Analysis of STB Optimization for Enhancing Multimedia Services on OLT Network in the Telecommunication Engineering Laboratory Building

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***Abstract*— The internet network is currently developing very rapidly, both in the fields of education, health, coffee shops, e-commerce, and so on. An example of using an internet network is WLAN. WLAN is wireless communication that uses radio waves as a data transmission medium. The form of implementation of this WLAN is Wi-Fi (Wireless fidelity). Wi- Fi generally works on the 2.4 GHz frequency. Microstrip antenna is a type of antenna that can be used for wireless communications. Microstrip antennas have the advantages of being small, cheap and light. This research discusses the design and manufacture of microstrip antennas which aim to widen bandwidth in Wi-Fi applications in the form of hexagonal patches arranged in a 4x4 array. The result of this research is an external device, namely a microstrip antenna, which can increase data transfer capacity and works on the Wi-Fi frequency, namely 2.4 GHz. This research is in accordance with the antenna test parameters, which have a return loss value of -14.52 dB and a VSWR of 1.5. The bandwidth produced by the 4x4 hexagonal patch microstrip antenna is 162 MHz. The results of the power level implementation of the 4x4 hexagonal array microstrip patch antenna were -37 dBm, able to increase the signal reception level by 12 dBm from the built-in antenna which was -49 dBm. These results show a better increase in power level than the built-in antenna with a difference of 12 dBm.**

Keywords*— *Live streaming, Multimedia, OLT fiber optic network, STB, Switch.

I. INTRODUCTION

The development of information and communication technology is increasingly advanced, the need for multimedia services is growing every year. In this case, the use of fiber optic networks is the main choice to meet the need for good and fast multimedia services. No exception in the campus environment of the Malang State Polytechnic, especially in the Telecommunication Engineering Laboratory Building. Currently, the network used is connected to the main server network of the Malang State Polytechnic, which utilizes fiber optic as a transmission medium to support various academic, administrative and multimedia activities.

One of the devices in providing multimedia services is by using an STB (Set Top Box), where this device is used to receive and process digital television signals and interactive services such as opening YouTube, Netflix, Amazon Prime Video and other applications without having to buy a new television [1]-[5]. These services can be obtained by using bandwidth that has a fairly high capacity and speed [6]-[8].

Efforts to improve the quality of multimedia services in the Malang State Polytechnic Telecommunication Engineering Laboratory Building require reliable, fast and efficient network infrastructure. Therefore, the transmission media on the fiber optic network has a significant impact on network performance or reliability, network quality, and costs that can affect success [9]-[10]. Optical Line Terminal (OLT) as the main component in fiber optic is a device used in fiber optic networks to manage and transmit data from various customers [11].

In previous research, analysis and optimization of FTTH (Fiber To The Home) networks were carried out based on data from complaining customers and also included calculations of network feasibility parameters, namely Power Link Budget [12], Rise Time Budget [13], and Bit Error Rate (BER) [14] with the help of Optisystem software. The results of the link test after optimization proved that the network that had been implemented with FTTH [15]-[17] had met the network standards determined by PT. Telkom [1].

Therefore, research was conducted using a fiber optic network as a transmission medium to improve the quality of multimedia services at the Telecommunication Engineering Building, Malang State Polytechnic. For this reason, the author took the title "STB Optimization Analysis for Improving the Quality of Multimedia Services on the OLT Network in the Telecommunication Engineering Laboratory Building". Testing was also carried out using a Switch as a comparison for multimedia quality results using an existing network. The purpose of this study is to conduct an in-depth analysis of the comparison of multimedia quality produced by

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ONT and Switch with Throughput, MSE and PSNR parameters through Matlab and Wireshark software as a measurement of audio image quality in the Telecommunication Engineering Laboratory Building.

II. METHOD

The type of research used in this study is a quantitative implementation and analysis research type where this research will implement the devices to be applied, collect data samples and describe the results of the data.

A. System Design

Ssystem flow using ONT, starting with connecting the OLT to the ONT via a local network connected to the center, where the OLT functions to send data to customers, while the ONT acts as an interface between the fiber optic network and users. After that, the ONT is connected to the STB with the appropriate cable, and the main data collection is carried out for testing image and audio quality using Matlab software. Furthermore, the ONT is connected to the user to do live streaming as a comparison, using software such as OBS Studio. The comparative data is then taken for the final multimedia quality test. After all data from the STB and live streaming is collected, QoS and multimedia quality testing is carried out with Throughput, MSE, and PSNR parameters to assess the image and audio quality produced by the ONT using a fiber optic network, as well as its comparison with the Switch using a local network. The last step is the analysis of the results and conclusions, which show a comparison of multimedia quality between the ONT and Switch and provide a deeper understanding of theresulting image and audio quality.

The system flow using Switch, starting with connecting an ethernet cable connected to the central network to the Switch, which functions to connect two LAN networks through several ports. After that, the Switch is connected to the STB using an ethernet cable, followed by the main data collection that will be used for testing image and audio quality via Matlab software. After the main data collection is complete, the Switch is connected to the user to do live streaming as a comparison, using software such as OBS Studio. The comparative data is then taken for final testing. Furthermore, QoS and multimedia quality testing is carried out using the Throughput, MSE, and PSNR parameters, which aim to assess the image and audio quality produced by the Switch with a local network and compare it with the ONT using a fiber optic network. The final stage is the analysis of the results and conclusions, which show a comparison of multimedia quality between the Switch and ONT, providing a clearer understanding of the image and audio quality produced.

B. Live Streaming System Model on ONT and Switch

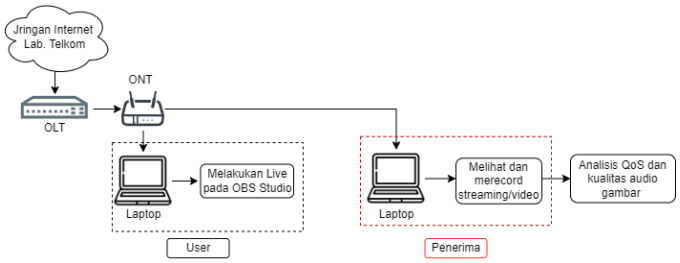

Figure 1 Live Streaming System Model with ONT

Figure 1 explains the live streaming system using ONT. Starting from the OLT connected to the local network and the splitter to the AL and AH Buildings. From the splitter, the ONT receives multimedia signals, then the ethernet cable from the ONT is connected to the user. Live streaming starts with OBS Studio to share the video recorded on the STB, and the recipient watches on YouTube. QoS is analyzed with Wireshark (throughput) andthe live streaming video results are recorded for 5 seconds at1080p, 720p, 360p resolutions. Image and audio quality analysis is done using MSE and PSNR in Matlab.

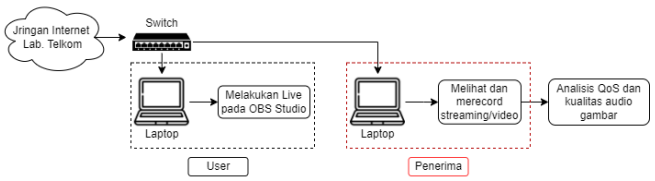

Figure 2 Live Streaming System Model with Switch

Figure 2 explains the live streaming system using Switch. The first step, the local network in the Telecommunication Engineering Lab Building is connected to the Switch via an ethernet cable, then the LAN cable from the Switch is connected to the user and receiver. Live streaming starts with OBS Studio to share video from the STB, and the receiver watches on YouTube. QoS analysis is performed with Wireshark (throughput) and the video is recorded for 5 seconds at 1080p, 720p, and 360p resolutions.Image and audio quality analysis uses MSE and PSNR in Matlab.

The measurement of test parameters in this study used Matlab software with MSE and PSNR parameters for image and audio quality produced by the ONT and Switch during live streaming, and also conducted QoS analysis with Throughput parameters via Wireshark software. Here are some basic theories that support this study :

1) Optical Network Terminal (ONT)

Optical Network Terminal (ONT) is an end device or last point of fiber optic path originating from STO or OLT installed on the customer side. This device provides an interface between the optical network and the customer for data, voice and video services. Optical signals transmitted through ODP are converted by ONT into electrical signals needed for customer service [1].

2) Switch

Switch is a device that allows multiple computers or network devices to share resources by connecting them together [2]. Switch is often called multi port bridge because its function is similar to bridge, which can connect two different LAN networks because of several ports. The main advantage of switch is its ability to maintain smooth communication on other ports when one port is busy. The weakness of switch is not able to send IP to other computers that are in different logical networks.

3) Set Top Box (STB)

Set Top Box (STB) is a small hardware device, has a processor, RAM, hardware ports and android operating system that is commonly found on many computers [3]. STB is also a device that allows television to become a user interface (intermediary) to connect to the internet. Android TV Box is a device similar to TV Box but this device has an embedded OS (Operating System) but is not equipped with a screen, therefore additional devices such as monitors, computers, or projection screens are needed that are connected using HDMI cables.

4) Video Streaming

Streaming can be defined as a technique used to transfer audio video data from a server to a receiver so that it can be processed continuously and continuously. Streaming is a method for making audio, video, and other multimedia available in real time on different types of networks [4]. Video streaming is also an important technology in digital content distribution that allows users to watch videos in real time over the internet.

5) Video Resolution

Resolution or frame dimension is the size of a frame in digital video. Resolution is expressed in pixels x pixels. There are several commonly used resolution levels such as 360p, 720p, and 1080p. Higher resolutions tend to produce better displays, but also require more bandwidth and resources to stream or play videos. Therefore, it is necessary to consider the balance between visual quality and resource efficiency in choosing a video resolution [5].

6) Video and Audio Conversion Methods

Videos can contain audio synchronized with images to provide a complete multimedia experience. Video formats vary, including MP4, AVI, MKV, and others. The word conversion in etymological terms comes from the Latin conversion, which means to move or change (state). The word is then used in English conversion, which means changing from a state [6]. JPG is very suitable for storing complex color images such as photos. Created to support the use of grayscale or color digital images and high-quality graphics on digital devices [7]. The WAV format was developed by Microsoft and IBM. The WAV file format itself is a subsection of the Microsoft RIFF specification that functions to store multimedia files. The advantages of this format are good sound quality, not compressed, easy to change and compress to MP3 format, can be played on all operations such as Windows or Mac, and popular browsers and widely used by mobile phones, so that its popularity is almost the same as MP3 files [8]. File conversion is done to make the converted format compatible with certain software or to make the file size smaller so that it saves more storage space.

7) Digital Image

An image is a two-dimensional representation created from images or various visualizations of objects. The numbers in the image are the result of quantifying the intensity of the brightness level of each pixel that makes up the image. Digital images can generally be divided into 3, color images or RGB (Red, Green, Blue) which have colors in each pixel in the form of red, green, and blue. The second digital image is a black and white or grayscale digital image which has a gradation of color from white to black on each pixel, and a binary digital image which only has black or white on each pixel [9].

8) Wireshark

Wireshark is a software that is often used for network analysis. This application can capture data packets or information on the network, so that the captured data can be analyzed for various network problems including network security checks and personal data [10]. Wireshark is also used in analyzing packet delivery, tracking connection processes, and understanding data delivery between computers in a network.

9) OBS Studio

Open Broadcast Software (OBS) Studio is an application designed to support the creation and broadcasting of live video content (live streaming) as well as to record videos that can then be uploaded to other platforms. This application provides a composition of recording, broadcasting and other file agendas from various sources [11].

10) OpenSpeedTest

OpenSpeedTest is a software used for testing network speed. This application is designed to test connections from 1 Kbps to 1 Gbps. The algorithm used automatically detects stable download and upload speeds. The internet speed tested is the connection speed between the server and the connected client and the final result is the average value of the download and upload speeds.

11) Mean Squared Image (MSE)

MSE is a good measure to measure the similarity of 2 images. The MSE method is often used to measure audio and image quality. The smaller the MSE value, the better the image quality improvement results. This means that the image quality after experiencing quality improvement is almost the same as the quality of the original image [12]. Likewise with audio, the more similar the two audios are, the smaller the value obtained. The formula for calculating MSE as shown in equation 1 and 2:

$$MSE = \frac{1}{MN}\sum_{n=0}^{M}\sum_{m=1}^{N}[f(n,m) - g(n,m)]^2 \quad (1)$$

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(x_i - y_i)^2 \quad (2)$$

Information:

M : Image length
N : Image width
(f,g) : Coordinates of each pixel
x : original audio signal
y : receiver audio signal
N : number of signal samples

12) Peak Signal to Noise Ratio (PSNR)

PSNR is the ratio between the maximum value of a measured signal and the amount of noise that affects the signal. Usually PSNR is measured in decibels (dB) [13]. PSNR is done after obtaining the MSE value. The higher the PSNR value, the better the image quality. A good image has a PSNR value between 20 dB and 60 dB. The formula for calculating PSNR as shown in equation 3:

$$PSNR = 10log_{10}(peakval^2)/MSE \quad (3)$$

Information :
Peakval : Maximum value in image data
MSE : MSE value

13) Quality of Service (QOS)

Quality of Service (QoS) is a method to measure how good a network is and is an effort to define the characteristics and properties of a service [14]. QoS is useful for managing a set of predetermined performance attributes and associated with a service. QoS refers to the network's ability to provide good service to network traffic. The parameters used in this study are Throughput. Throughput testing is the speed of the network in transferring data. Throughput is related to bandwidth because it can be considered as the actual bandwidth condition [15]. The formula for calculating Throughput as shown in equation 4:

$$\text{Throughput} = \frac{\text{Amount of data sent}}{\text{Second}} \quad (4)$$

TABLE I
THROUGHPUT CATEGORY ACCORDING TO THIPON

Category	Throughput (bps)	Index
Very good	>100	4
Good	75	3
Moderate	50	2
Bad	25	1

III. RESULTS AND DISCUSSION

A. Live Streaming with ONT

Figure 3 Live Streaming with ONT

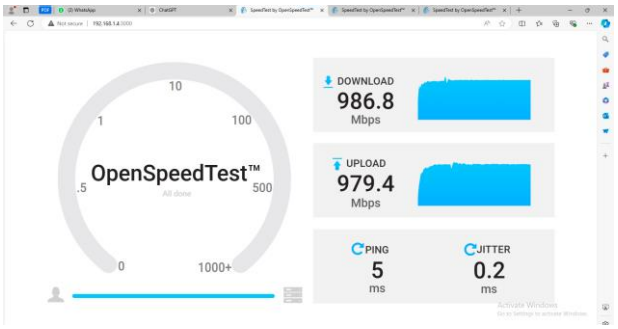

Figure 4 Network Speed using ONT

Figure 3 and 4 show that live streaming has been successfully carried out using the ONT that has been connected to the OLT network according to the system design. Live streaming is done by displaying the main video using the OBS Studio application on the user side and the YouTube platform on the receiver side, for video sampling, it is done by recording the live streaming results for 5 seconds as a comparison and taking resolutions of 1080p, 720p, and 360p. Figure 6 shows the overall network speed via the OpenSpeedTest software connected to the internet network of the Telecommunication Lab Building. The test results show that the download speed reaches 986.8 Mbps and the upload reaches 979.4 Mbps. The speed obtained is lower than the speed obtained by the Switch, but these results show that the network used has good performance and is suitable for supporting live streaming needs.

B. Live Streaming with Switch

Figure 5 Live Streaming with Switch

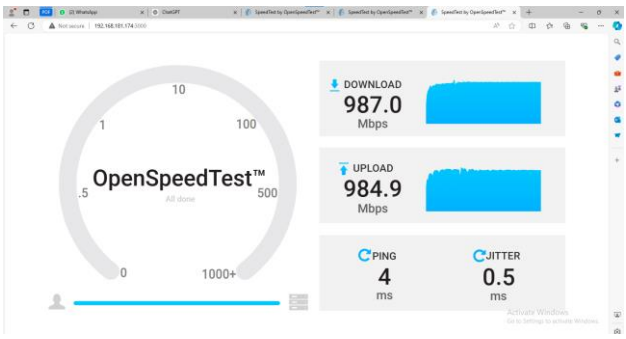

Figure 6 Network Speed using Switch

Figure 5 and 6 show that live streaming has been successfully carried out using a Switch connected to an existing

network according to the system design. Live streaming is done by displaying the main video using the OBS Studio application on the user side and the YouTube platform on the receiver side, for video sampling, the results of live streaming are recorded for 5 seconds as a comparison and the resolutions are 1080p, 720p, and 360p. Figure 6 shows the overall network performance through the OpenSpeedTest software connected to the internet network of the Telecommunication Lab Building via an ethernet cable. The test results show that the download speed reaches 987 Mbps and the upload reaches 984.9 Mbps. The speed obtained is higher than the speed obtained from the Optical Network Terminal (ONT). These results indicate that the network used has very good performance and is suitable for supporting live streaming needs.

C. Image Analysis

The image quality analysis process is carried out using Wireshark and Matlab software with 3 parameters, namely Throughput, MSE and PSNR. The following in tables I to IV is a comparison of image quality obtained from live streaming testing by recording live results using ONT and Switch.

1) Building AI

TABLE II
IMAGE QUALITY RESULTS ON THE AI BUILDING

Resolusi	Channel	ONT			SWITCH		
		Throughput (bps)	MSE	PSNR (dB)	Throughput (bps)	MSE	PSNR (dB)
1080p	TV ONE	219	28,4	33,6	266	13,3	36,9
	SCTV	348	10,9	37,7	382	3,60	42,6
	MNCTV	326	11,4	37,5	389	3,48	42,7
	METRO	218	22	34,7	242	15,2	36,3
	KOMPAS	231	19,4	35,2	332	6,94	39,7
	Total	**268**	**18,4**	**35,74**	**322**	**8,5**	**39,6**
720p	TV ONE	98	34,1	32,8	195	17	35,8
	SCTV	156	15,2	36,3	226	5	41,1
	MNCTV	183	16,3	36	218	5,6	40,6
	METRO	103	27,4	33,7	187	18,3	35,5
	KOMPAS	109	25,6	34	217	10,9	37,7
	Total	**129**	**23,7**	**35,3**	**208**	**11,3**	**38,1**
360p	TV ONE	70	34,6	32,7	89	19,6	35,2
	SCTV	88	14,3	36,6	97	5,9	40,4
	MNCTV	83	17,7	35,6	94	9,5	38,3
	METRO	78	27,6	33,7	68	19,6	35,2
	KOMPAS	75	28,1	33,6	91	15,6	36,2
	Total	**78**	**24,4**	**34,4**	**87**	**14,4**	**37,6**

Table II shows the results of the comparison of values between Throughput, MSE and PSNR, where the results obtained Throughput shows varying values in transmitting data from the server to the receiver during the streaming process. While MSE shows the total value between the images from the sender and receiver which will be seen as the similarity of the 2 images that have been tested and PSNR shows the comparison between the maximum pixel value and the noise in the image. The average results of Throughput, MSE and PSNR above show that Switch at 1080p resolution is better with a value obtained throughput of 322 bps, MSE 8.5 and PSNR 39.6 dB while ONT at 1080p resolution with a value obtained throughput of 268 bps, MSE 18.4 and PSNR 35.74 dB. The higher the resolution used, the higher the throughput value. The greater the PSNR value, the smaller the MSE value which indicates that the quality of the processed image is very good with little noise.

2) Building AL

TABLE III
IMAGE QUALITY RESULTS ON THE AL BUILDING

Resolution	Channel	ONT			SWITCH		
		Throughput (bps)	MSE	PSNR (dB)	Throughput (bps)	MSE	PSNR (dB)
1080p	TV ONE	226	20	35,1	279	16,3	36
	SCTV	337	4,42	41,7	366	2	45
	MNCTV	292	9,31	38,4	283	10,9	37,7
	METRO	255	13,6	36,8	248	38	32,3
	KOMPAS	238	16,1	36	227	19,7	35,2
	Average	269	12,6	37,6	280	17,3	37,2
720p	TV ONE	199	40,1	32,1	237	21,1	34,9
	SCTV	209	14,8	36,4	287	3	43,3
	MNCTV	242	9	38,5	228	12,2	37,2
	METRO	186	21,3	34,8	124	43,8	31,7
	KOMPAS	169	25,5	34	161	25,4	34,1
	Average	201	22,1	35,1	207	21	36,2
360p	TV ONE	68	44,2	31,7	80	24,7	34,2
	SCTV	95	16,2	36	109	4	42
	MNCTV	88	10,5	37,9	96	14,9	36,4
	METRO	78	21,1	34,9	61	45,7	31,5
	KOMPAS	72	28,6	33,5	68	30	33,3
	Average	80	24,1	34,8	82	23,8	35,4

Table III shows the results of the comparison of values between Throughput, MSE and PSNR, where the results obtained Throughput shows varying values in transmitting data from the server to the receiver during the streaming process. While MSE shows the total value between the images from the sender and receiver which will be seen as the similarity of the 2 images that have been tested and PSNR shows the comparison between the maximum pixel value and the noise in the image. The average results of Throughput, MSE and PSNR above show that Switch at 1080p resolution is better with a value obtained throughput of 280 bps, MSE 12.6 and PSNR 37.6 dB while ONT at 1080p resolution with a value obtained throughput of 269 bps, MSE 17.3 and PSNR 37.2 dB. The higher the resolution used, the higher the throughput value. The greater the PSNR value, the smaller the MSE value which indicates that the quality of the processed image is very good with little noise.

3) Building AH

TABLE IV
IMAGE QUALITY RESULTS ON THE AH BUILDING

Resolution	Channel	ONT Throughput (bps)	ONT MSE	ONT PSNR (dB)	SWITCH Throughput (bps)	SWITCH MSE	SWITCH PSNR (dB)
1080p	TV ONE	258	19,3	35,2	261	20,8	34,9
	SCTV	359	2,86	43,5	324	3,44	42,7
	MNCTV	272	10,4	37,9	320	3,59	42,6
	METRO	324	7,46	39,4	306	11,9	37,3
	KOMPAS	255	8,45	38,8	268	6,36	40,1
	Average	293	9,6	38,9	295	9,2	39,5
720p	TV ONE	129	26,4	33,9	124	22,9	34,5
	SCTV	217	9,39	38,4	238	4,85	41,3
	MNCTV	106	22,3	34,6	227	5,62	40,6
	METRO	150	14,5	36,5	136	16,4	36
	KOMPAS	147	16,9	35,8	164	10,2	38
	Average	149	17,8	35,8	177	11,9	38
360p	TV ONE	76	27,3	33,7	79	24,6	34,2
	SCTV	81	12,8	37	94	5,79	40,5
	MNCTV	61	30	33,3	82	10,4	37,9
	METRO	78	14,9	36,4	87	18,3	35,5
	KOMPAS	73	20,8	34,9	81	14,1	36,6
	Average	73	21,1	35	84	14,6	36,9

Table IV shows the results of the comparison of values between Throughput, MSE and PSNR, where the results obtained Throughput shows varying values in transmitting data from the server to the receiver during the streaming process. While MSE shows the total value between the images from the sender and receiver which will be seen as the similarity of the 2 images that have been tested and PSNR shows the comparison between the maximum pixel value and the noise in the image. The average results of Throughput, MSE and PSNR above show that Switch at 1080p resolution is better with a throughput value of 295 bps, MSE 9.2 and PSNR 39.5 dB while ONT at 1080p resolution with a throughput value of 293 bps, MSE 9.6 and PSNR 38.9 dB. The higher the resolution used, the higher the throughput value. The greater the PSNR value, the smaller the MSE value, indicating that the quality of the processed image is very good with little noise.

D. Audio Analysis

Tables V to VI show the comparative values of Throughput, MSE and PSNR using ONT and Switch for the audio quality obtained during live streaming via Wireshark and Matlab software at the Telecommunication Engineering Laboratory Building of Malang State Polytechnic.

1) Building AI

TABLE V
AUDIO QUALITY RESULTS ON THE AI BUILDING

Channel	Device	Throughput (bps)	MSE	PSNR (dB)
METRO TV	ONT	218	0,12	57,2
KOMPAS TV	Switch	332	0,03	63,1

Table V shows the results of the comparison of values between Throughput, MSE and PSNR where Throughput shows the value in transmitting data from the server to the receiver during the streaming process. While MSE measures the average difference between the original audio sample value at the sender and the processed audio at the receiver and PSNR shows the ratio between the maximum signal and noise levels in the audio signal. The comparison value of audio quality is obtained from live streaming that has been done using ONT and Switch. The results obtained show that Switch is better than ONT with a value of 332 bps, 0.03 MSE and PSNR 63.1 dB. The higher the resolution used, the higher the throughput value. The greater the PSNR value, thesmaller the MSE value, indicating that the processed audio signal has a very low noise level compared to the original signal.

2) Building AL

TABLE VI
AUDIO QUALITY RESULTS ON THE AL BUILDING

Channel	Device	Throughput (bps)	MSE	PSNR (dB)
METRO TV	ONT	226	0,12	57,2
KOMPAS TV	Switch	283	0,08	58,7

Table VI shows the results of the comparison of values between Throughput, MSE and PSNR where Throughput shows the value in transmitting data from the server to the receiver during the streaming process. While MSE measures the average difference between the original audio sample value at the sender and the processed audio at the receiver and PSNR shows the ratio between the maximum signal and noise levels in the audio signal. The comparison value of audio quality is obtained from live streaming that has been done using ONT and Switch. The results obtained show that Switch is better than ONT with a value of 283 bps, 0.08 MSE and PSNR 58.7 dB. The higher the resolution used, the higher the throughput value. The greater the PSNR value, thesmaller the MSE value, indicating that the processed audio signal has a very low noise level compared to the original signal.

3) Building AH

TABLE VII
AUDIO QUALITY RESULTS ON THE AH BUILDING

Channel	Device	Throughput (bps)	MSE	PSNR (dB)
SCTV	ONT	348	0,10	58,1
TVONE	Switch	266	0,09	58,5

Table VII shows the results of the comparison of values between Throughput, MSE and PSNR where Throughput shows the value in transmitting data from the server to the receiver during the streaming process. While MSE measures the average difference between the original audio sample value at the sender and the processed audio at the receiver and PSNR shows the ratio between the maximum signal and noise levels in the audio signal. The comparison value of audio quality is obtained from live streaming that has been done using ONT and Switch. The results obtained show that ONT is better than Switch with a value of 348 bps, 0.10 MSE and PSNR 58.1 dB. The higher the resolution used, the higher the throughput value. The greater the PSNR value, the smaller the MSE value, indicating that the processed audio signal has a very low noise level compared to the original signal.

IV. CONCLUSION

The following are the conclusions from the tests that have been carried out: based on the average results of image quality measured using the Throughput, MSE, and PSNR parameters, the Switch shows better performance compared to the ONT. This difference is caused by noise in the image, which is influenced by insufficient or excessive lighting, causing variations in values on each channel. Based on the THIPON standard, the results from the ONT and Switch with 1080p and 720p resolutions are included in the very good category, while for 360p resolution it is included in the good category. For audio quality, the Switch is also superior to the ONT. However, video resolution does not affect audio quality. The higher the PSNR value, the smaller the MSE value, which indicates that the audio signal has very low noise compared to the original signal. According to the THIPON standard, the audio quality produced by the ONT and Switch is included in the very good category.

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