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Comparison of Quality of Service Parameters for Four Cellular Network Providers in Punggur Kecil Village

Rico Kurniawan Silaban[1*] , Leonardus Sandy Ade Putra[2] , Neilcy Tjahjamooniarsih[2]
[1]Electrical Engineering Study Program, Faculty of Engineering, Tanjungpura University, Pontianak, Indonesia
[2] Department of Electrical Engineering, Faculty of Engineering, Tanjungpura University, Pontianak, Indonesia

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ABSTRACT

This research aims to analyze Quality of Service (QoS) parameters on cellular networks using four providers by measuring throughput, packet loss, delay and jitter parameters when conducting Video Streaming and Online Games using the Wireshark application. The research method involves direct measurement of QoS parameters in several strategic locations in Punggur Kecil village, data was taken at three different location points with a distance comparison of ±500 meters. From all the recapitulations of QoS parameter measurement results, it can be concluded that the value of each QoS parameter can vary for each package which includes the categories poor, medium, good and very good because the bandwidth received by each provider is different. The cause of high and low values of different QoS parameters, Throughput is caused by the number of packet arrivals measured during the observation process, Packet Loss is caused by the number of queues exceeding capacity, Delay is caused by low Throughput values and the number of packets sent, while the Jitter value is influenced by the Delay value. The results obtained are that the Indosat provider is the recommended provider when carrying out Video Streaming and Online Games, because the Quality of Service value produced is superior to other providers. The average values of the Throughput, Packet Loss, Delay and Jitter parameters at each location for the Indosat provider are respectively 796kbps, 2.63%, 22.6ms and 22.6ms. Provider XL is 708kbps, 1.67%, 12.6ms, and 12.6ms. Provider Telkomsel 667kbps, 0.33%. 55.9ms, and 56ms. As well as the Smartfren provider 50kbps, 0.38%, 102.6ms, and 102.7ms.

***) Corresponding author:**

Rico Kurniawan Silaban
Email: ricosilaban10@student.untan.ac.id

1. INTRODUCTION

In the current development of information technology and networks, many people really need to be able to communicate, send information or receive information with good service performance. Internet service providers are increasingly trying to make every effort to ensure customer satisfaction so they can access the internet comfortably. With the internet, anyone can access information quickly anytime and anywhere [1]. Many providers in Indonesia provide services and ease of accessing the internet. Service quality is one aspect of a company to achieve this goal. The internet is no longer seen as a secondary need, but has become an obligation. It cannot be denied that the internet is something that is very attached to society. Of course, each provider has its own advantages and disadvantages, especially in accessing the internet [2], [3]. Not all providers with fast and stable internet networks can be found in this area. Another factor is the geographical location of the research location, which is quite far from urban areas and also constraints in the coverage of each provider's network of BTS towers, which only cover certain areas, which triggers slow and unstable internet networks. Bad weather factors such as rain or storms can also affect signal quality and internet speed. This factor also needs to be considered in research [4], [5]. One solution to this problem is that cellular network providers can improve infrastructure, such as improving coverage area , which is an important factor in improving communication continuity between Mobile Station (MS) users, both in urban and inland areas, as well as building the availability of Base Transceiver Station (BTS) towers at each location. provider [6]This will help improve the quality of services provided to users. The solution offered in this research is collaboration between cellular network providers who can work together to improve the quality of internet network services.[7], [8]

2. RELATED WORK

Based on research entitled "Analysis of Differences in V Live Video Streaming Website Performance on Two Providers" in 2021 by Dwi Oktaviyanti in 2021. This research discusses the differences in cellular networks between two providers, namely Indosat Dana Tri with results and discussion that using the Tri provider to access videos on the V Live website at night are better than using the Indosat Ooredoo provider. The average parameter values for throughput, packet loss, delay, and jitter for provider B (Tri) are 2.9 Mbps, 8.95%, 2,873 ms, and 2,928 ms, respectively. And for provider A (Indosat Ooredoo), namely 2.6 Mbps, 0.01%, 3,795 ms, and 3,799 ms. This can happen due to several factors that influence internet access. These factors include the place of access (availability of signal), the time of access and the number of users (because usually evening hours are busy hours where lots of people are accessing the internet), the device used to access, and also the bandwidth used (the greater the bandwidth used, the speed in accessing the internet will also be greater)[9]

In research entitled "Comparative Study of Wi-Fi Networks with Cellular Data Packages on the Quality of Video Call Services " by Narwastu Dirgantara Putra in 2022. This research discusses whether the internet network is good or not for providing video call services . In this research, a comparison of service quality was carried out on cellular data packet networks and Wi-Fi networks which were assessed from the QoS network parameters determined by the Telecommunication and Internet Protocol Harmonization Over Network (TIPHON). Then observe the video call process using the SINPO (Signal, Interference, Noise, Propagation and Overall) approach. From this research, the results showed that using a Wi-Fi network is highly recommended for making video call services , compared to using cellular data networks[10]

2.1 Mobile Network

A cellular network or mobile network is a telecommunications network in which the link from sender to receiver (and vice versa) is wireless. This tissue is spread over several areas called cells . Each cell is served by at least one transceiver, usually three cell phone towers or a master transceiver station. These stations provide the cell with network coverage that can be used for transmitting voice, data, and other types of content. These cells provide radio coverage across a wide geographic area allowing many portable transceivers , such as mobile phones, tablet computers, laptops with modems, etc., to communicate with each other and with transceivers and fixed phones anywhere in the network via stations. primary, even if some of those transceivers move across multiple cells during transmission.

2.2 Quality Of Service

Quality of Service (QoS) is a measurement method used to determine the capabilities of a network to provide good and planned services so that they can meet the needs of a service[11], [12]

2.2.1 Throughput

Throughput is the effective data transfer speed (rate) measured in bps . Throughput is the total number of successful packet arrivals observed at the destination during a specified time interval divided by the duration of the specified time interval [13], show in Table 1.

Table 1. Throughput Categories

Category	Throughput (kbps)	Index
Very good	>2100	4
Good	1200 to 2100	3
Currently	700 to 1200	2
Bad	0 to 700	1

Throughput calculation Equation 1 :

$$V_T = \frac{P_R}{t_r} \quad (1)$$

2.2.2 Packet Loss

Packet loss is the number of IP packets lost during the transmission process from source to destination. One cause of packet loss is a queue that exceeds the buffer capacity on each node [14], show in Table 2.

Table 2. Packet Loss Categories

Category	Packet Loss (%)	Index
Very good	0-2	4
Good	3-14	3

Currently	15-24	2
Bad	>25	1

Packet Loss calculation Equation 2 :

$$P_L = \frac{(P_S - P_R)}{P_R} \text{ x } 100\% \quad (2)$$

2.2.3 Delay

Delay is the total amount of delay time for a packet during the process of sending the packet from one point to another point of its destination. Delay is also a delay in data transmission time from the sender and receiver, the unit of delay is seconds [15], show in Table 3.

Table 3. Delay Categories

Category	Delay (ms)	Index
Very good	<150 ms	4
Good	150 to 300 ms	3
Currently	300 to 450 ms	2
Bad	>450 ms	1

Delay calculation Equation 3 :

$$D_l = \frac{\sum t_s}{n} \quad (3)$$

2.2.4 Jitter

Jitter is the variation in arrival time between packets that are sent continuously from one terminal (source) to another terminal (destination) on an IP network . Jitter can be observed in characteristics such as consecutive frequencies [11], show in Table 4.

Table 4. Jitter Category

Category	Jitter (ms)	Index
Very good	0 ms	4
Good	1 to 75 ms	3
Currently	76 to 125 ms	2
Bad	126 to 225 ms	1

Jitter calculation Equation 4 :

$$J_t = \frac{\sum t_d}{n} \quad (4)$$

$$\sum t_d = D\,l - \overline{D_l}$$

2.3 Wireshark

Wireshark is a Network Packet Analyzer that will "capture" network packets and try to display all the information in the packet in as much detail as possible. We can think of a Network Packet Analyzer as a tool to check what is actually happening in a network cable, just like a voltmeter or test pen is used to check what is actually happening in an electrical cable. In the past, tools like this were very expensive and usually included copyright. However, with Wireshark , it will be very easy for us. Therefore, quite a few people say that Wireshark is one of the best free and even open source tools for analyzing network packets.[16]

2.4 Mobile Operators

Cell phone operators or wireless carriers are telephone companies that provide services to cell phone users. The operator gives a SIM card to the customer who inserts it into the cell phone to gain access to the service.[17]

2.5 Streaming Videos

Video Streaming is a communication carried out through broadcast internet access to produce an image. One service for video streaming is YouTube , YouTube is a platform that can be used to access videos easily and for free. However, currently YouTube has a premium feature that allows users to access videos without advertising.[12]

2.6 Online game

Online games are games that are played on a network (either LAN or Internet), these games are usually played simultaneously with an unlimited number of players. Online games are useful for refreshing or eliminating the player's boredom, whether from daily activities (work, study, and other factors) or just to fill free time. So an online game is a game that is played on a computer or cellphone and is done online (via the internet) and can be played by many people simultaneously at one time.[11]

3. METHOD

3.1 Research methods

The research method uses several methods to collect data in this research which is depicted in the form of a flowchart in Figure 1 as follows:

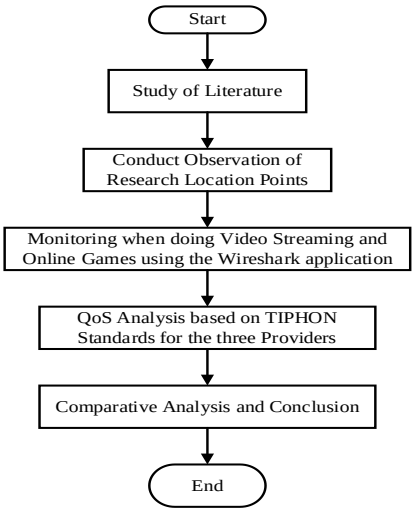

Figure 1. Research Flow Diagram

1. Literature study, carried out in order to obtain supporting theories and possible assumptions used and act as a reference in seeking theoretical approaches to the problems raised which originate from, among other things, handbooks, electronic books, journals that are related to research and browse the internet.
2. Observations are carried out to determine the location of field conditions and determine test points and determine the location of the BTS locations and the results obtained are the coordinates of each BTS.
3. Monitoring throughput, packet loss, delay and jitter parameters during video streaming and online games using the Wireshark application on these four providers.
4. After completing monitoring of each data, the author carried out calculations to compare with the measurement data.
5. If the measurement results are in accordance with the TIPHON standards, it can be concluded that if the measurement results are not appropriate, data collection and analysis can be carried out again from the measurement results.
6. Comparing data between the four providers and provider recommendations
7. Then provide conclusions and suggestions for each network quality provided to each provider.

3.2 Research sites

This research was carried out in Punggur Kecil Village which is located in Sungai Kakap District, Kubu Raya Regency , West Kalimantan with the help of a network from a WiFi modem which uses four cellular network operators, namely Telkomsel, XL, Indosat and Smartfren, where each sample was taken. One example is when streaming videos and online games . This research was carried out at several different point locations with a distance of ±500m.

3.3 Equipment used

In this research, the following tools are generally used:

1. Laptops are used to store data and monitor data.
2. Mobile phones are used to take pictures/photos as attachment documentation and are used to play mobile legend games
3. The simcard operators used are Telkomsel, XL, Indosat and Smartfren as network source providers.

4. MiFi modems are used to access the internet or internet sources.

3.4 Applications Used

The supporting applications used in this research are as follows:

1. Wireshark is used to measure parameters such as throughput, packet loss, delay and jitter.
2. Google Earth functions to view the location of BTS and the location of research sites in both 2D and 3D views, this application can also see coordinates and measure certain distances on the map.
3. Google Maps is used to guide roads and find out new desired locations.
4. YouTube was used to test QoS for ± 5 minutes carried out alternately for three operators as a Video Streaming service.
5. The Mobile Legend game was used to test QoS for ± 5 minutes, carried out alternately for three operators as an Online Game service.

3.5 Measurement Scheme

Parameters throughput , packet loss, delay and jitter using the Wireshark application on the mobile internet connected to the laptop in Figure 2 as follows :

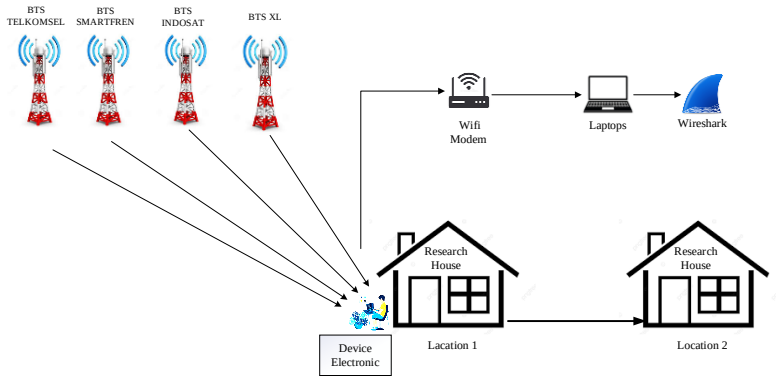

Figure 2. Measurement Scheme

1. Make sure the WiFi modem has a cellular card installed at each provider (Telkomsel, Indosat, XL, Smartfren) in turn.
2. Connect the laptop to the wifi modem using the wifi network on the laptop.
3. Then do video streaming and online games alternately using the cellular network.
4. Then open the installed Wireshark application, then select the internet source used, namely WiFi.
5. Wireshark will automatically read and display packets during data collection time and capture the data obtained.
6. Then filter the protocol by typing "tcp" in the filter display then select the Statistics menu and select Capture File Properties to obtain Throughput data.
7. Filter the protocol by typing "tcp.analysis.lost_segment" to obtain Packet Loss data.
8. To find Delay and Jitter we have to filter back to TCP, then export the observation results to MS. Excel by clicking File then selecting Export Packet Dissections.
9. Do the same thing at a different location that has been determined.
10. After obtaining the research data, calculations were then carried out at each location using four providers for QoS parameters using the formulas provided and comparing the measurement results based on THIPHON standards.
11. Make comparisons between each provider

4. RESULTS AND DISCUSSION

From the results of the measurements and calculations that have been carried out, the Throughput, Packet loss, Delay and Jitter values obtained using the Wireshark application in the Quality of Service parameters when conducting Video Streaming using the YouTube service and playing Online Games using the Mobile Legend Game at several locations in The Punggur Kecil area uses Telkomsel, Indosat, XL and Smartfrent cellular networks. At location (I) it was carried out indoors with open house conditions, at location (II) it was carried out outdoors but in a different location, while at location (III) it was also carried out outdoors, but in rainy weather conditions. Based on the Quality of Service parameter category, if the Throughput result is less than <700 kbps then it is interpreted as bad or the data transfer speed quality value in the Quality of Service parameter is very unsatisfactory for mobile internet users, so that internet access does not run smoothly. Throughput results from 700 kbps to 1200 kbps are interpreted as medium or the value of the quality of data

transfer speed in the Quality of Service parameter is less than satisfactory for mobile internet users. Throughput results from 1200 kbps to 2100 kbps are interpreted as good or the data transfer speed quality value in the Quality of Service parameter is satisfactory for mobile internet users, so that internet access becomes smoother. Throughput results of >2100 kbps are interpreted as very good or the data transfer speed quality value in the Quality of Service parameter is very satisfying for mobile internet users. Based on the Quality of Service parameter category, if the Packet loss result is smaller than 25% then it is interpreted as bad or the data transfer speed quality value in the Quality of Service parameter is very unsatisfactory for mobile internet users, so internet access does not run smoothly. Packet loss results from 15% to 24% are interpreted as moderate or the high quality value of data transfer speed in the Quality of Service parameter is less than satisfactory for mobile internet users. Packet loss results from 3% to 14% are interpreted as good or the data transfer speed quality value in the Quality of Service parameter is satisfactory for mobile internet users, so that internet access becomes smoother. Packet loss results from 0% to 2% are interpreted as very good or the data transfer speed quality value in the Quality of Service parameter is very satisfying for mobile internet users. Based on the Quality of Service parameter category, if the Delay result is smaller than 450 ms then it is interpreted as bad or the data transfer speed quality value in the Quality of Service parameter is very unsatisfactory for mobile internet users, so internet access does not run smoothly. Delay results from 300 ms to 450 ms are interpreted as moderate or the high quality value of data transfer speed in the Quality of Service parameter is less than satisfactory for mobile internet users. Delay results from 150 to 300 are interpreted as good or the data transfer speed quality value in the Quality of Service parameter is satisfactory for mobile internet users, so that internet access becomes smoother. Delay results smaller than 150 ms are interpreted as very good or the data transfer speed quality value in the Quality of Service parameter is very satisfying for mobile internet users. Based on the Quality of Service parameter category, if the Jitter result is from 126 ms to 225 ms then it is interpreted as bad or the data transfer speed quality value in the Quality of Service parameter is very unsatisfactory for mobile internet users, so internet access does not run smoothly. Jitter results from 76 ms to 125 ms are interpreted as medium or the high quality value of data transfer speed in the Quality of Service parameter is less than satisfactory for mobile internet users. Jitter results from 1 to 75 are interpreted as good or the data transfer speed quality value in the Quality of Service parameter is satisfactory for mobile internet users, so that internet access becomes smoother. A Jitter result of 0 ms is interpreted as very good or the data transfer speed quality value in the Quality of Service parameter is very satisfying for mobile internet users. The results for each measurement can be seen in Table 5 and Table 6 as follows:

Table 5. Recapitulation of Measurement Results During Video Streaming

Location	Providers	QoS parameters	Measurement results	TIPHON standardization	
				Category	Index
I	Telkomsel	Throughput	1.055 kbps	Currently	2
		Packet Loss	0.1 %	Very good	4
		Delay	6,05 ms	Very good	4
		Jitter	6,05 ms	Good	3
	Indosat	Throughput	1.541 kbps	Good	3
		Packet Loss	0,7 %	Very good	4
		Delay	3,98 ms	Very good	4
		Jitter	3,98 ms	Good	3
	XL	Throughput	1.490 kbps	Good	3
		Packet Loss	1,3 %	Very good	4
		Delay	4,68 ms	Very good	4
		Jitter	4,68 ms	Good	3
	Smartfren	Throughput	25,58 kbps	Bad	1
		Packet Loss	0,174 %	Very good	4
		Delay	75,14 ms	Very good	4
		Jitter	75.14 ms	Good	3
II	Telkomsel	Throughput	1.392 kbps	Good	3
		Packet Loss	0.14 %	Very good	4
		Delay	5,513 ms	Very good	4
		Jitter	5,513 ms	Good	3
	Indosat	Throughput	1.204kbps	Good	3
		Packet Loss	1,16 %	Very good	4
		Delay	5,35 ms	Very good	4
		Jitter	5,35 ms	Good	3
	XL	Throughput	1.387 kbps	Good	3
		Packet Loss	0.64 %	Very good	4
		Delay	4,33 ms	Very good	4
		Jitter	4,33 ms	Good	3

	Smartfren	Throughput	108,309 kbp	Bad	1
		Packet Loss	0,517 %	Very good	4
		Delay	27,103ms	Very good	4
		Jitter	27,103 ms	Good	3
III	Telkomsel	Throughput	11,36 kbps	Bad	1
		Packet Loss	0.5 %	Very good	4
		Delay	224,9 ms	Good	3
		Jitter	224,9 ms	Bad	1
	Indosat	Throughput	108,568 kbp	Bad	1
		Packet Loss	6,12 %	Good	3
		Delay	45,22ms	Very good	4
		Jitter	45,22ms	Good	3
	XL	Throughput	462,206 kbp	Bad	1
		Packet Loss	2,539 %	Very good	4
		Delay	11,31 ms	Very good	4
		Jitter	11,31 ms	Good	3
	Smartfren	Throughput	27,019 kbps	Bad	1
		Packet Loss	0,388 %	Very good	4
		Delay	118,25 ms	Very good	4
		Jitter	118,82 ms	Currently	2

Table 6. Recapitulation of Measurement Results During Online Games

Location	Providers	QoS parameters	Measurement results	TIPHON standardization	
				Category	Index
I	Telkomsel	Throughput	694 kbps	Bad	1
		Packet Loss	0.28 %	Very good	4
		Delay	7,27 ms	Very good	4
		Jitter	8,11 ms	Good	3
	Indosat	Throughput	1.324 kbps	Good	3
		Packet Loss	0,73 %	Good	3
		Delay	4,49ms	Very good	4
		Jitter	4,49 ms	Good	3
	XL	Throughput	327 kbps	Bad	1
		Packet Loss	1,29 %	Very good	4
		Delay	13,8 ms	Very good	4
		Jitter	13,8 ms	Good	3
	Smartfren	Throughput	108,309kbp	Bad	1
		Packet Loss	0,517 %	Very good	4
		Delay	27,103ms	Very good	4
		Jitter	27,103 ms	Good	3
II	Telkomsel	Throughput	798,875 kbp	Currently	2
		Packet Loss	0.57 %	Very good	4
		Delay	6,319 ms	Very good	4
		Jitter	6,319 ms	Good	3
	Indosat	Throughput	514,377kbp	Bad	1
		Packet Loss	0,657 %	Very good	4
		Delay	11,56 ms	Very good	4
		Jitter	11,56 ms	Good	3
	XL	Throughput	262,621 kbp	Bad	1
		Packet Loss	0.447 %	Very good	4
		Delay	20,48 ms	Very good	4
		Jitter	20,48 ms	Good	3
	Smartfren	Throughput	25,58 kbps	Bad	1
		Packet Loss	0,174 %	Very good	4

		Delay	75,14 ms	Very good	4
		Jitter	75,14 ms	Good	3
III	Telkomsel	Throughput	49,84kbps	Bad	1
		Packet Loss	0.402 %	Very good	4
		Delay	85,38 ms	Very good	4
		Jitter	85,31 ms	Currently	2
	Indosat	Throughput	58,201 kbps	Bad	1
		Packet Loss	6,39 %	Good	3
		Delay	65,07 ms	Very good	4
		Jitter	65,07 ms	Good	3
	XL	Throughput	273,897 kbp	Bad	1
		Packet Loss	0.78 %	Very good	4
		Delay	20,91 ms	Very good	4
		Jitter	20,91ms	Good	3
	Smartfren	Throughput	6,664 kbps	Bad	1
		Packet Loss	0,548%	Very good	4
		Delay	293,03 ms	Good	3
		Jitter	292,96 ms	Bad	1

4.1. Analysis of QoS Parameters on Telkomsel Providers

Based on Table 5 and Table 6, the results obtained from measuring QoS parameters for four providers Telkomsel, Indosat, XL, and Smartfren when conducting Video Streaming using the YouTubet service and playing Online Games using the Mobile Legend Game. So we get a comparison graph between the four providers as follows:

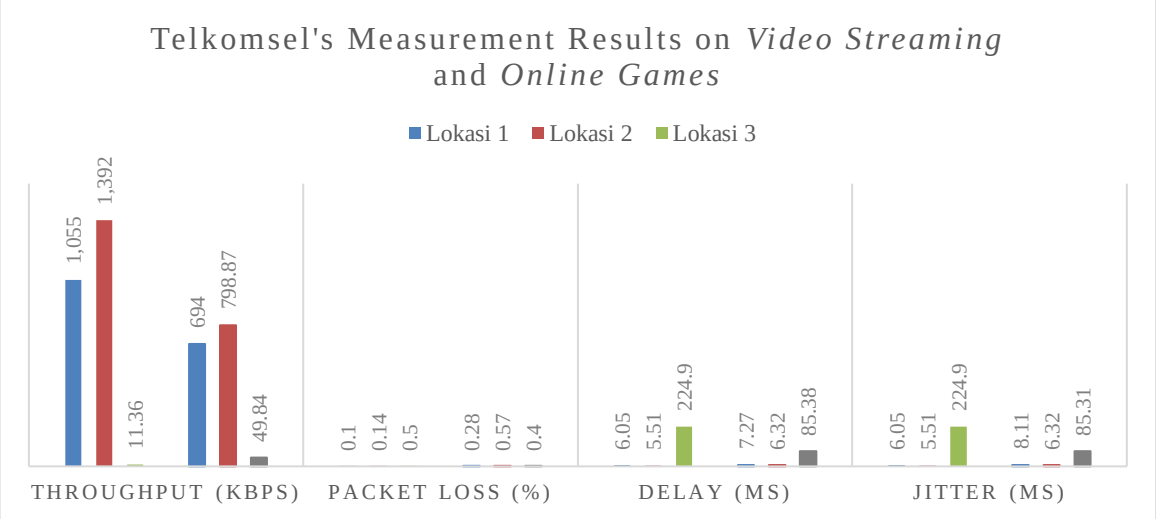

Figure 3. Graph of recapitulation of Telkomsel measurement results on video Streaming and Gaming Online

Based on Figure 3, the throughput value during video streaming is greater than when playing online games . This happens because the bandwidth generated when doing Video Streaming is greater than when playing Online Games , so the package measured in Online Games will be less than when doing Video Streaming . The Packet Loss value measured when Video Streaming is smaller than when playing Online Games . This is caused by queues that exceed the buffer capacity on each node and congestion in the network. The delay value during video streaming is smaller than when playing online games. This happens because the Throughput value is lower than the previous data, causing the delay to become greater. The Jitter value when Video Streaming is smaller when compared to when playing Online Games. This happens because the Delay value is greater than when playing online games, and the speed of the queues in data processing time.

4.2. Analysis of QoS Parameters on Indosat Providers

Based on Table 5 and Table 6, the results obtained from measuring QoS parameters for four providers Telkomsel, Indosat, XL, and Smartfren when conducting Video Streaming using the YouTubet service and

playing Online Games using the Mobile Legend Game. So we get a comparison graph between the four providers as follows:

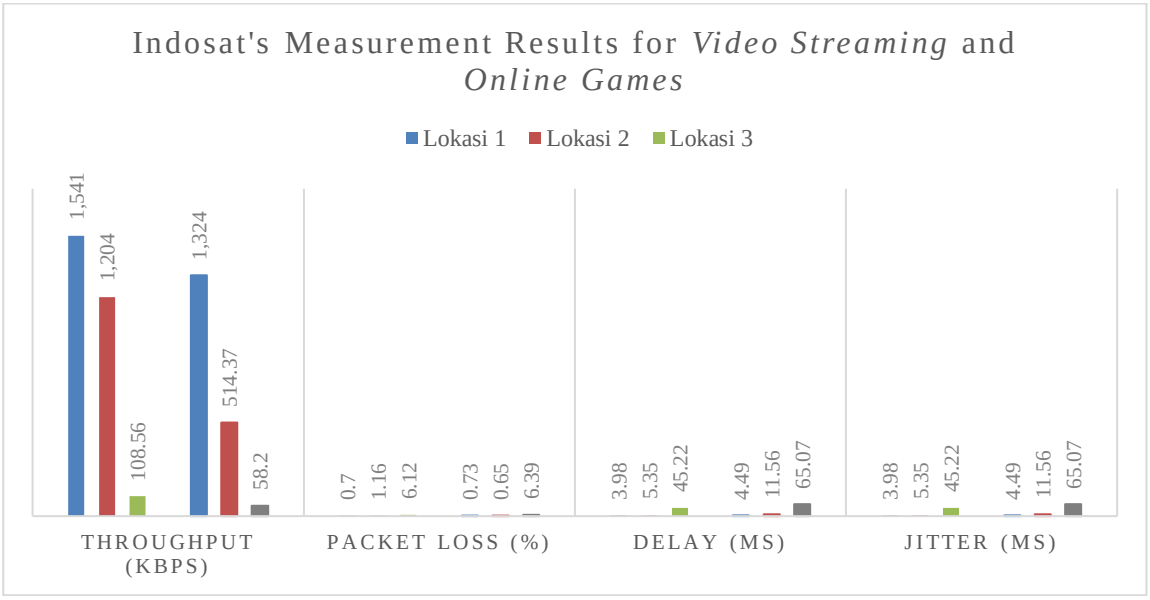

Figure 4. Graph of recapitulation of Indosat measurement results on video Streaming and Gaming Online

Based on Figure 4, the throughput value during video streaming is greater than when playing online games . This happens because the bandwidth generated when doing Video Streaming is greater than when playing Online Games , so the package measured in Online Games will be less than when doing Video Streaming . The Packet Loss value measured when Video Streaming is smaller than when playing Online Games . This is caused by queues that exceed the buffer capacity on each node and congestion in the network. The delay value during video streaming is smaller than when playing online games. This happens because the Throughput value is lower than the previous data, causing the delay to become greater. The Jitter value when Video Streaming is smaller when compared to when playing Online Games. This happens because the Delay value is greater than when playing online games, and the speed of the number of queues in data processing time .

4 .3. Analysis of QoS Parameters on Provider XL

Based on Table 5 and Table 6, the results obtained from measuring QoS parameters for four providers Telkomsel, Indosat, XL, and Smartfren when conducting Video Streaming using the YouTubet service and playing Online Games using the Mobile Legend Game. So we get a comparison graph between the four providers as follows:

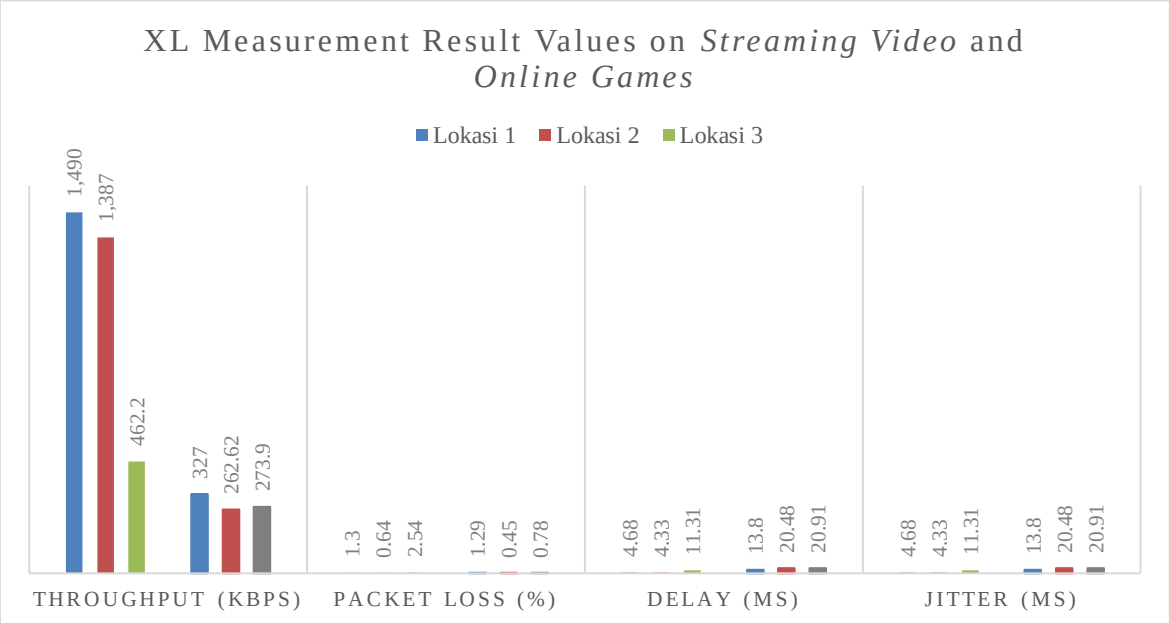

Figure 5. Graph of recapitulation of XL measurement results in video Streaming and Gaming Online

Based on Figure 5, the throughput value during video streaming is greater than when playing online games . This happens because the bandwidth generated when doing Video Streaming is greater than when playing Online Games , so the package measured in Online Games will be less than when doing Video Streaming . The Packet Loss value measured when Video Streaming is smaller than when playing Online Games . This is caused by queues that exceed the buffer capacity on each node and congestion in the network. The delay value during video streaming is smaller than when playing online games. This happens because the Throughput value is lower than the previous data, causing the delay to become greater. The Jitter value when Video Streaming is smaller when compared to when playing Online Games. This happens because the Delay value is greater than when playing online games, and the speed of the number of queues in data processing time .

4 .4. Analysis of QoS Parameters on Smartfren Providers

Based on Table 5 and Table 6, the results obtained from measuring QoS parameters for four providers Telkomsel, Indosat, XL, and Smartfren when conducting Video Streaming using the YouTubet service and playing Online Games using the Mobile Legend Game. So we get a comparison graph between the four providers as follows:

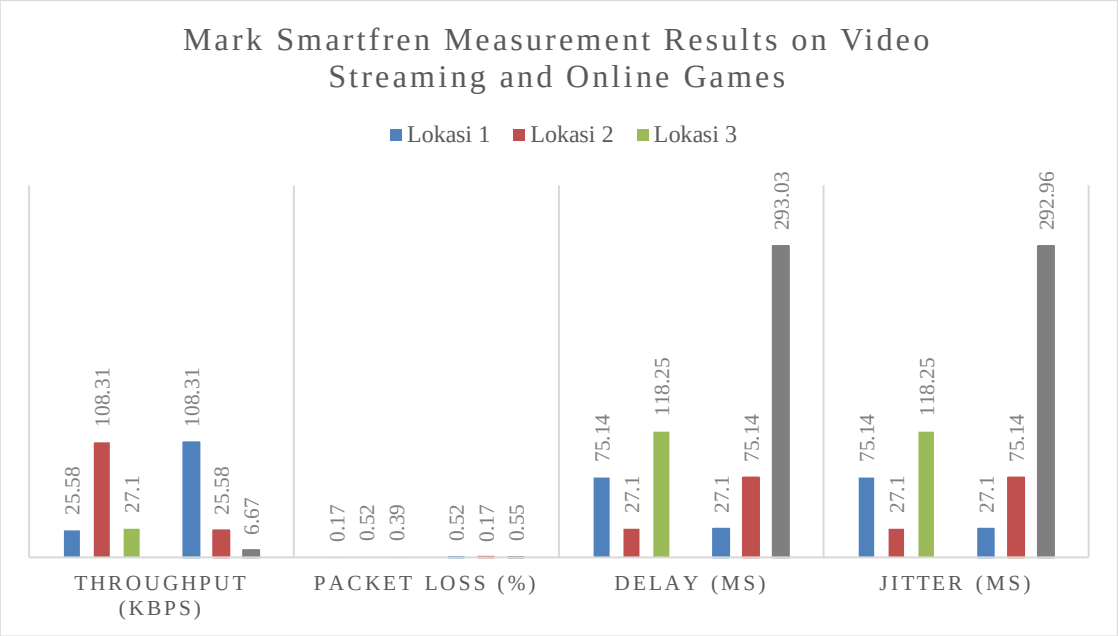

Figure 6. Graph of recapitulation of Smartfren measurement results on video Streaming and Gaming Online

Based on Figure 6, the throughput value during video streaming is greater than when playing online games . This happens because the bandwidth generated when doing Video Streaming is greater than when playing Online Games , so the package measured in Online Games will be less than when doing Video Streaming . The Packet Loss value measured when Video Streaming is smaller than when playing Online Games . This is caused by queues that exceed the buffer capacity on each node and congestion in the network. The delay value during video streaming is smaller than when playing online games. This happens because the Throughput value is lower than the previous data, causing the delay to become greater. The Jitter value when Video Streaming is smaller when compared to when playing Online Games. This happens because the Delay value is greater than when playing online games, and the speed of the number of queues in data processing time .

Table 7. Average Calculation of Quality of Service Parameters

Parameter	Telkomsel	Indosat	XL	Smartfren
Throughput	667 kbps	796 kbps	708 kbps	50 kbps
Packet Loss	0.33 %	2.63 %	1.67 %	0.38 %
Delay	55.9 ms	22.6 ms	12.6 ms	102.6 ms
Jitter	56 ms	22.6 ms	12.6 ms	102.7 ms

Based on Table 7, the results obtained on the QoS parameters in Punggur Kecil can be compared. The best throughput value is the Indosat provider of 796 kbps in the medium category, the XL provider of 708 kbps

in the medium category, the Telkomsel provider of 667 kbps in the poor category, and the Smartfren provider of 50 kbps in the poor category when compared based on the TIPHON standard. The best Packet Loss value is the Telkomsel provider at 0.33% in the very good category, the Smartfren provider at 0.38% in the very good category, the XL provider at 1.67% in the very good category, and the Indosat provider at 2.63 % with very good category when compared based on TIPHON standards. The best delay value is the XL provider at 12.6 ms in the very good category, the Indosat provider at 22.6 ms in the very good category, the Telkomsel provider at 55.9 ms in the very good category, and the Smartfren provider at 102.6 ms at very good category when compared based on TIPHON standards. The best Jitter value is the XL provider at 12.6 ms in the good category, the Indosat provider at 22.6 ms in the good category, the Telkomsel provider at 56 ms in the good category, and the Smartfren provider at 102.7 ms in the medium category when compared based on TIPHON standard.

5. CONCLUSION

After analyzing the quality of data transfer speed on cellular network internet services using four providers based on Quality of Service parameters, it can be concluded: Based on research conducted, the Indosat provider is the recommended provider when carrying out Video Streaming and Online Games, because of its Quality of Service value. The result is superior to other providers with measurement results averaged at the first location to the third location for the Throughput, Packet Loss, Delay and Jitter parameters for the Indosat provider respectively, namely 796 kbps, 2.63%, 22.6 ms , and 22.6 ms. Provider XL is 708 kbps, 1.67%, 12.6 ms, and 12.6 ms. Provider Telkomsel 667 kbps, 0.33%. 55.9 ms, and 56 ms. As well as the Smartfren provider 50 kbps, 0.38%, 102.6 ms, and 102.7 ms. In location (I), the Indosat provider is the best compared to the others, location (II) is the best Telkomsel provider, while location (III) is the best provider, even though the comparison of the QOS parameter values for each provider is very small. This can happen due to several factors that influence internet access. These factors include the place of access (availability of signal), time of access and number of users, bandwidth used (the greater the bandwidth used, the greater the speed of accessing the internet), weather conditions, and the farther the BTS distance to the research location.

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BIOGRAPHY

Rico Kurniawan Silaban was born in Jambur, 10 April 2000. He received his primary education at SD Negeri 030368 Jambur Indonesia, graduating in 2013 and continuing to SMP Negeri 2 Siempat Nempu Hilir, graduating in 2016, then continuing to SMA Negeri 1 Siempat Nempu Hilir, graduating in 2019. Obtained Bachelor's degree from the Electrical Engineering Study Program, Tanjungpura University, Pontianak in 2023

Leonardus Sandy Ade Putra a is a lecturer from Universitas Tanjungpura. He received his bachelor degree in electrical engineering from Sanata Dharma University, Yogyakarta, Indonesia. Then he continued his master degree in telecommunication engineering from Universitas Diponegoro, Semarang, Indonesia. His research is focused on telecommunication network, IoT, image and video processing, and artificial intelligence.

Neilcy Tjahjamooniarsih is lecturer from Universitas Tanjungpura. She received her bachelor degree in electrical engineering from Universitas Tanjungpura, Pontianak, Indonesia. She continued her master degree in Universitas Gadjah Mada, Yogyakarta, Indonesia. Her research is focused on telecommunications, signal processing, and communication systems.