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Comparison Download and Upload of Long Term Evolution Time Division Duplex 2300 Mhz and Fdd 2100 Mhz

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***Abstract*— Data communication such as downloads and uploads are used by users on different channels, namely downlink and uplink in data transceiver. This study analyzed the download and upload results of Time Division Duplex (TDD) 2300 MHz and Frequency Division Duplex (FDD) 2100 Mhz. The bandwidth used is 20 MHz. This research was conducted in the Cengkeh Nan XX area because of the availability of both TDD and FDD technologies in this area and including densely populated areas, so good service performance is needed. The average FDD Reference Signal Received Power (RSRP) value of downloaded and uploaded is in the very good category (-95 ≤ x < -80 dBm) of -91.4 dBm and -89.4 dBm, while TDD is included in the Good category (-100≤ x < -95 dBm) of -98.2 dBm and -97.6 dBm. The average TDD Signal to Interference Noise Ratio (SINR) downloaded and uploaded is in the very good category (10 ≤ x < 20 dB) of 13.4 dB and 12.1 dB, while FDD is included in the Good category (0≤ x < 10 dB) of 8.9 dB and 7.4 dB. Average download throughput on PDCP (Packet Data Convergence Protocol) and Physical Layer TDD is included in the very good category (500 ≤ x < 100,000 kbps) which is 22,457.3 kbps and 26,842.3 kbps, while FDD is 18,687.7 kbps and 21,790.6 kbps. Average Upload Throughput on PDCP and Physical Layer FDD is included in the very good category (2000 ≤ x < 5000 kbps) which is 3733.12 kbps and 4425.9 kbps, while TDD reaches 2832.34 kbps and 3175.4 kbps. TDD and FDD technologies use different frequencies and multiplexing techniques resulting in differences in service performance. Based on the results of the study, it was analyzed that the best parameters in FDD are RSRP and Upload Throughput, while in TDD frequencies are SINR, Download Throughput. Thus, TDD and FDD technologies are used in certain categories and purposes.**

Keywords*— *Download; Long Term Evolution; Frequency Division Duplex; Time Division Duplex; Upload.

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I. INTRODUCTION

Data communication needs, for example the use of social media for live streaming through internet services, are increasing. Based on research by the Internet Service Providers Association (APJII), the number of internet users in Indonesia reached 215.63 million in 2022-2023, and increased 2.67% compared to the previous period of 210.03 million users. Therefore, optimal performance is needed on the downlink and uplink sides of 4G LTE (Long Term Evolution) technology services. LTE data transfer rate reaches 100 Mbps on the downlink side and 50 Mbps on the uplink side [1].

There are several LTE technologies including Time Division Duplex (TDD) and Frequency Division Duplex (FDD) [2].These two technologies have differences in data transmission. LTE TDD technology allows the use of one channel for uplink and downlink, while FDD technology has different channels on downlink and uplink [3].

The use of internet services such as accessing images, files, videos, and the like utilizes downlink and uplink direction infrastructure along with certain multiplexing techniques. The technique used on the downlink is OFDMA (Orthogonal Frequency Division Multiple Access) which allows sharing between users simultaneously in the time and frequency

domain [4]. OFDMA will increase the Peak Average Power Ratio (PAPR) which reduces the transmission power efficiency thus requiring high transmit power. Therefore, in the uplink, Single Carrier Frequency Division Multiple Access is used [5] with the addition of DFT-spread OFDM (Discrete Fourie -

Transform - spread OFDM) which can overcome high PAPR [6]. In addition, the SC-FDMA system has better battery life [7].

According to research conducted by Dikky Chandra, et al (2020) said that service integrity TDD technology has better performance than FDD technology on throughput and latency parameters. Performance on LTE FDD and TDD can be a factor in comparing 4G LTE services [2]. Based on research by Kusuma et al (2020), the average throughput on the downlink is greater than the uplink [8]. In addition, modulation affects the Throughput received by the UE, such as the use of QPSK, 16 QAM, and 64 QAM on downlink and uplink services [9].

Based on previous research, it can be concluded that there is still a lack of research that examines the performance when downloading and uploading data with the aim of analyzing the downlink and uplink parameters of LTE TDD and FDD technology, so this research will examine this by analyzing both technologies based on RF (Radio Frequency) parameters such as Reference Signal Received Power (RSRP), Signal Interference Noise Ratio (SINR), and Throughput.

The research data collection uses the drive test method by measuring the radio signal received by the customer's cellphone in real time to determine the performance of the cellular network. In data analysis, modulation and The bandwidth used is also an important parameter in this research. The frequencies used are 2300 MHz for TDD technology and 2100 MHz for FDD technology. This is because both frequencies use the same bandwidth of 20 MHz. For the selection of research sample location is in Clove Nan XX village because this area is one of the densely populated areas and supports LTE FDD and TDD services. Based on BPS Padang city data processed from "Lubuk Begalung sub-district in numbers 2021", the population of Cengkeh Nan XX village reached 4,390 people. Therefore, internet service users are high in this area.

II. Methods and Materials

A. Method

The method used in this research is a qualitative approach with a type of case study. The case study research method is used in research to answer the main research question "how" or "why" with the aim of obtaining a description to produce theory (Dewi Nur'aini, 2020). This research discusses the difference between download and upload methods by comparing each parameter of Radio Frequency LTE to the performance received by users on a predetermined route or path. This research collects and analyzes data and adjusts the needs of the users.

B. Material

1. TEMS Pocket

TEMS Pocket is a cellular network diagnostic software on mobile phones. TEMS Pocket functions for data retrieval to measure data transmission performance during downlink and uplink. The smartphone used is ensured to have an active GPS, this is needed in tracking the route during the data record period. The internet service used is Telkomsel operator. The selection of this operator is due to the presence of 2300 MHz TDD and 2100 MHz FDD services which are the frequencies used in this study.

III. Result and Discussion

Based on measurements of both LTE technologies, namely Time Division Duplex frequency 2300 MHz and Frequency Division Duplex frequency 2100 Mhz, the results of data processing with download and upload methods are obtained.

A. Download Result Processing

1. Reference Signal Received Power

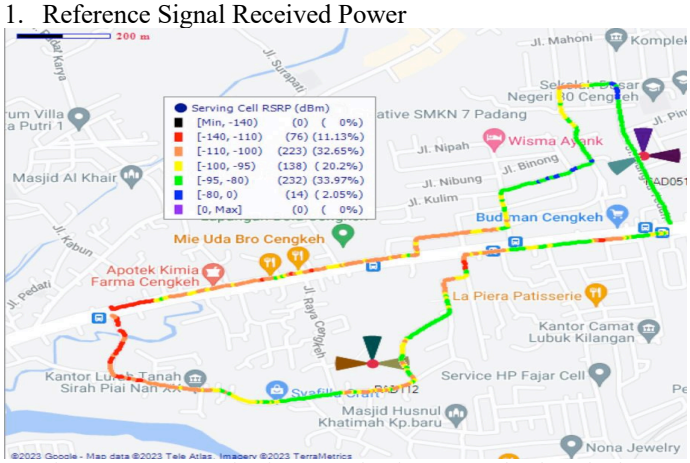

Figure 1 RSRP result of TDD technology Download method

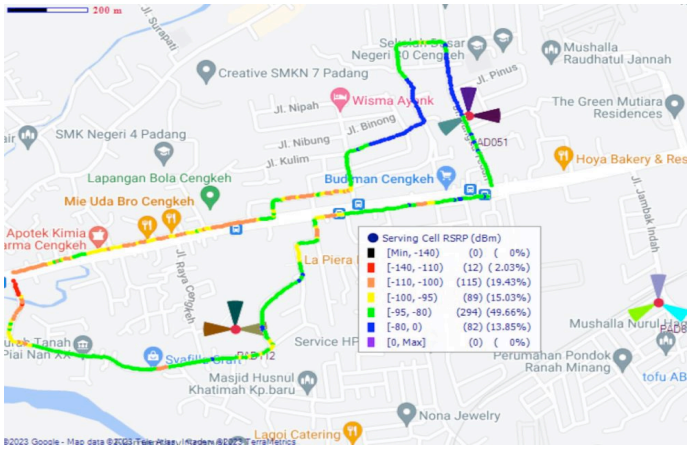

Figure 2 RSRP result of FDD technology Download method

The following table shows the value of the sample data obtained from data collection in the field based on the plotting results in the figures above. Furthermore, Figure 3 shows a histogram of RSRP parameters based on the percentage value of the sample obtained.

Table 1 RSRP Parameter Value Data

RSRP	Strength (dBm)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	-80 ≤ x	14	2,05%	82	13,85%
Very Good	-95 ≤ x < -80	232	33,97%	294	49,66%
Good	-100 ≤ x < -95	138	20,20%	89	15,03%
Bad	-110 ≤ x < -100	223	32,65%	115	19,43%
Very Bad	-140 ≤ x < -110	76	11,13%	12	2,03%
Total		683	100%	592	100%

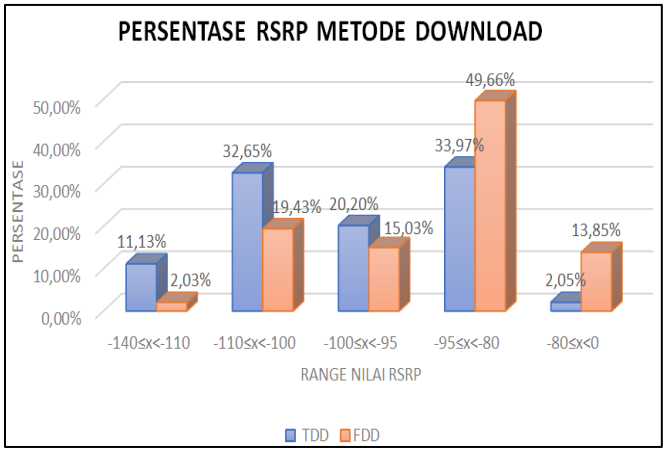

Figure 3 RSRP Percentage Diagram of Download method

2. Signal to Interference Noise Ratio

The SINR parameter shows the quality of the signal received by the user against the services provided by the eNodeB. The following are the results of SINR parameter data for 2300 MHz TDD and 2100 MHz FDD technologies.

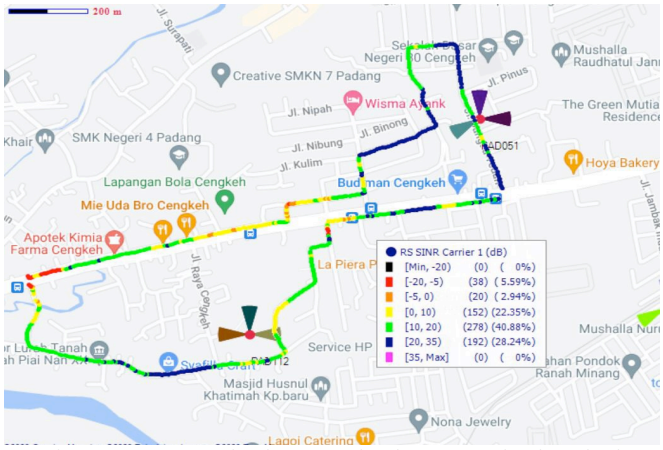

Figure 4 SINR result of TDD technology Download method

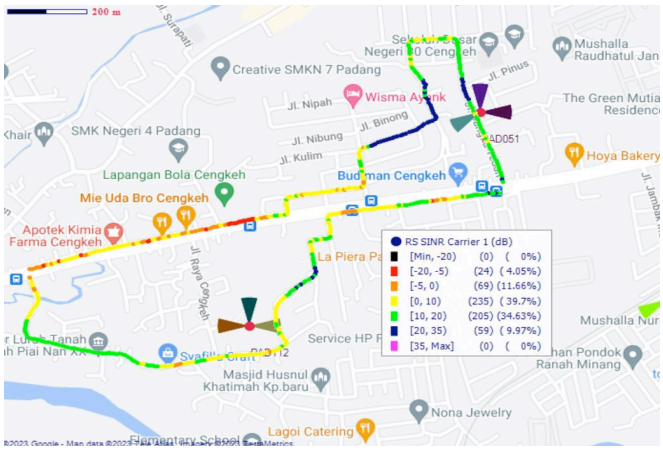

Figure 5 SINR result of FDD technology Download method

The following table shows the value of the sample data obtained from data collection in the field based on the plotting results in the figures above. Furthermore, Figure 6 shows a histogram of SINR parameters based on the percentage value of the sample obtained

Table 2 SINR Parameter Value Data

SINR	Strength (dBm)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	20 ≤ x ≤ 35	192	28,24%	59	9,97%
Very Good	10 ≤ x < 20	278	40,88%	205	34,63%
Good	0 ≤ x < 10	152	22,35%	235	39,70%
Bad	-5 ≤ x < 0	20	2,94%	69	11,66%
Very Bad	-20 ≤ x < -5	38	5,59%	24	4,05%
Total		**680**	**100%**	**592**	**100%**

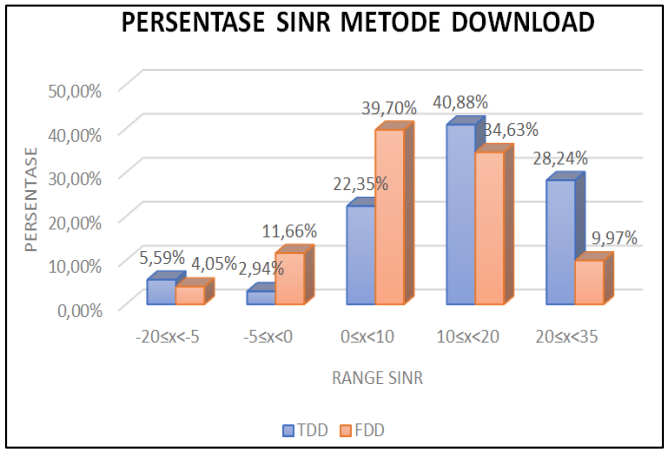

Figure 6 SINR Percentage Diagram of Download method

3. Throughput Downlink

Throughput is a parameter that shows the speed and transfer of data when downloading and uploading. Since the download method predominantly utilizes the downlink channel, this section discusses downlink throughput. Throughput parameters can be analyzed from several layers, namely the Physical Layer (PDSCH layer) and the PDCP Layer.

Table 3 Throughput parameter value data PDSCH

Throughput PDSCH	Strength (Kbps)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	100.000 ≤ x < 200.000	0	0%	0	0%
Very Good	5.000 ≤ x < 100.000	634	95,05%	538	90,88%
Good	3.000 ≤ x < 5.000	9	1,35%	39	6,59%
Bad	1.500 ≤ x < 3.000	6	0,90%	14	2,36%
Very Bad	0 ≤ x < 1.500	18	2,70%	1	0,17%
Total		667	100%	592	100%

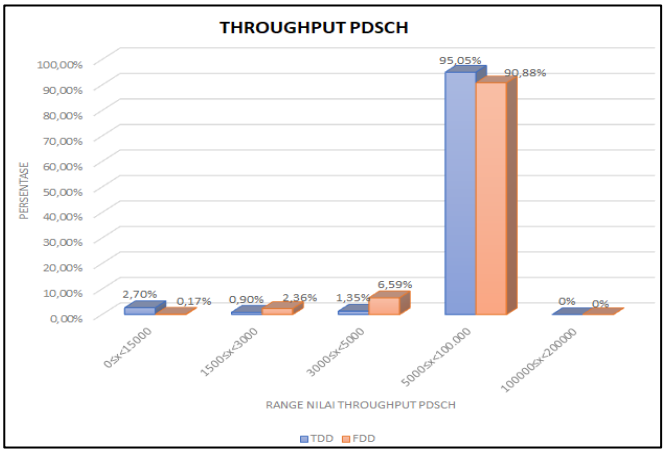

Figure 7 Diagram Persentase Throughput PDSCH

Table 4 PDCP Throughput parameter value data downloaded

Throughput PDCP	Strength (Kbps)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	100.000 ≤ x < 200.000	0	0%	0	0%
Very Good	5.000 ≤ x < 100.000	626	95,14%	518	87,65%
Good	3.000 ≤ x < 5.000	11	1,67%	49	8,29%
Bad	1.500 ≤ x < 3.000	7	1,06%	18	3,05%
Very Bad	0 ≤ x < 1.500	14	2,13%	6	1,02%
Total		**658**	**100%**	**621**	**100%**

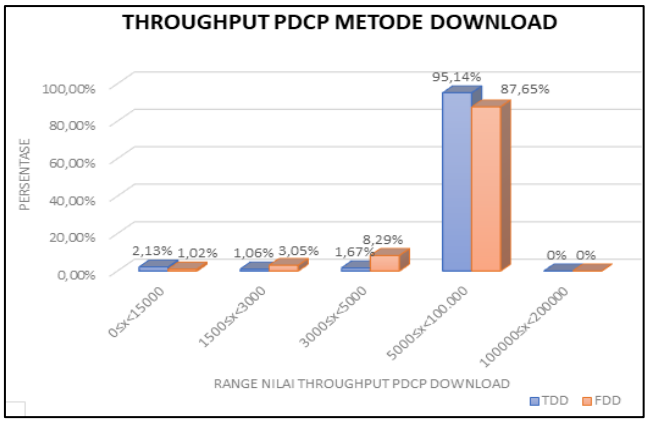

Figure 8 PDCP DL Percentage Chart

B. Upload Result Processing

The upload method measurement also pays attention to the following drive test parameters:

1. Reference Signal Received Power (RSRP)

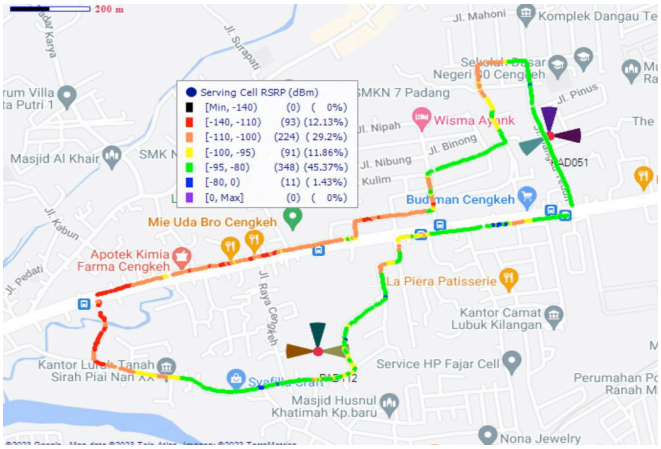

Figure 9 RSRP result of TDD technology Upload method

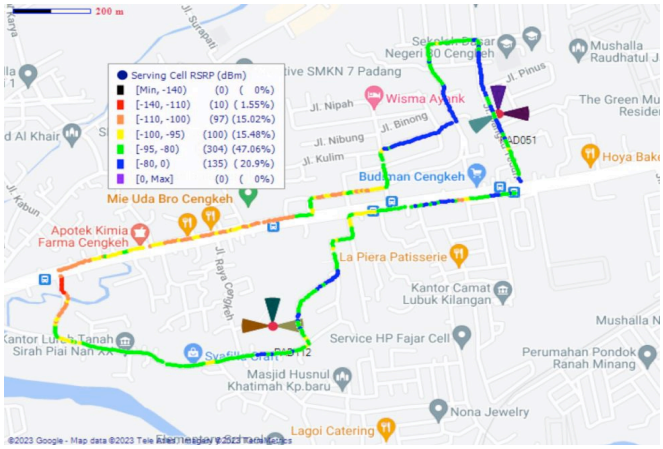

Figure 10 RSRP result of FDD technology Upload method

Table 5 RSRP result of TDD technology Upload method

RSRP	Strength (dBm)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	-80 ≤ x < 0	11	1,43%	135	20,90%
Very Good	-95 ≤ x < -80	348	45,37%	304	47,06%
Good	-100 ≤ x < -95	91	11,86%	100	15,48%
Bad	-110 ≤ x < -100	224	29,20%	97	15,02%
Very Bad	-140 ≤ x < -110	93	12,13%	10	1,55%
Total		**767**	**100%**	**646**	**100%**

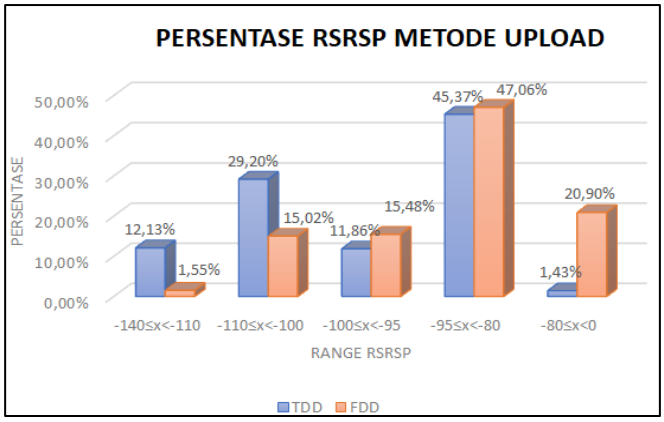

Figure 11 RSRP Percentage Diagram of Upload method

2. Signal to Interference Noise Ratio (SINR)

SINR indicates the quality of the signal received by the user.

Figure 12 SINR result of TDD technology Upload method

Figure 13 SINR result of FDD technology Upload method

Table 6 Uploaded SINR Parameter value data

SINR	Strength (dBm)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	20 ≤ x ≤ 35	185	24,18%	56	8,67%
Very Good	10 ≤ x < 20	297	38,82%	184	28,48%
Good	0 ≤ x < 10	194	25,36%	284	43,96%
Bad	-5 ≤ x < 0	38	4,97%	105	16,25%
Very Bad	-20 ≤ x < -5	51	6,67%	17	2,63%
Total		765	100%	646	100%

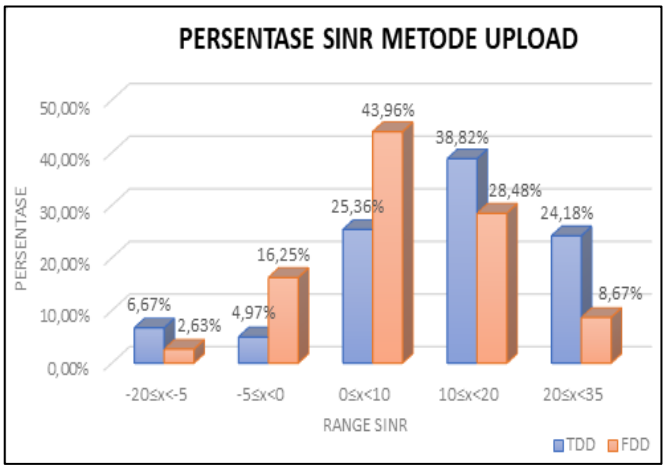

Figure 14 SINR Percentage Diagram of Upload method

3. Throughput Uplink

Throughput arah *uplink* pada penelitian ini dianalisis pada PUSCH Phy *Throughput* dan PDCP UL *Throughput*.

Table 7 PUSCH Throughput parameter value data

Throughput PUSCH	Strength (Kbps)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	5.000 ≤ x < 100.000	132	20,34%	257	45,89%
Very Good	3.000 ≤ x < 5.000	217	33,44%	48	8,57%
Good	1.500 ≤ x < 3.000	135	20,80%	51	9,11%
Bad	1.000 ≤ x < 1.500	45	6,93%	26	4,64%
Very Bad	0 ≤ x < 1.000	120	18,49%	178	31,79%
Total		649	100%	560	100%

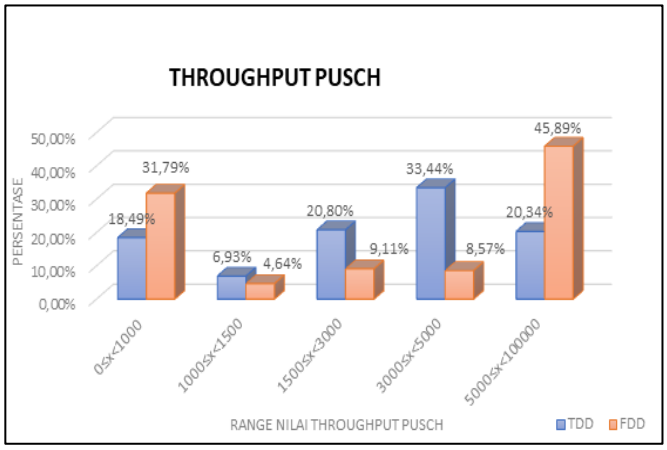

Figure 15 PUSCH Throughput Diagram

Table 8 PDCP Throughput parameter value data

Throughput DCPC	Strength (Kbps)	TDD 2300 MHz		FDD 2100 MHz	
		Sampel	Persentase	Sampel	Persentase
Excellent	5.000 ≤ x < 100.000	127	18,30%	244	42,00%
Very Good	3.000 ≤ x < 5.000	198	28,53%	48	8,26%
Good	1.500 ≤ x < 3.000	140	20,17%	53	9,12%
Bad	1.000 ≤ x < 1.500	51	7,35%	26	4,48%
Very Bad	0 ≤ x < 1.000	178	25,65%	210	36,14%
Total		694	100%	581	100%

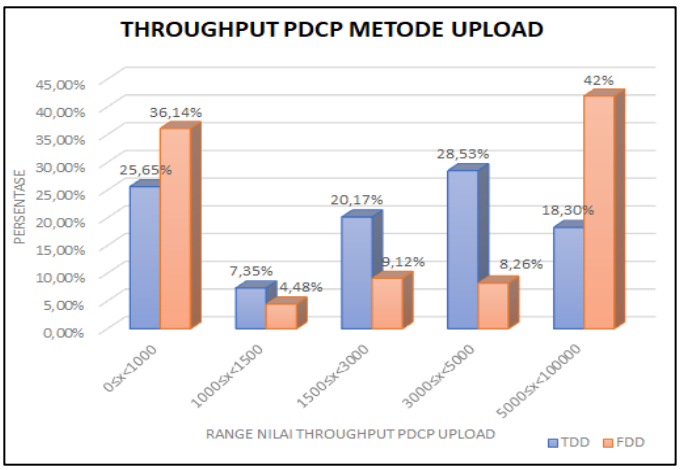

Figure 16 PDCP Throughput Percentage Diagram of Upload method

C. Discussion

This section discusses the average, maximum, and minimum values of LTE TDD technology frequency 2300 MHz and FDD frequency 2100 MHz on both download and upload data collection methods.

1. Download and Upload parameters in TDD technology

Table 9 RSRP and SINR parameter data of TDD technology

Parameter		Metode Drive Test	
		Download	Upload
RSRP (dBm)	Rata-rata	-98,2	-97,6
	Maksimum	-75,1	-76,2
	Minimum	-135,3	-130,9
SINR (dB)	Rata-rata	13,4	12,1
	Maksimum	29,5	29,2
	Minimum	-14,9	-15,8

Based on the table, it can be analyzed that the RSRP data of TDD download and upload methods have an average of -98.2 dBm and -97.6 dBm. This data is included in the good category (-100 dBm ≤ x < -95 dBm). The maximum values of RSRP of TDD download and upload methods are -75.1 dBm and -76.2 dBm, which belong to the excellent category (-80 dBm ≤ x < 0 dBm), while the minimum values of RSRP of TDD download and upload methods are -135.3 dBm and -130.9 dBm which belong to the very bad category (-140 dBm ≤ x < -110 dBm).

Furthermore, it is analyzed that the average SINR value of the download and upload method is 13.4 dB and 12.1 dB including the very good category (10 dB ≤ x < 20 dB). The maximum value of SINR download and upload methods in TDD is 29.5 dB and 29.2 dB including the excellent category (20 dB ≤ x < 35 dB). The minimum value of the SINR parameter of the TDD download and upload method is -14.9 dB and -15.08 dB including the very bad category (-20 ≤ x < -5 dB).

Table 10 Data Throughput of TDD technology

Parameter *Throughput* TTD		*Metode Drive Test*	
		Throughput Download (Kbps)	*Throughput Upload* (Kbps)
Maksimum	PDCP	53.324,99	7653,52
	PHY	59.300,83	7677,54
Minumum	PDCP	0,00	0,00
	PHY	0,01	0,00
Rata-rata	PDCP	22.457,28	2832,34
	PHY	26.842,32	3275,40

Based on the table description, the throughput of download and upload results shows data differences. The average throughput of PDCP and PHY layer download results is greater than the upload results. This is due to the configuration type settings used in TDD technology. This research uses TDD technology with type 5 configuration mode which has a downlink and uplink ratio of 8:1. Therefore, the use of the downlink channel is designed to be greater than the uplink. This also affects the signal strength (RSRP) of the download, so that the RSRP obtained is smaller, while the SINR download produces a greater value.

2. Download and Upload parameters in FDD technology

Table 11 RSRP and SINR parameter data of FDD technology

Parameter		Metode Drive Test	
		Download	Upload
RSRP (dBm)	Rata-rata	-91,4	-89,4
	Maksimum	-61,2	-62,6
	Minimum	-118,0	-117,5
SINR (dB)	Rata-rata	8,9	7,4
	Maksimum	28,6	26,2
	Minimum	-9,5	-13,6

Based on the table, it can be analyzed that the RSRP parameters of FDD technology download and upload methods are -91.4 dBm and -89.4 dBm which are included in the RSRP parameters. 73 very good category (-95 dBm ≤ x < -80 dBm). Furthermore, the maximum RSRP data of FDD technology download and upload methods are -61.2 dBm and -62.6 dBm which are included in the excellent category (-80 dBm ≤ x < 0 dBm). The minimum data of RSRP of FDD technology are -118.0 dBm and -117.5 dBm and belong to the very bad category (-140 dBm ≤ x < -110 dBm).

The average value of TDD technology SINR parameters in Table 4.14 analyzed that the download and upload methods show average data of 8.9 dB and 7.4 dB. Then, the maximum values of SINR FDD technology download and upload methods are 28.6 dB and 26.2 dB which are included in the excellent category (20 dB ≤ x < 35 dB), while the minimum values are -9.5 dB and -13.6 dBm including the very bad category (-20 dB ≤ x < -5 dB).

Table 12 Data Throughput of FDD technology

Parameter *Throughput* FDD		*Metode Drive Test*	
		Throughput Download (Kbps)	*Throughput Upload* (Kbps)
Maksimum	PDCP	18.687,65	3733,12
	PHY	21.790,62	4425,90
Minumum	PDCP	131,40	0,00
	PHY	1172,03	0,00
Rata-rata	PDCP	37.045,84	9287,70
	PHY	48.080,92	10.714,18

The download and upload results of FDD technology show that the download throughput value is greater than the upload. This is due to the downlink peak data rate which is greater than upload, which is 100 Mbps on the downlink and 50 Mbps on the uplink. This affects the RSRP of upload results with a high value, while the SINR of upload results is smaller than download.

IV. CONCLUSION

From the analysis of the results and discussion that has been carried out, the researcher obtained the following conclusions:

1. The performance of 2100 MHz FDD technology download results show RSRP parameters with an average value of -91.4 dBm, while 2300 MHz TDD technology is -98.2 dBm. Furthermore, the 2300 MHz TDD technology shows SINR, and download throughput parameters (PDCP and PDSCH) with the average value of the sequential parameters of 13.4 dB; 22,457 kbps; 26,842.32 kbps, while the FDD technology is only 8.9 dB; 18,687.65 kbps; 21,790.62 kbps.
2. The performance of 2100 MHz FDD technology upload results show RSRP parameters and Throughput Upload (PDCP and PUSCH) with a sequential average of -89.4 dBm; 3733.12 kbps; 4425.90 kbps, while 2300 MHz TDD is worth -97.6 dBm; 2832.34 kbps; 3175.40 kbps. Furthermore, 2300 MHz TDD technology shows SINR parameters with an average value of 13.4 dB, while 2100 MHz FDD technology reaches 8.9 dB.

3. The cause of performance differences in LTE FDD 2100 MHz and TDD 2300 MHz download and upload results are due to differences in frequency and multiplexing techniques used. Lower frequency produces greater RSRP value, but the value of SINR, modulation, and download throughput is small, and vice versa. Multiplexing techniques used in download and upload, as well as different TDD and FDD duplex techniques affect the performance of LTE services.

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