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Comparative Analysis of Network Development Local Area Network (LAN) Fiber Optical Cable with Unshielded Twisted Pair (UTP) Cat 6 Cable at SMK Negeri 2 Tasikmalaya

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Abstract

The LAN Network at SMK Negeri 2 Tasikmalaya previously used media UTP Cat5e network with poor performance due to bandwidth UTP Cat5e is only 200 Mb/s, therefore the school choose to replace it network media with fiber optics, with a bandwidth that can reach 1 Gb/s. On the other there is still UTP Cat6 with the same bandwidth of 1Gb/s at a cost installation is lower than fiber optic network installation. Data collection on performance is carried out using the Quality of Service (QoS) approach with the parameters measured, namely Delay, Jitter, Packet loss and Throughput using Wireshark software. Performance of fiber optic and UTP Cat6 networks at SMK Negeri 2 Tasikmalaya in categorize "Good" according to Telecommunications and Internet Protocol Hormonization Over Network (TIPHON) standards. Test results from optical fiber obtained a delay of 2.58 ms, jitter of 2.38 ms, packet loss of 0.254 and throughput of 805.92 Mbps. The test results of the UTP Cat6 cable were obtained delay of 5.59 ms, jitter of 5.21 ms, packet loss of 0.559 and throughput of 623.73 Mbps.

Keywords: Fiber optic, UTP Cat6, QoS, performance analysis.

1. Introduction

Along with the development of science and technology, humans need to obtain information will increase. Technology that growing rapidly will bring benefits to the community in accessing it necessary information, such as the time to obtain the information becomes shorter and easier to find information. One way to getting information is the internet network where technology becomes a major concern for human technology (Hutchby, 2013).

Since its birth, internet technology has developed rapidly and it has been used all over the world. With internet technology, humans have succeeded connecting regions of the world into one computer network which is very large, so it seems as if there are no boundaries to one area with others (Apigian, 2005). Internet according to Hasyim (2009), "Abbreviation for interconnected network, namely a network system that connects millions computers in the world.

The internet is needed in every environment, one of which is indoors educational environment. SMK Negeri 2 Tasikmalaya use LAN network facilities as supporting facilities and infrastructure in learning and teaching activities.

Therefore it is very important for parties The school provides good network services so that the learning process does not occur hampered. SMK Negeri 2 Tasikmalaya has 6 skills programs, among others Broadcasting, Technical Drawing, Electricity, Automotive, Machinery and Engineering Network Computer.

The LAN network at SMKN 2 Tasikmalaya previously used media UTP Cat5e network with poor performance due to bandwidth Cat5e UTP cable only has a speed of 200Mb/s, therefore SMK Negeri 2 Tasikmalaya chose to replace the network media with fiber optic cable with bandwidth reaching 1Gb/s. On the other hand, there are still UTP Cat6 cables with the same bandwidth of 1Gb/s and lower installation costs than network installations Fiber optic cable LAN. For this reason, it is necessary to analyze and test the fiber cable LAN network optics and UTP CAT6 cable by analyzing performance comparisons. From this description the author takes title "Comparative Analysis of Fiber Optic Cable Network Development and UTP CAT6 cable on performance at SMK Negeri 2 Tasikmalaya.

2. Literature Review

Quality of Service (QoS) is a measurement method on a network determines that a network service can operate in accordance with standards established service quality. QoS is used for measures various performance characteristics specified and related to maintenance (Karakus & Durresi, 2017).

(Aprianto Budiman, 2020) Research by doing analysis of QoS on the Internet network at SMK Negeri 7 Jakarta emphasizes the process of monitoring and measuring QoS parameters, namely throughput, delay, packet loss and jitter. The tools used to measure QoS parameters are Axence Net Tools Pro 5.0 and bandwidth monitor speedtest apps. The final result obtained after carrying out QoS measurements is that the Internet network of SMK Negeri 7 Jakarta is in the medium category based on the TIPHON standardization with an index value of 2.14.

(Irvika Romana, 2021) Conducting research using the Design Science Research (DSR) method which has 6 stages, namely problem identification and motivation, determining solution objects, design and development, demonstration, evaluation and reporting results. This scientific analysis was carried out by measuring traffic from the Local Area Network (LAN). The parameters measured and analyzed are bandwidth, delay, jitter, and packet loss by providing loads in the form of data packets on TCP and UDP to see the characteristics of the network using Jperf and Wireshark software to see whether the quality of the Unila intranet network is good or bad. The results of this research can be categorized as "Good" based on the ITU-T G.114 standard reference.

(Muhammad Deagama Surya Antariksa, 2022) analyzing computer networks, namely to find out the process of the working system on a computer network and find out the advantages and disadvantages of a computer network system. Apart from that, you can find out the topology of the computer network at UNRAM Hospital. The results after creating a network topology, if a problem occurs on the computer network, can be found by looking at the network topology that has been created. And by creating a network topology, mapping the computer network becomes easier

3. Materials and Methods

3.1. Materials

The location taken in this research was SMK Negeri 2 Tasikmalaya which of course uses Internet facilities as support
facilities and infrastructure in learning and teaching activities. This research carried out to determine the comparison of fiber optic cable LAN networks and UTP Cat6 cable LAN network on performance and cost.

Data collection on performance is carried out using the QoS approach with the parameters measured, namely Delay, Jitter, Packet loss and Throughput using Wireshark software. Data collection on costs are carried out by collecting data from schools regarding the design budget and budget that has been used for installation network, from online and offline stores.

3.2. Methods

This research uses quantitative research using descriptive method. Quantitative research is a type of research the specifications are systematic, well planned and clearly structured. Descriptive quantitative research methods aim to explain something phenomena using data or numbers that describe the subject checked.

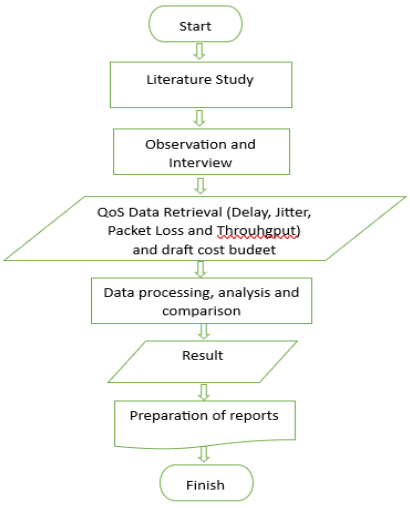

Figure 1: Research Flow Diagram

The stages in this research are:

1. Observation of the research location.
2. Gathering theoretical basis to support the research to be conducted.
3. Data collection using Wireshark software with an approach QoS parameters.
4. Processing test result data.
5. Retrieval of budget data on fiber optic LAN network installation costs and UTP Cat6.
6. Conduct comparative analysis.
7. Draw conclusions for research into the development of LAN network cables in SMK Negeri 2 Tasikmalaya

3.2.1. Delay and Jitter Calculation

Delay or latency is the delay time a packet carries the transmission process from one point to another is the destination. Delay can be influenced by distance, transmission media, total traffic and processes long. The Delay categories according to TIPHON are:

Table 1: Delay Standardization

Latency Category	Delay (*ms*)	Index
Very Good	< 150	4
Good	150 - 300	3
Average	300 - 450	2
Bad	> 450	1

$$Delay = \frac{Total\ Packet\ Delay}{Total\ Packet\ Received}. \quad (1)$$

Jitter is the variation in delay between queued packets, in data processing time and also in the time of regrouping packets in the network. Jitter is normal called Delay variation, is closely related to Latency, the number of Delay variations in data transfer on the network. Jitter depends on how big the load is traffic on the network, the greater the traffic, the greater it is congestion which causes the jitter value to increase, as a result, QoS continues to decrease and maintains a good network, the jitter value must be as small as possible. The Jitter category according to TIPHON are:

Table 2: Jitter Standardization

Jitter Category	Jitter (*ms*)	Index
Very Good	0	4
Good	0 – 75	3
Average	75 – 125	2
Bad	125 - 225	1

$$Jitter = \frac{Total\ Delay\ Variation}{Total\ Packet\ Received}. \quad (2)$$

Measuring delay and jitter values uses data that has been taken by wireshark software when 100 packets are sent from the laptop to the router. And that package only ICMP Reply packets are measured.

3.2.2. Packet Loss Calculation

Packet loss is a parameter that describes a condition shows the number of packets lost due to collisions and congestion network. The package failure was caused by several possibilities including traffic overload, errors on physical media, failure on the receiving side and congestion on the line. In network implementation, the value of packet loss expected to be as minimal as possible. The Packet Loss category according to TYPHON is:

Table 3: Packet Loss Standardization

Packet Loss Category	Packet Loss (%)	Index
Very Good	0 – 2	4
Good	3 – 14	3
Average	15 – 24	2
Bad	> 25	1

$$Packet\ Loss = \frac{(data\ packet\ is\ sent - data\ packet\ received)}{data\ packet\ received}\ x\ 100\%. \quad (3)$$

The packet loss value is taken from the CMD window after packet transmission is complete.

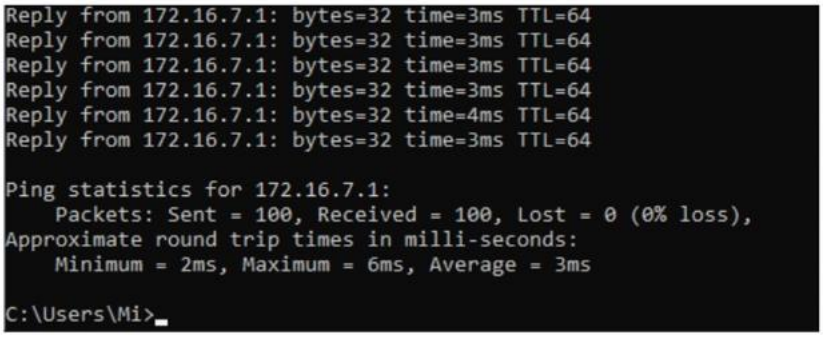

Figure 2: The Packet Loss Value is Taken from CMD Window

3.2.3. Troughput Calculation

Throughput is the measured effective data transfer speed (rate) in bps (bits per second). Throughput can also be called the total amount Successful packet arrivals are observed at the destination during a time interval a certain amount divided by the duration of that time interval. As for the Throughput category according to TIPHON are as follows:

Table 4: Troughput Standardization

Troughput Category	Troughput	Index
Very Good	>2.1 Mbps	4
Good	1.2 – 2.1 Mbps	3
Average	700 Kbps – 1.2 Mbps	2
Bad	338 – 700 Kbps	1
Very Bad	0 – 338 Kbps	0

$$Troughput = \frac{Received\ Data\ Packet\ (Kb)}{Available\ Bandwidth\ (s)}. \quad (4)$$

Data for throughput measurements are taken from Wireshark software

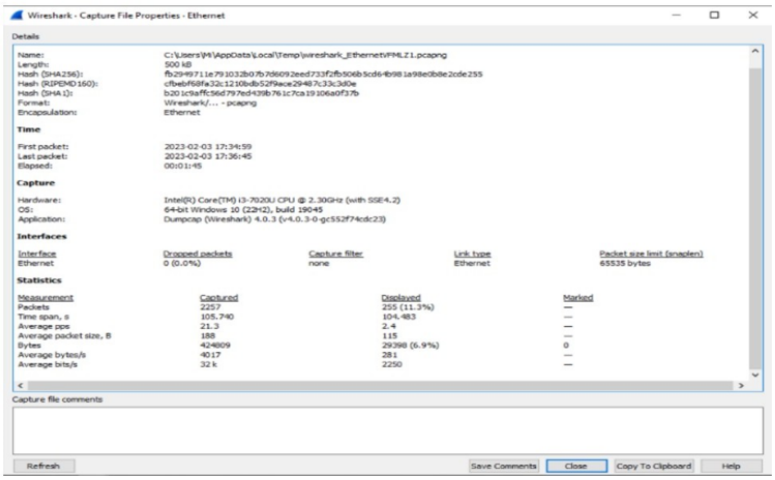

Figure 3: Data Capture from Wireshark Software

3.2.4. Testing Mechanism

In carrying out data measurements, it is carried out alternately with the same scheme. Testing LAN network performance using fiber cables optical and UTP Cat6 is done by measuring the values of delay, jitter, throughput, and packet loss. Testing is carried out by connecting computers and the router using the media to be tested. To count fourth These parameters are used by the ping program running on the operating system CMD. When the ping program is executed, packets are exchanged between computers and routers, namely Internet Control Message Protocol (ICMP) packets. There is a laptop that starts to send ICMP packets, these packets called an ICMP Request packet. Meanwhile, the router receives the packet ICMP Reguest will provide a reply in the form of sending an ICMP Reply package. 100 packages will be sent 20 times. From sending ICMP Reply packets later, you can see the values of delay, jitter, packet loss and throughput.

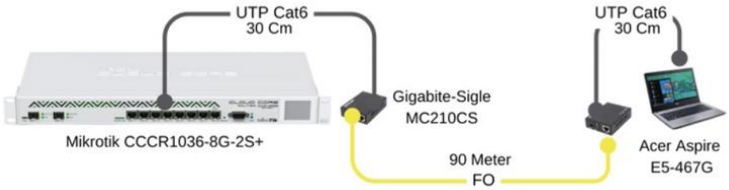

Figure 4: Fiber Optic Cable Testing Configuration

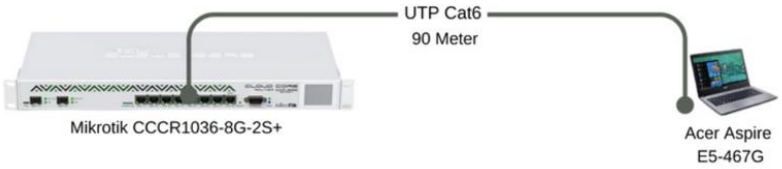

Figure 5: UTP Cat6 Cable Testing Configuration

3.2.5. Quality of Service

Ouality of Service (QoS) is a measurement method on a network determines that a network service can operate in accordance with standards established service quality. QoS is used for measures various performance characteristics specified and related to maintenance.

In OoS there are standards set, one of which is is the Telecommunication and Internet Protocol Harmonization Network (TIPHON) (Wulandari, 2016).

Table 5: THIPON QoS Parameter Index

Index	Percentage (%)	Category
3.8 - 4	95 - 100	Very Good
3 – 3.79	75 – 94.75	Good
2 – 2.99	50 – 74.75	Average
1 – 1.99	25 – 49.75	Bad

4. Results and Discussion

In carrying out data measurements, it is carried out alternately with the same scheme. 90 meters of fiber optic and UTP Cat6 cable will be installed connect from the router to the laptop by sending an ICMP (Internet Control Message Protocol) 100 packets from the laptop to the router 20 times.

Table 6: Data from Fiber Optic Performance Processing Results

No	Delay (ms)	Jitter (ms)	Packet Loss (%)	Throughput (Mbps)
1	2.55	2.47	0	728.66
2	3.16	2.94	0	863.54
3	2.21	2.07	0	803.69
4	2.47	2.28	0	893.32
5	2.21	2.07	0	798.64
6	2.31	2.18	0	785.04
7	2.01	1.97	0	843.89
8	2.78	2.56	0	843.64

9	3.93	3.68	2	763.98
10	2.81	2.61	0	752.85
11	2.12	1.82	0	824.76
12	2.34	2.12	0	903.81
13	2.41	2.29	0	723.56
14	2.62	2.39	0	841.13
15	2.21	2.07	0	762.44
16	3.29	2.96	1	860.81
17	3.42	2.86	2	701.59
18	2.23	2.07	0	821.01
19	2.42	2.23	0	739.92
20	2.12	1.98	0	862.13
Average	**2.58 ms**	**2.38 ms**	**0.25 %**	**805.92 Mbps**
Index	**4**	**3**	**4**	**4**
Category	**Very Good**	**Good**	**Very Good**	**Very Good**

Table 7: Data from UTP Cat6 Performance Processing Results

No	Delay (ms)	Jitter (ms)	Packet Loss (%)	Throughput (Mbps)
1	6.54	6.19	0	646.84
2	6.71	6.43	2	681.05
3	5.49	5.09	0	656.97
4	4.96	4.57	0	587.19
5	5.21	4.85	0	693.35
6	3.43	3.12	0	691.01
7	4.92	4.38	0	643.57
8	4.64	4.43	0	596.48
9	5.72	5.39	0	605.62
10	6.02	5.63	0	619.07
11	6.56	6.32	2	571.25
12	7.01	6.69	1	598.91
13	6.32	5.89	1	536.78
14	5.91	5.26	0	697.54
15	4.69	4.07	0	654.61
16	5.37	4.98	0	539.94
17	6.24	5.97	3	527.39
18	5.62	5.21	0	695.81
19	4.57	4.26	2	636.92
20	6.02	5.54	0	594.28
Average	**5.59 ms**	**5.21 ms**	**0.55 %**	**623.73 Mbps**
Index	**4**	**3**	**4**	**4**
Category	**Very Good**	**Good**	**Very Good**	**Very Good**

Table 8: Average Data of Performance Testing Results

No	Cable Type	Delay (ms)	Jitter (ms)	Packet Loss (%)	Throughput (Mbps)	Index QoS
1	Fiber Optic	2.58	2.38	0.25	805.92	3.75
	Index	4	3	4	4	
	Category	Very Good	Good	Very Good	Very Good	Good
2	UTP Cat6	5.59	5.21	0.55	623.73	3.75
	Index	4	3	4	4	
	Category	Very Good	Good	Very Good	Very Good	Good

5. Conclusion

Conclusions that can be obtained from the results of analytical research development of fiber optic LAN and UTP Cat6 networks on performance at SMK Negeri 2 Tasikmalaya are as follows:

a). The choice of network media at SMK Negeri 2 Tasikmalaya is FO cable with a throughput value of 182.19 Mbps, greater than UTP Cat6 cable, where the main need for SMK Negeri 2 Tasikmalaya is network performance which is good, to support daily network needs, such as exams competency, computer practice, networking and others.

b). The test results of the fiber optic cable obtained an average delay value of 2.58 ms, with the "Very Good" category, the average jitter value is 2.38 ms, with category "Good", the average packet loss value is 0.25 % with the category "Very Good" and an average throughput value of 805.92 mbps. Then results testing of UTP Cat6 cables obtained an average delay value of 5.59 ms, with "Very Good" category, the average jitter value is 5.21 ms, with category "Good", the average packet loss value is 0.55 % in the "Good" category and the average throughput value is 623.73 Mbps.

Acknowledgments

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References

Apigian, C. H., Ragu-Nathan, B. S., Ragu-Nathan, T. S., & Kunnathur, A. (2005). Internet technology: the strategic imperative. *Journal of Electronic Commerce Research*, *6*(2), 123.

Aprianto Budiman, M. F. (2020). Analysis of Quality of Service (QoS) on the Internet Network of SMK Negeri 7 Jakarta. Journal of Information and Computer Engineering Education.

Forouzan, B. A. (2007). *Data Communications and Networking* . New York: McGraw-Hill.

Hutchby, I. (2013). *Conversation and technology: From the telephone to the Internet*. John Wiley & Sons.

Irvika Romana, G. F. (2021). Analysis Performance Jaringan Gigabit Ethernet Local Area Network (LAN) Universitas Lampung. *Jurnal Informatika dan Teknik Elektro Terapan (JITET)*, Vol. 9 Nomor 1.

Karakus, M., & Durresi, A. (2017). Quality of service (QoS) in software defined networking (SDN): A survey. *Journal of Network and Computer Applications, 80*, 200-218.

Muhammad Deagama Surya Antariksa, A. A. (2022). Analisis Jaringan Local Area Network (LAN) di Rumah Sakit UNRAM. *JBegaTI*, 201-212.