

Optimization of Overshooting Cells in 4G LTE 1800 MHz Network at Telkomsel Site CJR017

Windy Meisari^a, Dipal Irpandi^{b,*}, Amelia Yolanda^b

^a Telecommunication Engineering , Politeknik Negeri Padang, 25166 , Indonesia,
Corresponding author: dipalirpandi10@gmail.com

Abstract— This study aims to Overshooting cell issues are among the critical challenges in 4G LTE networks, causing interference, degraded signal quality, and reduced service reliability. This study focuses on optimizing overshooting at the Telkomsel site CJR017_CMBCIDATAR_CISURUPAN-PTI using Huawei equipment. The main objectives are to improve Reference Signal Received Power (RSRP), Signal-to-Noise Ratio (SINR), and throughput, while addressing the overshooting problem to enhance network performance. The methodology involved conducting detailed site surveys and drive tests with the Genex Assistant application to collect baseline performance data. The optimization process included mechanical tilt adjustments from 0° to 2° and electrical tilt modifications from 2° to 4°, targeting improved signal transmission and reduced overshooting. Post-optimization results showed significant improvements in network parameters: RSRP increased from -110 dBm to -90 dBm, SINR rose from -10 dB to 5 dB, and throughput improved markedly, with download speeds increasing from 11.5 Mbps to 120 Mbps and upload speeds from 0.18 Mbps to 27.9 Mbps. Additionally, overshooting from neighboring sites was effectively minimized, enhancing coverage and service quality in previously weak signal areas. These findings highlight the critical role of systematic optimization in addressing overshooting issues and improving the overall performance of cellular networks. Future research should focus on evaluating long-term optimization impacts and exploring the integration of advanced technologies, such as 5G, to further enhance network efficiency and performance.

Keywords— 4G LTE, antenna tilt, network optimization, overshooting, RSRP, SINR, throughput.

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I. INTRODUCTION

In the evolution of telecommunication networks, 4G LTE technology has become the primary system used to meet the growing demand for fast and reliable data communication. Since its introduction, 4G LTE has provided significant improvements in data speeds, lower latency, and better spectrum efficiency compared to previous technologies like 3G (Rappaport, 2019). However, despite its advancements, certain technical challenges still persist, one of which is overshooting.

Overshooting occurs when a cell site transmits signals beyond its intended coverage area, leading to interference between cells and a reduction in service quality, especially in terms of Reference Signal Received Power (RSRP) and Signal-to-Noise Ratio (SINR) (Holma & Toskala, 2019). This can

result in slow and unstable data services, negatively affecting the user experience.

Recent studies have focused on addressing the overshooting issue, particularly in high-traffic environments. Solutions to this problem often involve antenna tilting, either mechanical or electrical, to adjust the signal coverage and reduce interference (Sesia et al., 2020). These optimization techniques have proven effective in enhancing signal quality and throughput in 4G LTE networks, thus improving overall service quality (Peng et al., 2020).

This study aims to identify and optimize the overshooting issue in the New Infra 4G LTE 1800 MHz network at the CJR017_CMBCIDATARCISURUPAN-PTI site. By implementing optimizations such as physical tuning and antenna tilting adjustments, it is expected that signal quality received by users will improve, and interference caused by

overshooting will be minimized (Berliansa, 2019; Yuliana et al., 2021).

II. METHOD

The research was conducted at PT. ZMG Telekomunikasi Service Indonesia, a telecommunications infrastructure provider located at Jalan Alexandri No. 11, Cijagra, Kec. Lengkong, Kota Bandung, West Java. The study identified a problem at the site CJR017_CMBCIDATARCISURUPAN-PTI, where poor Reference Signal Received Power (RSRP), Signal to Noise Ratio (SINR), and throughput were observed. This issue was caused by overshooting at the site. Overshooting significantly affects signal parameters, such as RSRP, SINR, and throughput. When a site has poor RSRP and SINR values, users experience weak signal strength and quality, which in turn affects download and upload throughput. As a result, users may struggle with accessing websites, downloading files, streaming YouTube, and other internet activities. The RSRP and SINR parameters for the CJR017_CMBCIDATARCISURUPAN-PTI site can be monitored using the Genex Assistant application, commonly used by telecommunications engineers.

A. Radio Frequency Optimization Procedure

To perform radio frequency optimization at a site, several factors must be known before proceeding with the optimization. These include the site's location (longitude and latitude), planning parameters, site configuration data, Material On-Site (MOS) information, and the installation timeline specified in the Request For Information (RFI). On January 25, 2024, the installation at the CJR017_CIDATARCISURUPAN-PTI site was completed. The site's coordinates are longitude 107.17906 and latitude -6.80566. Details of the site include

- The site went on air on January 27, 2024.
- The site consists of 3 azimuth sectors (20/110/240).
- The tower's height is 29 meters.

The primary goal of the optimization is to achieve optimal results in terms of radio frequency network performance, reduce signal quality degradation, improve signal efficiency, and enhance user traffic benefits. This optimization significantly aids in improving network quality and restoring signal conditions after installation and on-air activation, ensuring user traffic within the site's coverage area remains secure and efficient.

B. Parameters Used for Optimization

Key Performance Indicator (KPI) is a metric used to measure and evaluate the performance of a network. KPIs provide insights into how well, poorly, or moderately the signal is received by user devices, compared to the levels of interference and noise in a given area. Different colors are used to represent each parameter's performance level.

A KPI drive test is a process of testing where measurements are taken while driving along a specific route using devices connected to the cellular network. The primary goal of a drive test is to collect data on the network's performance in real-world conditions. This process helps network operators monitor, analyze, and optimize the quality of service provided to customers. The parameters used in the KPI drive test are :

1) Reference Signal Received Power (RSRP)

RSRP represents the strength of the signal at a specific frequency, received by user equipment (UE), measured in dBm. The RSRP value differs for each coverage point within a network. If a user is outside the network's coverage area, they will not be able to access the LTE network. The RSRP signal quality categories in a drive test can vary between providers. As the distance between the site and the UE increases, the RSRP value decreases, and vice versa. From Figure 1, the service of a site can be compared to the reference signal. The closer the user is to the serving site, the stronger the signal they receive. However, as the user moves farther away from the site's coverage area, the signal strength weakens

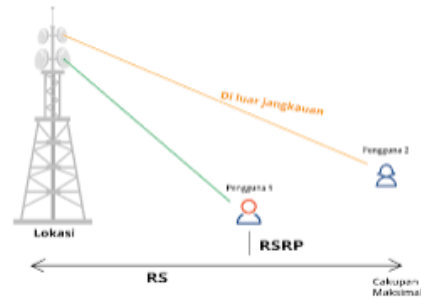


Fig. 1 How RSRP works

RSRP has a KPI range that is divided into five standard value categories, each represented by its own color.

TABLE I RANGE RSRP

Range	Legend	
- 80 <= RSRP	Excellent	
-95 <= RSRP -80	Good	
-100 <= RSRP -95	pretty good	
-110 <= RSRP -100	quite poor	
-145 <= RSRP -110	very poor	

The blue color is rated as excellent, showing a range of -80. The dark green color is rated as good, showing a range of -80 to -95. The light green color is rated as pretty good, showing a range of -95 to -100. The yellow color is rated as quite poor, showing a range of -100 to -110. The red color is rated as very poor, showing a range of -110 to -145.

2) Signal to Noise Ratio (SINR)

SINR (Signal to Interference plus Noise Ratio) is one of the signal parameters used to measure signal quality in wireless communication, particularly in the context of cellular networks. Specifically, SINR represents the ratio between the main signal transmitted and the interference and noise that occur (mixed with the main signal). The higher the SINR value, the better the quality of the signal.

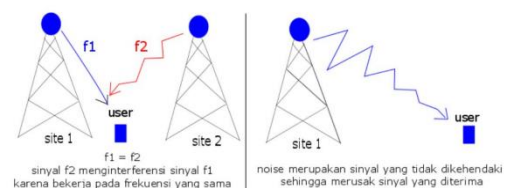







Fig 2 Difference Between Interference and Noise

The difference between interference and noise is that interference refers to disturbances caused by other sources or sites, which affect the received signal. This can occur due to several factors, including the use of the same frequency, signal reflections from various surfaces, or electromagnetic interference from other devices. On the other hand, noise refers to random signals or unwanted interference within the communication channel itself, which results in the degradation of the received signal. Not only does RSRP have its own KPI range, but SINR also has its own KPI range. The SINR KPI range is divided into five standard value categories, each represented by different colors.

TABLE II
RANGE SINR

Range	Legend	
$20 \leq \text{SINR} < 50$	Excellent	
$10 \leq \text{SINR} < 20$	Good	
$0 \leq \text{SINR} < 10$	pretty good	
$-5 \leq \text{SINR} < 0$	quite poor	
$-20 \leq \text{SINR} < -5$	very poor	

From the table above, it can be concluded that the blue color is classified as excellent, showing a value range of 50 to 20. The dark green color is classified as good, showing a range of 20 to 10. The light green color is classified as pretty good, showing a range of 10 to 0. The yellow color is classified as quite poor, showing a range of 0 to -5. The red color is classified as very poor, showing a range of -5 to -20.

3) Throughput

Throughput refers to the bandwidth measured over a while and is used to transfer files of specific sizes within the network. There are two types of throughput: download and upload. Download throughput indicates the speed at which data is received, including text, images, music, videos, web pages, online streaming, gaming, and other online data. On the other hand, upload throughput refers to the speed of sending data from a device to the internet, such as transferring large files via email or using video chat to communicate with others online. Throughput for both download and upload can be measured using the Ookla application.



Fig 3 Throughput View

C. Physical Cell Identity (PCI)

PCI (Physical Cell Identity) is a number and color used by user equipment (UE) to identify cells, synchronized in time and frequency. Each cell in a cellular network has a unique PCI, which helps mobile devices determine which cells are connected or available in their vicinity. The principle of PCI operation is similar to the scrambling code (SC) allocation used to distinguish and identify cells within WCDMA systems. PCI is crucial in the process of cell search and handover (the transition between cells) in cellular networks. As a device moves while communicating with the cellular network, one of its tasks is to search for and synchronize with nearby cells. By using PCI, mobile devices can differentiate between the cells in the network, thereby avoiding confusion with other cells that may have similar identity numbers.

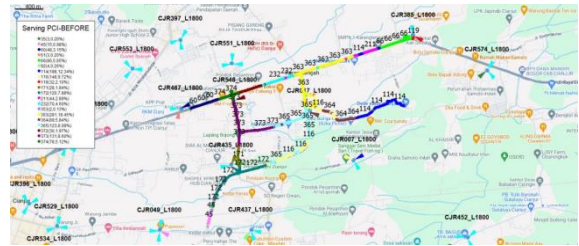


Fig 4 PCI display

III. RESULTS AND DISCUSSION

The optimization process on the site was carried out to overcome problems related to overshooting and improve signal quality. Key performance indicators such as Reference Signal Received Power (RSRP), Signal to Noise Ratio (SINR), and throughput are measured before and after optimization. Based on the results from the driving test and the use of the Genex Assistant application, it can be analyzed that a bad spot has occurred around the site, resulting in poor signal quality and strength. To enhance signal quality and strength, corrective action is required at the source site or nearby sites. The bad spot around the site can be caused by several factors, such as incorrect up-tilting, down-tilting, misaligned azimuth direction, or overshooting.

The data acquired from the site visit can be used to analyze the cause of the bad spot around the CJR017_CIDATARCISURUPAN-PTI site. The first step is to check the source site to identify the cause and find a solution for the bad spot and overshooting in the area. At the CJR017_CIDATARCISURUPAN-PTI site, Sector 1 with PCI 363 is directed towards the bad spot area. Ideally, Sector 1 should cover this area to ensure strong signal quality around the site. However, the problem arises because the area that Sector 1 is supposed to cover is experiencing a bad spot. Therefore, further analysis and corrective actions must be taken for Sector 1 of the CJR017_CMBCIDATARCISURUPAN-PTI site to improve the signal quality and strength in the bad spot area. From the site visit to CJR017_CIDATARCISURUPAN-PTI, the data revealed that Sector 1 has an azimuth of 30 degrees, mechanical tilting of 0 degrees, electrical tilting of 2 degrees, an antenna height of 29 meters, and a tower height of 42 meters. Based on the data collected from the site visit for Sector 1, it can be concluded that the antenna in Sector 1 is positioned vertically, causing the signal to be transmitted horizontally.

This results in the signal and beam not being optimally directed towards the bad spot area, leading to an over-horizon issue, as shown in Figure 3.20. Additionally, as shown in Figure 3.21, the Google Earth application confirms that Sector 1 of the CJR017_CIDATAR CISURUPAN-PTI site has a bad spot in an area with a low contour. Since the antenna in Sector 1 transmits horizontally at a tower height of 41 meters and an antenna height of 29 meters, the signal fails to effectively reach the bad spot.

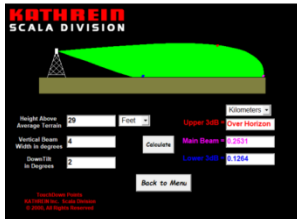


Fig 5 Antenna Coverage Area Before Optimization

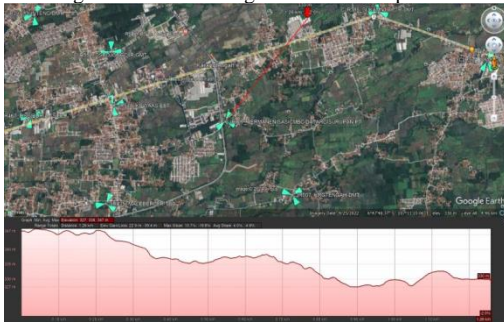


Fig 6 Antenna Contour and Coverage Area View Before Optimization

To maximize signal coverage and transmission from Sector 1 in the bad spot area, optimization must be performed through Physical Tuning (physically adjusting the antenna). This involves changing the mechanical tilt of Sector 1 at the CJR017_CIDATAR CISURUPAN-PTI site from 0 degrees to 2 degrees and adjusting the electrical tilt from 2 degrees to 4 degrees.

Antenna ID	Frequency	Actual Sector ID	Actual Sector ID	Actual Sector ID	Actual Sector ID	Actual Sector ID	Actual Sector ID	Actual Sector ID	Actual Sector ID
1	2100	1	1	1	1	1	1	1	1
2	2100	2	2	2	2	2	2	2	2
3	2100	3	3	3	3	3	3	3	3
4	2100	4	4	4	4	4	4	4	4
5	2100	5	5	5	5	5	5	5	5
6	2100	6	6	6	6	6	6	6	6
7	2100	7	7	7	7	7	7	7	7
8	2100	8	8	8	8	8	8	8	8
9	2100	9	9	9	9	9	9	9	9
10	2100	10	10	10	10	10	10	10	10

Fig 7 Electrical Data Tilting After Optimization

After improving Sector 1 at the CJR017_CIDATAR CISURUPAN-PTI site using the physical tuning method, it was proven that the signal transmission and beam from Sector 1 became significantly more effective than before. This can be demonstrated by comparing Figure 3.19 and Figure 3.22. In Figure 3.19, it is shown that before the optimization, the antenna's coverage area and the signal transmission from Sector 1 were not fully optimized for the bad spot area and instead overshooted the horizon. However, after the optimization, as shown in Figure 3.22, the signal transmission and beam from Sector 1 became nearly optimal for the bad spot area, with a transmission distance of 0.1264 km, and the best performance creature at a distance of 0.0629 km.

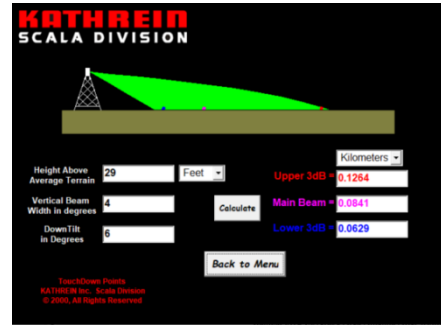


Fig 8 Antenna Area Coverage After Optimization

The next step is to check three neighboring locations that are experiencing overshooting of the source site to improve signal quality and strength in the bad spot area around the source site. The first task is to check the parameter data of the three neighboring sites: CJR007_KRGTEGAH-DMT, CJR044_MARTIKOLOLOT, and CJR551_DSBOJONCJR-GMT. After the inspection, optimization will be carried out using the RET (Remote Electrical) parameter by adjusting the electrical tilting on the three neighboring sites. Specifically, for CJR007_KRGTEGAH-DMT Sector 3, the electrical tilting will be changed from 2 degrees to 4 degrees, for CJR044_MARTIKOLOLOT Sector 2 from 2 degrees to 4 degrees, and for CJR551_DSBOJONCJR-GMT Sector 2 from 4 degrees to 5 degrees.

The optimization method used for these three neighboring sites involves only electrical tilting to ensure the neighboring coverage does not interfere with the bad spot area and to reduce overshooting from the three neighboring sites. If mechanical tilting were also applied to these neighboring sites, they would not be able to optimize signal transmission and beam coverage to the planned areas, potentially leading to new issues.

After all optimization processes on the source site and the three neighboring sites have been completed to improve the bad spot area as previously explained, the next step is to conduct a recheck or drive test to evaluate the results of the optimization. The purpose of this recheck/drive test is to ensure that the optimization has truly improved the previously poor signal quality and strength in the bad spot area of the CJR017_CIDATAR CISURUPAN-PTI site. Following the recheck or drive test around the CJR017_CIDATAR CISURUPAN-PTI site, it was observed that the signal quality and strength were significantly better compared to before the optimization of both the source site and the three neighboring sites. Additionally, the optimization successfully reduced overshooting from the three neighboring sites, allowing them to cover their intended areas without interfering with the coverage area of other sites.

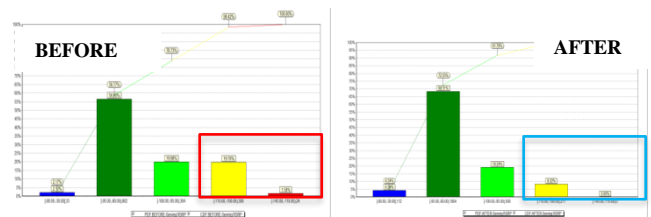


Fig 9 Comparison of RSRP Before and After Optimization

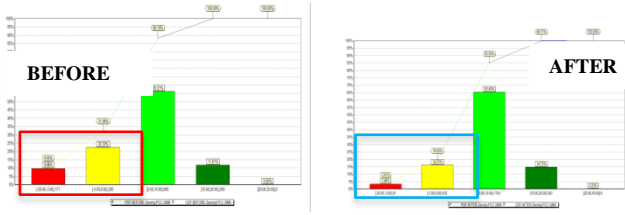


Fig 10 Comparison of SINR Before and After Optimization

From Figures 9 and 10 above, marked with red and blue boxes, it can be observed that the percentage values of RSRP and SINR at the CJR017_CMBCIDATARCISURUPAN-PTI site have decreased in the ranges indicated as fairly poor (yellow) and very poor (red). Before optimization, the percentage of RSRP in the range of -100 to -145 was 1.58%, and in the range of -100 to -110, it was 19.70%. After optimization, the percentage of RSRP in the range of -100 to -145 decreased to 0%, while the range of -100 to -110 dropped to 8.22%. Similarly, the percentage of SINR also showed a decrease in the ranges marked as fairly poor (yellow) and very poor (red). Before optimization, the percentage of SINR in the range of -5 to -20 was 9.66%, and in the range of 0 to -5, it was 22.32%. After optimization, the percentage of SINR in the range of -5 to -20 decreased to 3.41%, and the range of 0 to -5 decreased to 16.21%. These percentages indicate that the optimizations performed on both the source site and the neighboring sites have successfully reduced the poor quality of RSRP and SINR in the bad spot area around the CJR017_CIDATARCISURUPAN-PTI site.



Fig 14 SINR Display After Optimization

In addition to the changes in the percentages of RSRP and SINR, overshooting, which caused the bad spot, also experienced a reduction, as shown in Figure 3.28. Furthermore, the download and upload throughput at the CJR017_CMBCIDATARCISURUPAN-PTI site, Sector 1 with PCI 363, also changed following the optimization, which can be accessed using the Ookla application in the speed test section. Initially, the download throughput was measured at 11.5 Mbps, while the upload throughput was 0.18 Mbps. After optimization, the download throughput increased to 120 Mbps, and the upload throughput rose to 27.9 Mbps.



Fig 15 Fig 11 RSRP Display Before Optimization

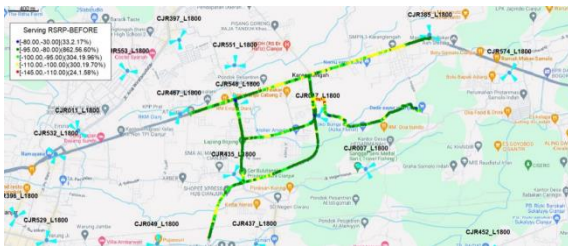


Fig 11 RSRP Display Before Optimization



Fig 12 RSRP Display After Optimization

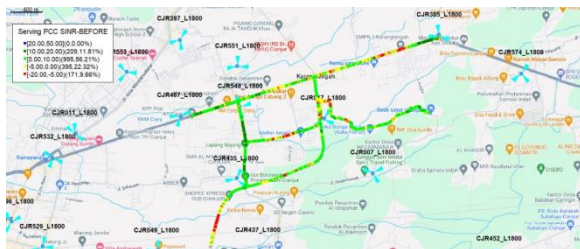


Fig 13 SINR Display Before optimization



Fig 15 Fig 11 Throughput Display Before Optimization

IV. CONCLUSION

Based on the discussion in the previous chapter, the following conclusions can be drawn:

- 1) To reduce overshooting at a site, it is important to adjust the placement of bts towers according to the geographic conditions and population density and to ensure that the antenna tilting is done correctly.
- 2) At the cjr017_cmbcidatarcisurupan-pti site, there is a bad spot area nearby that results in low signal quality and strength. This is caused by overshooting from the three neighboring sites

and incorrect antenna tilting. Being close to the site does not guarantee good signal quality, as shown by the bad spot area, located 0.25 km from the cjr017_cmbcidarcisurupan-pti site, which has poor signal quality and strength.

3) The 4g lte network at the cjr017_cmbcidarcisurupan-pti site was optimized using the physical tuning method, by adjusting the mechanical and electrical tilting of the antenna. The principle is that a smaller mechanical tilt increases the signal range, while a larger mechanical tilt shortens the range. Similarly, a smaller electrical tilt widens the signal coverage, while a larger electrical tilt narrows the coverage.

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