and two connections on each cable with a length of 10 m, which can be seen in Figure 12.

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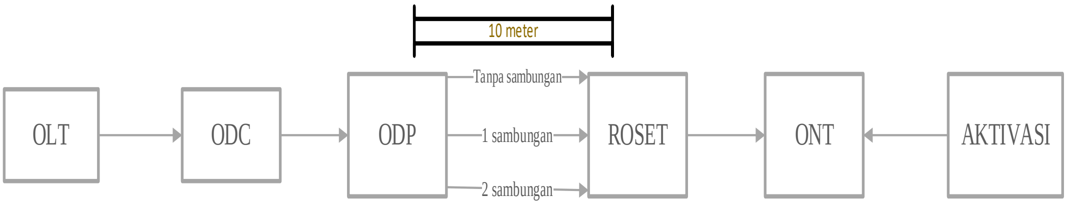

Figure 12. FTTH network design

FTTH Network Activation

At this stage, the network activation design is carried out on the FTTH network which has been built in the final assignment that was previously appointed. The internet source used in this activation comes from a personal hotspot which is connected to the Mikrotik via laptop. The steps in activating the FTTH network are as follows. device following the topology as shown in Fig.12 :

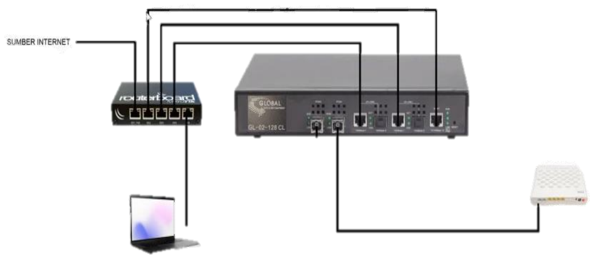

Fig.12 FTTH network activation topology

FTTH network activation steps

1. Connect port 1 on the proxy with an internet source. In this study, the internet source used comes from a personal hotspot which is connected to the proxy via the network sharing feature on the computer, then port 2 of the proxy is connected to the MGMT port on the OLT while port 3 of the proxy is connected to the UPLINK1 port on the OLT and port 5 on the proxy is connected to the desktop which is used to configure the proxy device as well as configure the OLT, then attach the SFP to the PON port on the OLT then connect it with a fiber cable to the FTTH network, at the end of the FTTH network attach the ONT using a patchcore cable.
2. Enter the Winbox application to configure the Mikrotik. The new Mikrotik will be configured using the admin login and empty password then press connect.
3. After successfully entering the Winbox application, open the interface menu as shown in the picture. Then change the name of each interface by double-clicking the interface you want to replace, then change the name section, click apply and OK, change all interface names according to the use of the interface.
4. Open VLAN in the interface menu window, click the blue plus sign and create a new VLAN, in the name column fill in VLAN100, and VLAN ID with 100 then click apply then OK.
5. Next, open the bridge menu and add a new bridge with the name CLIENT.
6. Then open the port menu in the bridge window and add a bridge port with the vlan100 and ethernet5-lebtop interfaces.
7. Open the IP menu then address in the address menu add the address 192.168.0.1/24 and with the ether2-MGMT OLT interface then press apply then ok then the network section column will be filled with the network IP that matches the IP that has been added.
8. Then open the DHCP client in the IP menu then add a DHCP client with the ethernet1-INET SOURCE interface then apply and ok.
9. Open the PPP menu then PPPoE Servers then add PPPoE servers with CLIENT interfaces that were created on the previous bridge. Then open the secrets menu then create New PPP Secrets with name TEST1 password TEST1 service pppoe local address 172.0.0.1 and remote address 172.0.0.100 then apply and ok.
10. Then create a hotspot feature by opening the IP menu then Hotspot, press the hotspot setup button on the hotspot interface select CLIENT then next to DNS server then fill in IP 8.8.8.8 next then in DNS name fill in global.com in the Name of Local bar Hotspot User fill in admin and password 123 select next then ok.
11. After that, set the ONT/ONU on the configuration web by opening IP 192.168.1.1 in a web browser then typing admin in the username and password, filling in admin.
12. After successfully logging in to the configuration web, in the network menu, select network settings, then fill in the username and password according to those set in the PPP Secrets manual, namely TEST1, then check the Enable VLAN point and set the VLAN ID according to the VLAN ID that was created previously.

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13. Then select wireless settings in the network menu and set the SSID and wireless key you want to use on the activated network.
14. When activation of the ONT has been completed, you will see that the internet indicator light will light up indicating successful activation and the FTTH network can be used to send internet packet data.

Fig.13 ONT condition after activation

RESULT

FTTH network attenuation measurement results before activation

The results of the FTTH network attenuation measurement where the HLS as input is connected to the feeder cable input and output at each end of the segment using OPM where the measurements are carried out before activation aims to ensure that the FTTH network that will be activated has attenuation that meets the standards for activation. The results of attenuation measurements before activation are in accordance with table 1.

Table 1. Attenuation table for each FTTH device before activation

Device	λ (nm)	Pt (dBm)	Pr(dBm)	Attenuation (dB)
Feeder	1310	-7,28	-7,90	-0,62
ODC (Passive spliter 1:4)			-15,02	-7,74
ODP			-25,74	-18,46
ONT (Feeder Without connection)			-29,65	-22,37

FTTH network attenuation measurement results after activation

The results of measuring the attenuation of the FTTH network after activation can be seen in table 2

Table 2. Attenuation table for each FTTH device after activation

Device	λ (nm)	Pt (dBm)	Pr(dBm)	Attenuation (dB)
Feeder	1310	7,98	7,26	-0,72
ODC (Passive spliter 1:4)			0,05	-7,93
ODP			-11,53	-19,51
ONT (Feeder Without connection)			-15,81	-23,79

Drop core cable loss measurement results

This measurement aims to measure the losses in connecting drop core cables using the Fusion Splicing method using a Fusion splicer tool on cables with a length of 10 meters with several types of connections. Where these connection losses can be seen on the Fusion splicer tool when the connection is finished, as shown in the figure.

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Fig.14 Results of connecting a single connection drop core cable

Fig.15 Results of connecting the drop core cable to the first two connection connections

Fig.16 Results of connecting two drop core cables to two connection connections

Connection losses on a drop core cable with a length of 10 meters can be seen in table 3.

Table 3. Measurement results for drop core cable connection losses

Cable length (m)	Number of connections	Connection losses (dB)
10	One connection	0.00
	Two connection	0.01
	Two connection	0.02

Results of total attenuation measurements on drop core cables

This is the result of measurements carried out to determine the effect of the number of connections on the total attenuation in the FTTH circuit. This attenuation is measured from the feeder cable to the ont. The total attenuation of the ont with a cable length of 10 meters can be seen in table 4.

Table 4. Table of measurement results for the total attenuation of the FTTH network for each type of connection

Cable length (m)	Number of connections	Output power (dBm)	Input power (dBm)	Attenuation (dB)
10	No connection	-29,65	-7,28	22,37
	One connection	-32,10	-7,28	24,82
	Two connection	-37,42	-7,28	30,14

DISCUSSION

Discussion of FTTH network activation

It can be seen in table 1 and table 2 that there is a slight difference in attenuation before and after installation because before activation it uses input power (Pt) from the HSL of -7.28 dBm, whereas during activation the Pt comes from the OLT with an SFP which functions to converts electrical signals into light signals with an input power of 7.89 dBm with attenuation results according to the table.

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Where an attenuation of 15 dB is produced on cables without connections, meaning that the FTTH network can/can be activated if the total attenuation ranges between 15-28 dBm.

Apart from being located at the input, it can be seen that after activation, the internet indicator light on the ONT will light up differently before activation, where before activation only the power indicator light which indicates the ONT is connected to a power source and the phone indicator which indicates the ONT is connected to the FTTH network is lit.

Discussion of connection losses in drop core cables

Based on the data listed in table 3, it can be seen that the connection losses for a 10 meter dropcore cable are different between the connection losses for 1-connection and 2-connection cables.

Differences in the results of connection losses can be seen on the monitor screen of the Fusion Splicer tool. These differences in connection losses can be caused by connection results or poor connection quality. This can affect the quality of data transmission on fiber optic cables to decrease.

Poor connection quality can be caused, among other things, by cutting the optical fiber with a poor fiber cleaver, or there is a distance between the connection points between the optical cable cores which causes the transmitted light to spread.

CONCLUSION

In this research, activation of the FTTH network has been carried out and analysis of drop core cable connection losses on fiber optic network performance has resulted in the following conclusions:

1. Standard attenuation for fiber optic network activation starting from OLT to ONT according to IEEE Std 802.3ah states that the permissible attenuation / loss tolerance is between 20-24 to 29 dB.
2. Splicing losses using a fusion splicer have different results from 0.00 to 0.02.
3. Splicing losses are caused by errors in the process of joining the fiber optic cable cores
4. The number of connections in the optical heart cable can affect the attenuation value in the fiber optic cable, the more connections the attenuation in the optical heart cable will be higher.

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