HANDOVER ANALYSIS OF 4G LTE (LONG TERM EVOLUTION) AT A FREQUENCY OF 2400 MHZ

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ABSTRACT

Information technology has now become a primary need for many individuals, facilitating access to various needs, including work, learning, and other activities. Mobile phones allow users to stay connected to the internet without interruption, even when traveling out of town, thanks to their ability to switch between cells or through a process known as handover. The focus of this article is on the impact of handover on 4G LTE networks. The data collection approach in this research uses the drive test method by utilizing the terms pocket application to retrieve internet network data. The research results highlight the importance of understanding how handover can affect 4G LTE network performance. With the role of information technology increasingly dominating everyday life, a deep understanding of technical aspects such as handover has become essential to maintaining the quality and efficient availability of cellular communications services.

Keywords: Drive test, Informatics Engineering, Internet, Telecommunication Engineering, Handover

1. INTRODUCTION

Mobile networks are part of radio access technology. One of the current cellular networks is 4G LTE (Long Term Evolution) network technology (Yuhanef et al., 2023). LTE technology has several frequency bands. Bandwidth is the area or width of the frequency coverage used by the signal in transmission. Within this framework, Bandwidth can be interpreted as the difference between the components of a high-frequency signal and a low-frequency signal (X. Zhang, 2019), (Okoli et al., 2023). According to the Indonesian Ministry of Communication and Information (Kominfo) in Mawardi, (2019), LTE networks utilize more than one frequency, namely in the frequency bands of 850 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2300 MHz.

In the world of telecommunications, there is a BS (Base Station), and each BS has a specific coverage area, so a solving procedure is needed that can maintain communication relations if the user moves from the area reached by one BS to another (Liu et al., 2019), (S. Zhang et al., 2019). The handover process can be called cell reslection for idl mode and handover for dedicated mode (Poikajärvi, 2021). Given the need for this handover system in mobile communication systems, this algorithm is a reference for the quality of cellular telecommunications operator services (Ndashimye et al., 2021), (Safitri & Santosa, 2016).

Handover means the process of transferring traffic channels directly from MS (Mobile Switching) which is used for communication services without internet connection disconnection (X. Zhang, 2019).

According to previous handover research, research has been carried out to determine the quality of a signal that will affect the performance of the handover frequency both intra-frequency handover and inter-frequency handover on the 4G LTE network by paying attention to the thereshold value (Umar Bin Farooq, 2021), (Zaidi, 2021), (Y. Zhang et al., 2019). The method used to determine signal quality and network performance in an area is to measure and retrieve data with a drive test. As stated in the research of (Farsi et al., 2019), (Nisyah & Mustafa, 2020) on "Signal Quality Analysis of Intra and Inter Handover Performance on 4G LTE Networks Using the SSV (Single Site Verification) Method", this research was conducted in the Tlogomas Malang area using Telkomsel operators. In this study, it was found that the signal quality and handover quality of the 4G LTE network met the standardization provided by the KPI, for the condition of handover success (Krasniqi et al., 2019), which was 100% with the signal quality of the RSRP and SINR parameters resulting in a percentage of 73% and 91.21% in accordance with the standards desired by operators and vendors using the Single Site Verification drive test method (Okorogu et al., 2023). In addition, there is also about handover research conducted by (Setiadi et al., 2020), which discusses the quality analysis of handover on video call communication on 4G LTE (Long Term Evolution) networks based on drive test data in ketapang city (Shakir et al., 2023), (Kheddar, 2022). In research conducted using the parameters RSRP, RSRQ, SNR. From the analysis of this study, the quality of the service worked well because it still met the Key Performance Indicators (KPI Standards) with the RSRP value being in the good category, namely -89.68 and the RSRQ value was included in the excellent category, namely -8.54 dB. Based on the data above, this study raised the title of handover analysis of 4g LTE (long term evolution) networks at a frequency of 2400 MHz.

2. THEORY

2.1 4G LTE (Long-Term Evolution)

4G LTE Long-Term Evolution, is a wireless communication standard representing the fourth generation (4G) in cellular network technology (Čaušević & Medić, 2021), (W. Li et al., 2021). Replacing 3G, it was developed to enhance data transfer speed, network capacity, and reduce latency (Iqbal & Prasetyo, 2019). Key features include high speed, low latency, spectrum efficiency, backward compatibility with 3G, IP-based network architecture, utilization of various frequency bands, improved security, and support for diverse services (Cao et al., 2019). It is important to note that 4G LTE is part of the evolution of cellular network technology, and currently, 5G stands as the latest generation offering advanced speed and capabilities beyond 4G (Mishra, 2018).

2.2 Frequency of 2400 MHz

The expression "Frequency of 2400 MHz" denotes a particular point on the electromagnetic spectrum. The abbreviation "MHz" stands for megahertz, representing a frequency equivalent to one million hertz (Riyas, 2015). In this instance, 2400 MHz indicates a frequency of 2400 million cycles per second (Z. Li et al., 2020), (Lebofsky et al., 2019). This particular frequency falls within the microwave segment of the electromagnetic spectrum. In various technological

scenarios, a 2400 MHz frequency is commonly linked with wireless communication, particularly in the 2.4 GHz (gigahertz) band (Chen et al., 2023), (Sharma & Singh, 2023), (Islam et al., n.d.). For example, it finds frequent use in Wi-Fi networks, Bluetooth technology, and certain cordless phones. The adoption of this frequency facilitates rapid data transmission rates and serves as a standard in numerous wireless communication applications. Internet

2.3 Internet

The Internet is a global system electronically interconnected, enabling the exchange of information, data, and interactions among users worldwide (Sunyaev & Sunyaev, 2020), (Vermesan et al., 2022). It constitutes a global framework consisting of a network of computers, servers, communication devices, and various services, accessible through various devices such as computers, smartphones, and tablets (Bansal & Kumar, 2020), (Elazhary, 2019), (Al-Turjman et al., 2020). The Internet facilitates various activities, including research, communication, e-commerce, entertainment, and various other endeavors (Shaikh & others, 2021). This technology utilizes standard communication protocols such as TCP/IP (Transmission Control Protocol/Internet Protocol) to unify local and global networks, forming a widespread and dynamic digital ecosystem (Kurfess et al., 2020), (Petrenko, 2022).

2.4 Telecommunication Engineering

Telecommunication Engineering involves the specialized study of designing, developing, installing, and maintaining electronic communication systems (Otung, 2021), (Maral et al., 2020). In this domain, a variety of technological aspects are utilized for the transmission, reception, and exchange of voice, text, images, and videos, employing both wired and wireless channels (Kolluru & Reddy, 2021). The exploration of Telecommunication Engineering encompasses a wide array of communication technologies, including telephones, televisions, radios, computer networks, and satellite technology (Balogun et al., 2020).

Professionals within the Telecommunication Engineering field shoulder the responsibility of creating and executing efficient, dependable, and secure communication infrastructures (Malik et al., 2022), (Biden, 2021). They actively participate in research, development, and the implementation of cutting-edge communication technologies, ensuring the seamless operation of communication systems that cater to user requirements (Allioui et al., 2023), (Ali et al., 2023). This field demands a profound comprehension of network protocols, wireless communication systems, data transmission technology, and the hardware and software integral to contemporary communication systems (Aceto et al., 2019), (Fitzek et al., 2020). Adapting in tandem with technological progress, Telecommunication Engineering continuously adjusts to confront emerging challenges, such as the rollout of 5G networks, the advancement of the Internet of Things (IoT), and the latest trends in communication technologies (Mourtzis et al., 2021), (Yang et al., 2021).

3. METHOD

In this method, the author plunged directly into the location to collect data, located in fresh water in the field. There are several ways to work in this method, here are the steps, like figure 1.

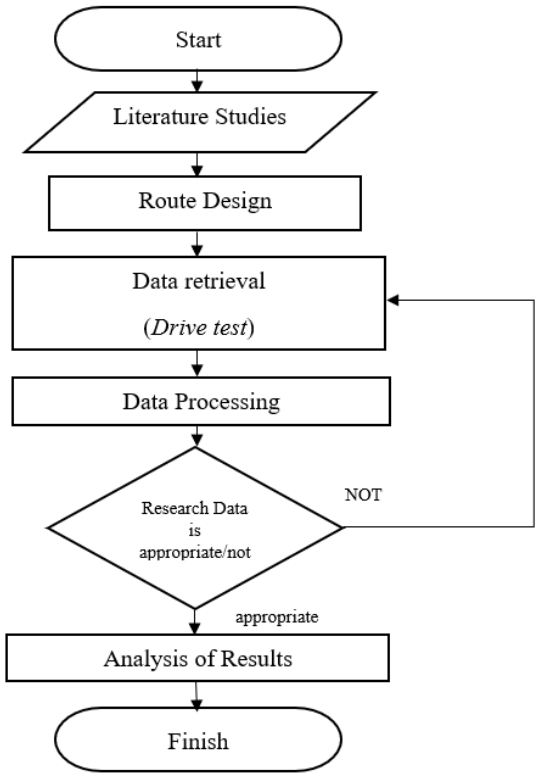

Figure 1. Flowchart

In the flow above, there are several processes, namely:

1. Literature Study
   This process is the first before research, where this process is carried out a series of activities related to the method of collecting library data, reading and recording, and managing research materials.
2. Route Design
   To save time and costs, a path must also be determined when driving the test so that the area passed is indeed the correct area to be tested. The application for designing regional routes is mapinfo.
4. Test drive data retrieval
   In this process, data retrieval is carried out using the drive test connected mode method. Connected mode is the process of measuring signal performance followed by channel occupation (download / upload). Data retrieval using a drive test tool, namely TEMS Pocket, which is carried out while driving on a predetermined path. Data collection is carried out during peak hours, according to (Syifa, 2019) from 08:00 to 17:30 WIB because at this hour there are often traffic spikes. The data taken is KPI quality parameter data such as RSRP.
5. Data Processing
   This process is the processing of the test drive result data. By using the TEMS investigation application, if the data is not as desired, data retrieval (drive test) is carried out again so that the data can be analyzed.
6. Analysis of Results
   At this stage, this process understands the problems that have been obtained By conducting data analysis, it is hoped that it can help in understanding the problem better, and can find out the conclusions of the data results obtained.

4. RESULTS AND DISCUSSION

Currently, data analysis is carried out from the measurement results when taking data using the drive test ping mode method to determine the strength, quality and performance of the Telkomsel operator's LTE network against the handover that occurs, in accordance with the measured parameters such as RSRP, SINR, Handover Attempt, Handover Failure, Handover Success , in order to be able to calculate data using the Key Performance Indicator (KPI) formula HOSR (Handover Success Rate) and find out the dominant cause of handover fallure that occurs in the LTE network.

1. Measurement Results

Based on the measurement results on LTE, the following data will be obtained.

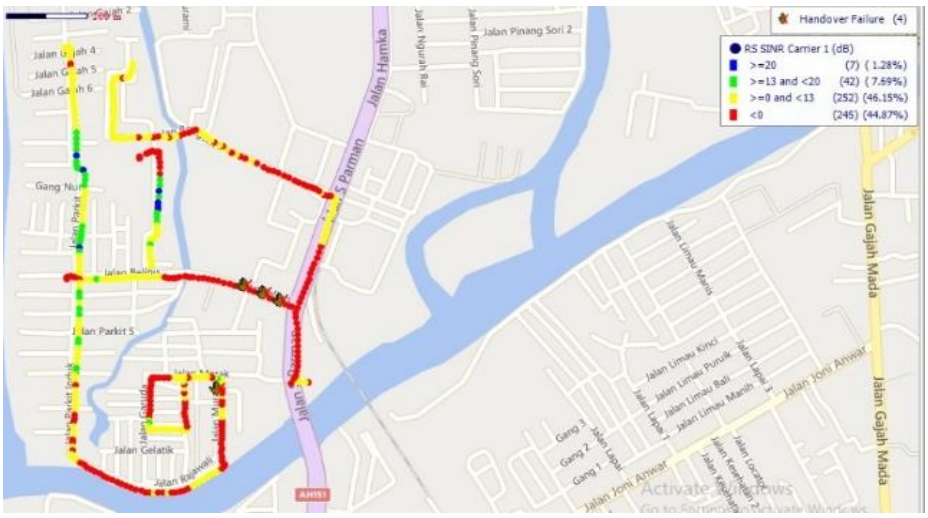

Figure 2. Handover Failure Results

In Figure 2 above, you can see the quality of the parameters and Handover Failure there are 4 Points of Handover Failure, following the location of the latitude and longitude on Figure 3.

	Time	Date	Latitude	Longitude	Handover ...
1	17:04:32.759	4/14/2022	-0.9026078	100.3488235	andover Failure
2	17:12:29.057	4/14/2022	-0.9002824	100.3494298	andover Failure
3	17:12:36.655	4/14/2022	-0.9004622	100.3498425	andover Failure
4	17:12:43.462	4/14/2022	-0.9006178	100.3502226	andover Failure

Figure 3. Location of latitude and langitude Handover Failure

2. Attemp Handover Measurement Results

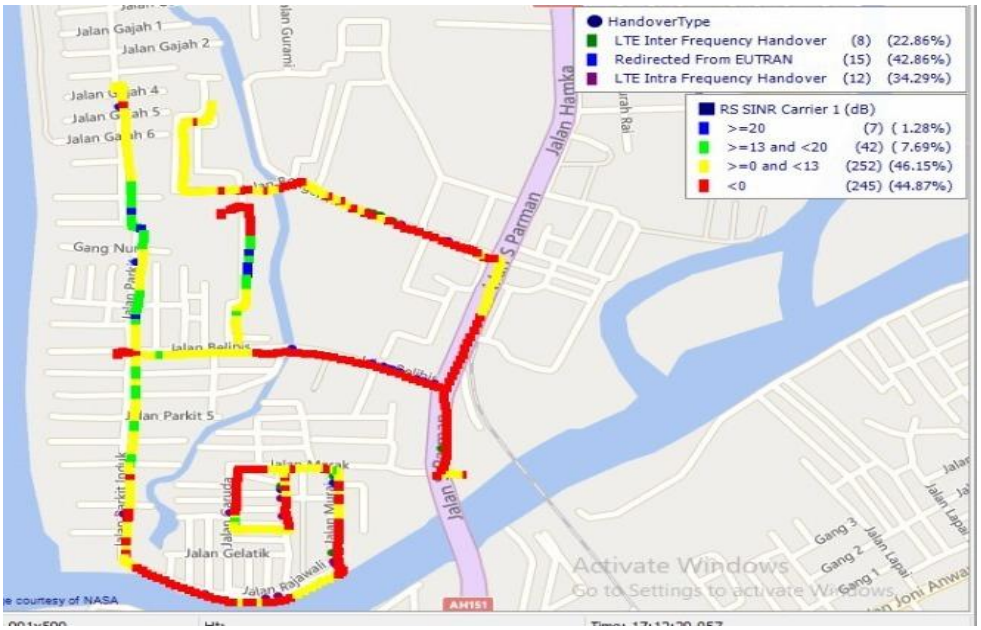

Figure 4. Attemp Handover plotting results

In figure 4 there are 35 Handover Attempt points that occur on the LTE network, on Intra Frequency handover 12 times, on Inter Frequency handover 8 and Redirected From Eutran 15 times.

Table 1. Result Handover Type

Event	Amount
LTE Intra Frequency *Handover*	12 Point
LTE Inter Frequency *Handover*	8 Point
Redirected From UETRAN	15 Point

3. Handover Success Rate Measurement Results

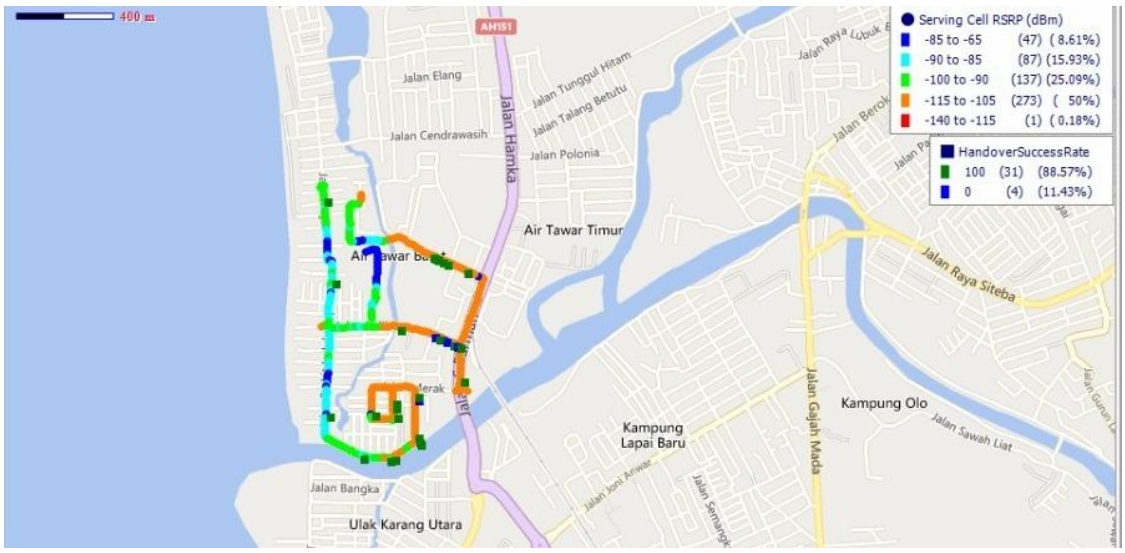

Figure 5. Attemp Handover plotting results

In figure 5 there are 31 Handover Success rate points that occur LTE networks. From the three handover measurement results, an event was obtained which can be seen in Table 2.

4. Handover Type Measurement Results

Based on the events in Table 2, the LTE Intra Frequency Handover is obtained, Intra-frequency handover is a handover that occurs from one source cell to the target cell using the same frequency. LTE Intra Frequency Handover has 35 points on the measurement results.

LTE Inter-frequency handover is a handover that occurs in one source cell to the target cell using a different frequency LTE Inter frequency handover has 8 points on the measurement results. Redirected From UETRAN is a Mechanism redirection to change a cell from one (let's call this "serve/source cell") to another (let's call this "cell target"), Redirected From UETRAN consists of 15 measurement result points.

5. Causes of Handover Failure

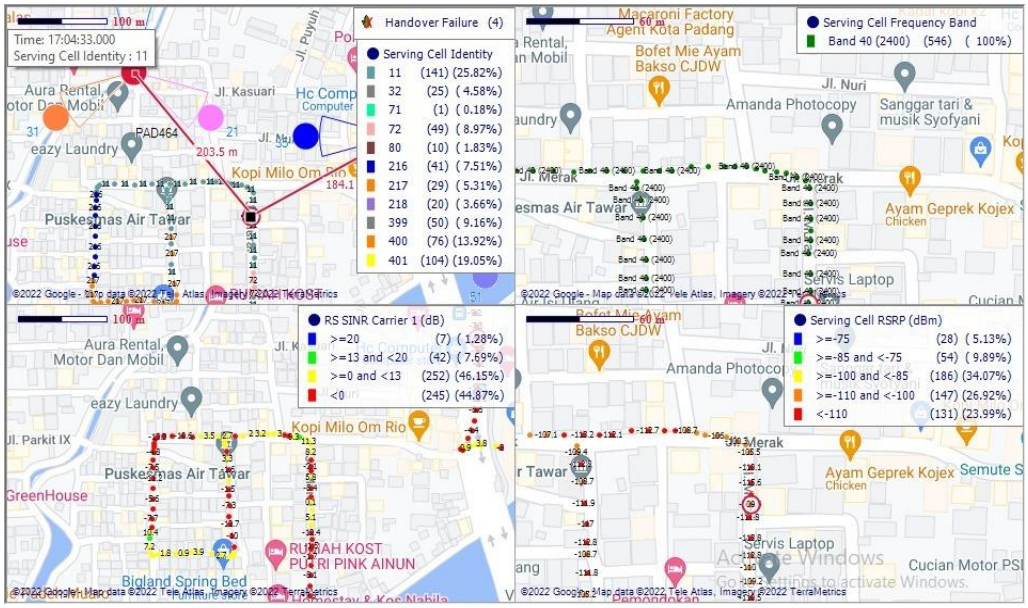

Figure 6. Results of point 14 *Failur Handover*

In figure 6 above is the failure of *failover handover in* the freshwater area of padang city. In the picture above on PCI 11, there is a handover failure caused by interference between the PAD464 site in sector 2 (*serving* cell) and the PAD311 site in sector 3 (*neighbor cell*), which results in a handover failure at that location point, this occurs at other *handover* failure points.

5. CONCLUSIONS AND SUGGESTIONS

Based on what can be obtained from the results of the data analysis above, it can be concluded that.

a) This method of retrieving *service mobility* data is carried out in ping mode by paying attention to the aspect of the e-nodeB point.
b) Handover failure in the above data occurs due to interference with the *site*.

This jouranal can be improved by adding ways and steps for optimization, because there are still RSRP and SNIR parameters that do not meet the KPI standards.

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