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ANALYSIS OF RADIO PARAMETERS FOR OPTIMAL PERFORMANCE IN A 900MHZ 3G NETWORK

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Abstract - This paper focused on the analysis of radio parameters for optimal performance in a 900MHz-3G Network**.** A telecommunication network located in Lagos State, Nigeria, and operating at a frequency of 900 MHz was the network under study. The network has rolled out services with sixteen BTS (Base Station Transceiver) sites. The BTS sites are connected to the Lagos BSC (Base Station Controller) via a 16E1 leased fibre link. The checking, uploading, and analysis of transmission alarms, RSSI, FER, and other traffic statistics data from the M2000 and the LMT from all the operational BTS in Lagos were carried out, for the acquisition of initial knowledge of network quality. Drive tests were carried out, and an analysis of the traffic statistics was made. The network optimization was then implemented at a higher level using the various models. Results showed that optimal performance is achieved by combining prediction models with dynamic measurements and applying coverage and diversity means accordingly.
Keywords: CDMA, Optimization, spread spectrum, call drop rate, call setup rate

1. Introduction

Bidirectional wireless mobile communication is one of the world's fastest-growing technologies. A widespread commercial rollout of wireless mobile communications was made possible by the standardization of the first-generation cellular mobile radio technologies in the 1980s (Dongmei et al., 2020). The TDMA-based second-generation standards were developed concurrently with the IS-95 in the USA. It makes use of Direct Sequence (DS) spectrum spreading and Code Division Multiple Access (CDMA). The origin of CDMA may be traced back to the early 1900s, when spread spectrum communications first emerged. CDMA is one of the most promising medium access techniques for future cellular networks. Since the latter half of the 20th century, spread spectrum communications have become increasingly popular for commercial applications, such as mobile multi-user communications. At the same time, they were initially employed in the creation of secure digital communication systems for military usage (Edward B. and Abu S. 2024). The receiver is aware of the spreading code used in spread spectrum transmissions, which is independent of the message. The receiver despreads the received signal using a synchronized replica of the spreading code, which enables the recovery of the message (Venugopal V. and Andrew S., 2009). Spread spectrum communications need to be highly redundant to combat interference caused by the channel's properties, intentional disruptions, and various user accesses. The method of employing spread spectrum technology to enable several users to access the channel simultaneously is known as Code Division several Access (Esmael D. and Aleksey K. 2016). Since CDMA One, this technology has advanced to 3G, and CDMA2000 1x is currently one of the IMT-2000 3G standards. The CDMA2000 specifications are being implemented in two phases. In the first phase, the CDMA2000 still uses the spread spectrum rate CDMA, which is 1 × 1.2288 Mbps. One carrier has a bandwidth of 1.25 MHz. It makes use of DS spread spectrum technology, often known as DS-CDMA. Another name for the first-phase CDMA2000 system is CDMA20001x. The spread spectrum rate in the second phase is 3 × /6 × /9 × /12 × 1.2288 Mbps, which takes up 5/10/12/15 MHz of bandwidth, appropriately. It makes use of multi-carrier modulation technology, or MC-CDMA. CDMA2000 3X is another name for the second-phase CDMA2000 system. Additionally, the 1xEVDO Rev A, an enhanced standard supplemental to IS-2000, supports data transmission up to 3.1 Mbps in a 1.25 MHz bandwidth. The frequency and timing are not specific to any one user; all CDMA users share the same frequency at the same moment. CDMA coding is used to distinguish users. Adjacent users are the main cause of CDMA interference. The Forward Link (also called the Down Link) from Base Station (BS) to Mobile Station (MS) and the Reverse Link (also called the Up Link) from Mobile Station to Base Station are the two 1.25 MHz-wide channels that comprise the CDMA physical layer. Each channel has a unique identification that is determined by mathematical codes. The code channels in the Forward Link are Pilot, Synchronous, Paging, and Forward Traffic Channels (Mel Menke, 2019). The code channels in the Reverse Link are Access and Reverse Traffic Channels. With CDMA, the spread spectrum concept and process gain are used to boost the number of users per frequency band. The operating frequency spectrum of the CDMA2000 is divided into eight band classes according to the IS-2000.

Recent years have seen an increase in the use of wide-band services, such as wireless networks, for video conferences and video phones. As a result, networks are quickly transitioning from voice-only networks to multi-service networks, which are able to support a wide variety of services with various traffic patterns. Improved bandwidth allocation is a critical requirement for the viability of next-generation cellular networks. Supporting a large number of services with different traffic patterns and Quality of Service (QoS) requirements is challenging. System-level performance in terms of coverage, capacity, and quality of service is made possible by the exact model for network performance optimization provided by this paper. Among the unique features that CDMA offers are diversity reception, equalization, interleaving, and RAKE receivers. It also makes handoff simple and suppresses rapid fading. One of CDMA's unique characteristics is its universal frequency reuse factor, which makes it simple for mobile devices to move between cells. Traditional cellular systems must halt communication with their current base station before establishing a new connection with the new one. For analytical purposes, a normal zone and a soft handoff region are usually defined. The base station in the current cell controls the power for mobile stations in the usual zone, but two or more base stations can control the power for mobile stations in the soft handoff region. During the soft handoff procedure, the base stations individually and first decode the signal they receive from the mobile station. After receiving the data from the base stations, the mobile switching center prioritizes the base station with the strongest signal. The signals from several base stations on the forward link are combined by the mobile station (Joseph Shapira, 2014).

Performance is enhanced when the mobile station combines all of the different multipath signals to strengthen the received signals. Figure 1 shows a typical CDMA network with soft handoff and a normal region. (Michael J., 2016). Today, in cellular networks, poor network services exist among the subscribers. This is due to multipath fading signal, interference, attenuation, and reflections. In solving this problem, there is a need to constantly optimize the networks to minimize traffic growth and signal degradation. The proposed work has a specific objective to ensure that the radio parameters are maintained at their standard thresholds after the optimization of the network to enhance the network. Optimization after network errors is to correct the network errors, which results in improved network capacity, enhanced coverage, and quality of service.

The 3G 900MHz network is a widely used cellular technology providing mobile broadband services. Optimizing its performance is crucial for ensuring reliable coverage, high data speeds, and a quality user experience. This analysis focuses on radio parameters affecting 3G 900 MHz network performance. The 3G 900MHz network faces challenges such as: Poor coverage and indoor penetration, interference from neighboring cells or external sources, insufficient network capacity, and suboptimal handover performance. These issues lead to dropped calls, slow data speeds, and poor user experience. The objectives of this study include:

(1) To evaluate and analyze the signal strength and quality parameters (RSCP, RSSI, Eb/No, Eb/Ic, CSSR, CDR, HOSR, FFER) in the investigative sites

(2) To identify areas of worst, good, poor, and fair network performance

(3) To provide recommendations for optimizing network parameters to enhance coverage and QoS.

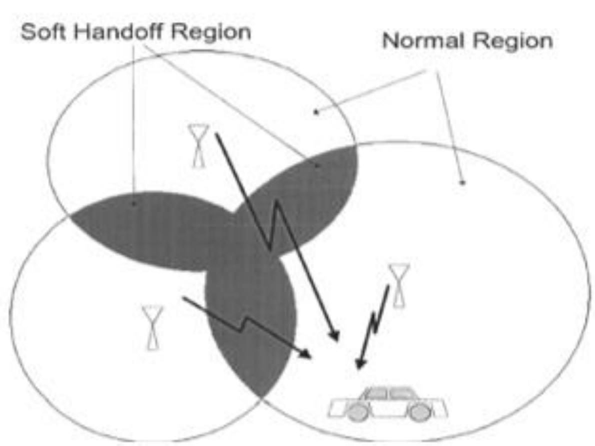

Fig 1: CDMA network coverage specifying the handoff and normal regions

2. Radio Parameters

The radio parameters considered are (Myron D., 2016)

i) Forward link received power level (RSCP): According to the protocol specification TIA/EIA-98-C, the threshold of this parameter is -101dBm.
ii) (ii)Reverse link needed MS transmit power (Tx): The maximum required transmit power for a reverse link is 24 dBm (250 mW). In networks, like CDMA networks, cell coverage is limited by the maximum power broadcast by the mobile station; in other words, a cell's coverage radius is reverse link constrained.
iii) Ec/Io for downlink pilots: The percentage of energy generated by each pilot of to total energy received. Qualcomm recommends an Ec/Io threshold of -15 dB. If Ec/Io is -15dB, dropped or unsuccessful calls may occur.
iv) The Forward Frame Error Rate (FFER): This is the average frame error of each transmitted frame. The link data rate can be used to modify the frame error rate of the forward link. When the data rate is low, as in the case of speech, the FER can be changed to a lower value; when the data rate is increasing, it can be changed to a higher value, such as 5%.
v) (v). The Received Signal Strength Indicator (RSSI): RSSI values are crucial to CDMA systems' reverse link. The main and diversity antenna value differences shouldn't be more than -1.05 dBm, and the average RSSI value under various load scenarios should be between -90dBm and -113dBm.
vi) (vi) Call Setup Success Rate (CSSR): This figure evaluates the ease of setting up or establishing calls. The value increases with the ease of setting up a call. For this metric, the Nigeria Communications Commission (NCC) has set a standard that is at least 98% of attempted calls.

vii) vii. Call Drop Rate (CDR): This measure evaluates a network's ability to maintain a call after it has been established or started. For this indication, the NCC set a baseline of 2% or less.

The summary of the radio parameters is shown in Table 1

Table 1: Radio Parameters Thresholds

Parameters	Good Performance	Fair Performance	Poor Performance	Unacceptable performance
RSCP	-80dBm to -70dBm	-90dBm to -80dBm	-100dBm to -90dBm	< -100dBm
Ec/Io	≥-6dB to -3 dB	-8dB to-6 dB	-10dB to- 8dB	-12dB to12d B
Ec/No	≥6-8dB	3-6dB	0-3dB	<0dB
FFER	≤ 1-2%	2-5%	>5%	>7%
RSSI	-70dBm to -50dBm	-80dBm to -70dBm	-90dBm to -80dBm	≤ -100dBm
CSSR	≥98%	95-98%	90-95%	< 90%
CDR	≤ 2%	2-5%	5-10%	.>10%
HOSR	≥ 95%	90-95%	85-90%	<85%

3. Materials and Method

3.1 Materials

The materials used and their functions in this work are summarized in Table 2. The system specification is shown in Table 3

Table 2: Measurement Tools

Name	Function	Set
Software	Dingli Panorama	**1**
Dingli Panorama	Drive Test/ Post-Processing	1
Test mobiles	Samsung x199	2
Car	Drive Test	1
GPS	Drive Test	1
Laptop	Drive Test	1
Simulation Tool	TEMS Discovery, Map Info, Excel, cell Planner, Network simulation software: ICS Telecom	5

3.1.1 System Specifications

Table 3: System Specification

Parameters	Value
Network	3G
Carrier Frequency	900MHz
Grade of Service (GOS)	3%
Spread Bandwidth:	1.2288MHz
Data Rate:	9.6-153.6 kbps
Process Gain:	21dB
Terminal Noise	8dB
Min. Transmit Power	-50
Transmitter Power:	24dBm
Antenna Gain	15 dBi/directional
Feederloss:	2-5 dB

Demodulator's Eb/No:	3.5 dB (For 9.6kps RC3)
Noise Figure of Receiver:	3.2 dB
Gain of Antenna:	2 dBm
Body Loss	0 dB
Shadow Fading Standard Deviation σ:	8 dB
Soft-Handoff Gain	3.7 dB
the error/user during peak hours	0.1
volts. Probability of boundary coverage	76%
outdoor coverage in an urban location	91%.
system load factor	50%
data and voice service	32% and 71% voice

3.1.2: Test Bed Environment

The investigative networks were located in Lagos State, Nigeria, which is at a longitude and latitude of 3.406448 and 6.46542, respectively. Due to the need for more network optimization in Lagos State of Nigeria, sixteen 3G 900MHz base station sites were involved in the investigation. The base station configurations are S1/1/1, with a frequency of the 900 MHz band. The list of the base station sites, their coordinates, and configurations is listed in Table 5.

Table 5: Longitude and Latitude of Sixteen 3G 900MHz sites

BTS Name	Longitude(°)	Latitude (°)	BTS Configuration
LAG001	3.406448	6.46542	S1/1/1
LAG002	3.46147	6.45820	S1/1/1
LAG 003	3.41257	6.49567	S1/1/1
LAG 005	3.42346	6.42187	S1/1/1
LAG 006	3.41237	6.43672	S1/1/1
LAG 007	3.48321	6.45314	S1/1/1
LAG 008	3.40345	6.43921	S1/1/1
LAG 009	3.44646	6.40293	S1/1/1
LAG 010	3.45785	6.48149	S1/1/1
LAG 011	3.47486	6.41326	S/1/1/1
LAG 012	3.41993	6.40883	S1/1/1
LAG 013	3.48673	6.48932	S1/1/1
LAG 014	3.48345	6.43541	S1/1/1
LAG 015	3.47562	6.45432	S1/1/1
LAG 016	3.43693	11.8253	S1/1/1

3.1.3 Procedure for Data Collection

The Qualcomm 3G test mobile station and a set of GPS-enabled drive test devices were installed in the test car. A suitable computer with the program software Pilot Panorama installed was used for a drive test. The network analyzer software is useful for processing drive test data, visualizing data, analyzing the data, and identifying network problems for subsequent resolution.

The mobile stations were configured to the Markov long call and short call statuses at full rate. Mobile Station was used to confirm the transmit level (Tx Level), receive level (Rx Level), and downlink pilot (Ec/Io) of the primary pilot. The Ec/Io of the primary pilot and Rx level determine the forward coverage range of the system. The transmit power of the MS determines the reverse coverage range.

The pre-optimization drive test in Lagos city was done after the setup. Data were collected from Voice long call – origination of outdoor coverage drive test and Voice short call-origination of outdoor coverage drive test. This is shown in Table 6 and Table 7 respectively.

The RSCP, RSSI, Ec/Io, Ec/No, FFER, CSSR, CDR, HOSR data before optimization were pulled from the M2000 server. In Figure 2, the interconnection of various measurement units is shown.

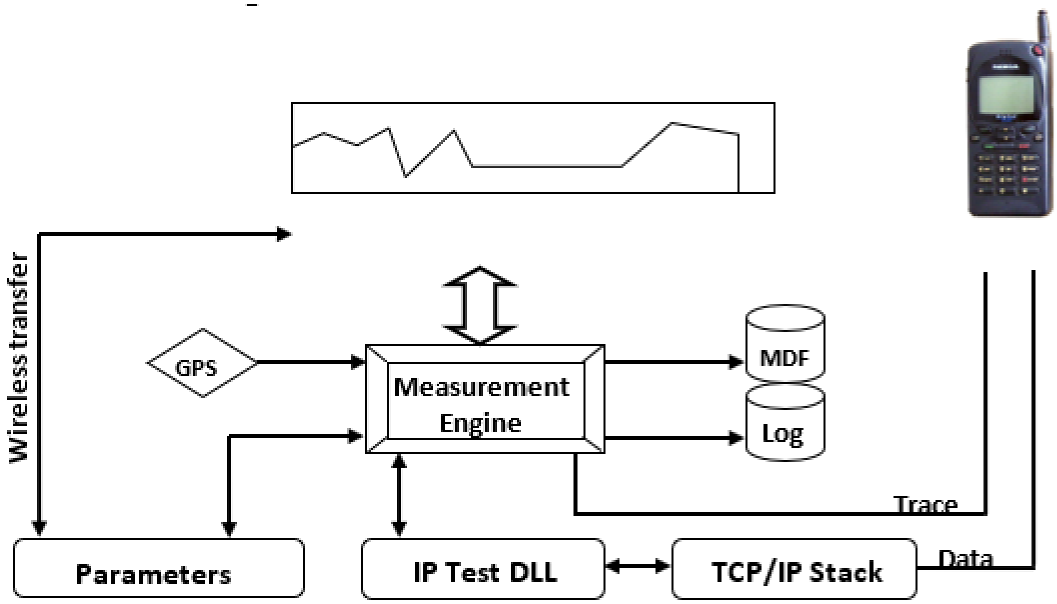

Figure 2: Block diagram showing Interconnections of Equipment

i. **Voice Long Call from Outdoor Drive Test**

Table 6: Case of Long Call

Prerequisites	MS is ok. Test laptop with Dingli software installed Select the test routes
Duration	300min
Action	Connect the ms and GPS to the computer, and make sure it's ok. Start Dingli application software. Start logging at the mobile station Reception the call automatically. Highlight the Original call Service option: Markov Call setup timer: 10s Conversation timer: 99999s Call tears down timer: 5s Pause timer: 5s Redial while drop: Yes (checked) Start driving test follows the selected route 300 minutes later, end the call. End logging at the mobile terminal, and record the mobile log. Finish the Voice Long call- Reception of Outdoor Coverage Drive Test
Cleanup	Release the call

ii.Voice Short Call Origination of Outdoor Coverage Drive Test

Table 7: Case of Short Call

Prerequisites	MS is ok. Test the laptop with Dingli software installed Select the test routes
Duration	300min
Action	Connect the MS and GPS to the computer, and make sure it's ok. Start the Dingli application software. Start logging at the mobile station Receive the call automatically. Highlight the Original call Service option: EVRC Call setup timer: 10s Conversation timer: 30s Call tears down timer: 5s Pause timer: 5s Redial while drop: Yes (checked) Start driving test follows the selected route 300 minutes later, end the call. End logging at the mobile terminal, and record the mobile log. Finish the Voice S call- Reception of Outdoor Drive Test
Cleanup	Release call

3.1.4 Antenna Choice and Azimuth Setting

1. **Selecting an antenna**

Site type, the density of BTS and their relative placements, the area's density, and other considerations should all be taken into consideration when choosing a BTS antenna. When selecting antennas, the following guidelines should be followed:

Beamed antennas with a small half-power angle can be used to lessen interference in crowded situations.

Beamed antennas with a strong gain value and a wide half-power angle can be used in rural and suburban areas to improve coverage; diversity antennas are typically used in suburban or rural areas, whereas dipolar antennas are typically used in city zones.

2. **Setting the azimuth**

With site placements and azimuths forming a network topological structure, choose the appropriate azimuth based on several parameters, including topography and physiognomy, antenna type, and site relative position.

3.2 Simulation for 900MHZ 3G Radio Network Planning

Table 8: Simulation Software Input

Basic Parameters	Value
Frequency	900MHz
Digital map solution	Planet 20m
Minimum transmit power of terminal (dBm)	-50
Maximum transmit power of terminal (dBm)	24
Noise figure of terminal (dB)	8
Nominal rate	9.6K
Correct Loss for terminal (dB)	0.3

Antenna gain of terminal (dB)	2
Antenna height of terminal (m)	1.5
Maximum Power (dBm)	43
Pilot power (dBm)	36
Synchronous power (dBm)	26
Paging power (dBm)	34.5
Directional antenna gain of BTB (dB1)	15
Antenna height of BTS (m)	According to each lower height
Feeder cable length in BTS (m)	According to the lower height
Feeder loss per meter (dBm)	0.027
Connector reception loss (dBm)	0.3
Connector transmission loss (dB)	0.3
Noise figure of BTS (dB)	3.2
Reverse noise floor connection (dB)	0
Area margin coverage probability	90%
Interference margin (dB)	5.5
Reverse system load	50%
Overhead CE/cell downlink	4
Overhead CE/cell uplink	1
Voice activity factor	0.4
Data activity factor	1

Simulation Parameters are shown in Table 8. The simulation for 900 MHz 3G network planning uses computers to estimate the coverage effect of the existing BTS sites and the propagation of signals in the current environment, based on digital maps and radio propagation models. The following are the goals of the simulation:
The following is the simulation process:

1. Enter site location data, wireless parameters (transmitting power, antenna height, down tilt, antenna type, etc.).
2. Import a digital map with vector data, altitude, and physiognomy.
3. 3. Choose the appropriate model for each site based on its location.
4. Run a simulation to examine the coverage of the pilot, forward link, reverse link, and other parameters. The simulation's output ought to accurately depict the region's coverage situation.
5. To determine whether the outcome is satisfactory, first alter the wireless parameters for the region that is having issues in the simulation, such as azimuth, down tilt, antenna height, and antenna type of corresponding sites. After that, move the site until the outcome satisfies the capacity and coverage requirements.
6. Provide the wireless design specifications that can direct the engineering process.

4. Results and Discussion

4.1: Results

The result of the data for pre-optimization is shown in Table 9, and the key performance indicator data after optimization is shown in Figure 10.

Site Name	Start Time	Sector	RSCP	RSSI	Eb/No	Eb/Io	CSSR	CDR	HOSR	FFER
LAG001	01/04/2025	1	-110.21	-90.01	2.53	-9.68	89.34	11.65	72	1.50

	20:00:00									
LAG002	01/04/2025 20:00:00	1	-115.52	-82.98	0.16	-10.21	87.97	10.65	95	7.6
LAG003	01/04/2025 20:00:00	1	-92.10	-90.98	2.5	-15.41	86.17	13.32	96	8.7
LAG004	01/04/2025 20:00:00	1	-93.40	-100.56	2.5	-13.01	87.20	14.78	86	6.2
LAG005	20:00:00	1	-94.56	-111.24	6	-9.25	93.76	9.32	86	5.32
LAG006	01/04/2025 20:00:00	1	-98.16	-95.24	5	-10.45	87.34	12.67	84	5.49
LAG 007	01/04/2025 20:00:00	1	-98.26	-101.56	4	-13.25	92.45	6.00	87	6.27
LAG 008	01/04/2025 20:00:00	1	-88.24	-117.24	2	-7.91	97.25	2.4	96	6.21
LAG 009	01/04/2025 20:00:00	1	-89.20	-127.00	6	-2.93	99.25	2.68	96	7.21
LAG 010	01/04/2025 20:00:00	1	-89.34	-113.00	7	-5.49	98.34	23.91	97	6.2
LAG 011	01/04/2025 20:00:00	1	-94.21	-112.52	6	-3.49	97.25	4.671	87	6.5
LAG 012	01/04/2025 20:00:00	1	-98.25	-97.12	7	-4.43	96.88	6.79	86	5.6
LAG 013	01/04/2025 20:00:00	1	-96.41	-85.62	6	-5.25	98.34	8.72	87	5.7
LAG 014	01/04/2025 20:00:00	1	-74.18	-92.74	2	-3.35	99.26	8.19	88	5.7
LAG 015	01/04/2025 20:00:00	1	-78.21	-94.46	2	-5.55	100.00	15.00	89	5.1
LAG 016	01/04/2025 20:00:00	1	-69.97	-99.65	2	-6.25	96.25	16.00	90	6.1

Table 9: Data before optimization

Table 10: Key performance indicator data after optimization

Site Name	Start Time	Sector	RSCP	RSSI	Eb/No	Eb/Io	CSSR	CDR	HOSR	FFER
LAG001	01/04/2025 20:00:00	1	-68.65	-90.01	6.37	-4.68	98.23	2.46	97	1.50
LAG002	01/04/2025 20:00:00	1	-88.26	-82.98	7.16	-2.21	99.32	2.97	96	2.3
LAG003	01/04/2025 20:00:00	1	-87.54	-90.98	6.25	-.4.56	99.34	1.98	97	3.5
LAG004	01/04/2025 20:00:00	1	-74.98	-100.56	6.52	-4.06	97.45	2.87	98	2.6
LAG005	20:00:00	1	-84.65	-111.24	6.78	-7.25	98.23	2.57	99	3.4
LAG006	01/04/2025 20:00:00	1	-98.16	-95.24	8.93	-5.45	95.87	2.67	98	2.8
LAG 007	01/04/2025 20:00:00	1	-88.52	-101.56	8.89	-3.27	96.45	2.00	98	61.64
LAG 008	01/04/2025 20:00:00	1	-88.24	-117.24	7.56	-5.89	99.25	2.4	96	1.68
LAG 009	01/04/2025 20:00:00	1	-89.20	-127.00	.6.56	-2.93	98.25	2.68	96	2.78
LAG 010	01/04/2025	1	-89.34	-113.00	7.97	-5.49	97.43	2.18	97	2.89

	20:00:00									
LAG 011	01/04/2025 20:00:00	1	-84.96	-112.52	6.10	-3.49	97.25	2.66	98	2.82
LAG 012	01/04/2025 20:00:00	1	-72.25	-97.12	7.56	-4.43	98.68	2..22	96	1.56
LAG 013	01/04/2025 20:00:00	1	-76.41	-85.62	6.78	-5.25	98.34	1.68	97	2.7
LAG 014	01/04/2025 20:00:00	1	-74.18	-92.74	7.88	-3.35	98.62	3.27	97	3.2
LAG 015	01/04/2025 20:00:00	1	-78.21	-94.46	8.45	-5.55	98.00	2.80	98	1.23
LAG 016	01/04/2025 20:00:00	1	-69.97	-99.65	7.80	-1.45	96.25	2.89	96	2.44

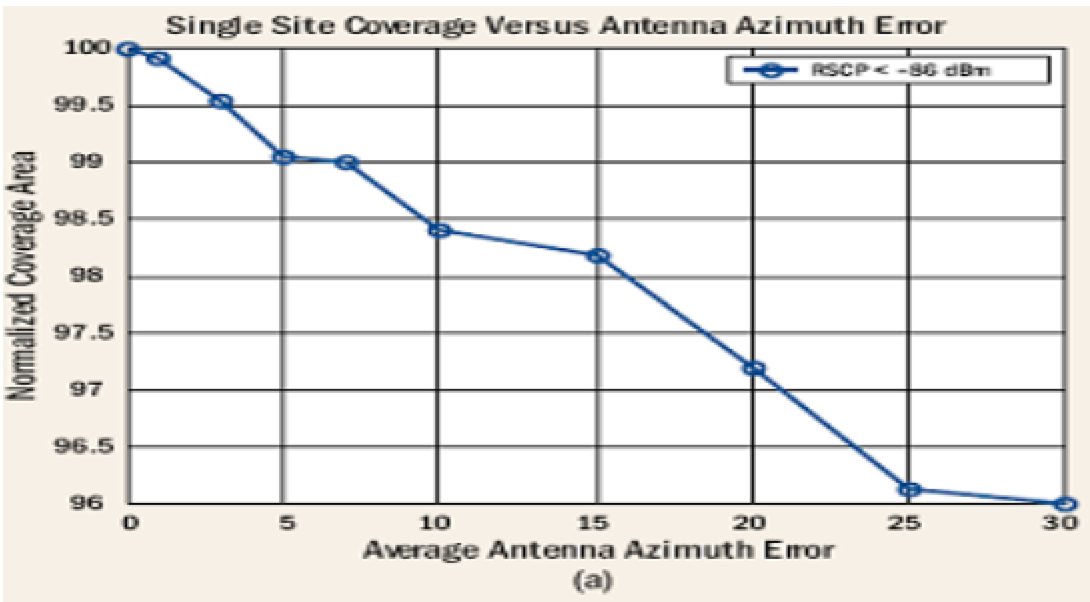

Fig 4: Average antenna azimuth error

4.2 Discussion

The results shown in Table 9 indicate the average key performance parameter values for Lagos for the sixteen BTS sites for sector 1 recorded during the Busy Hour (BH) before the optimization exercise. The values as observed fell short of the threshold values as explained in detail as follows:

In the result for RSCP, 12.5% experienced the worst-case scenario. The areas are LAG 001 and LAG 002. The result showed that 37.5% coverage area was in good performance. These areas are located in LAG 008, LAG 009, LAG 016, LAG 014, LAG 015, and LAG 016. Also,56.25 % coverage area was in poor performance as witnessed in areas located in LAG 004, LAG 005, LAG 006, LAG 007, LAG 011, LAG 012, and LAG 013. The result showed that 43.75% area was in the worst condition as noticed in LAG 004, LAG 005, LAG 006, LAG 007, LAG 008, LAG 009, and LAG 010. There was 56.24% poor network performance in areas such as LAG 001, LAG 002, LAG 003, LAG 006, LAG 012, LAG 013, LAG 014, LAG 015, and LAG 016. The Eb/No values showed 43.75 % coverage areas witnessed poor network performance as evident in sites located in LAG 001, LAG 003, LAG 004, LAG 007, LAG 008, LAG 014, LAG 015, LAG 016. Also,31.25% areas have a good network, as noticed in LAG 009. LAG 010, LAG 011, LAG 012, and LAG 013. The results of Eb/Eb also showed that 18.75% of coverage areas witnessed fair performance as indicated in LAG 005, LAG 006, and LAG 007. An unacceptable network of 6% is noticed in LAG 002. The result of Eb/Io showed that 43.75 % of the area was in the worst network performance. These areas are located in LAG 001, LAG 002, LAG 003, LAG 004, LAG 006, and LAG 007. 43.75 % coverage area witnessed good network performance: LAG 008, LAG 010, LAG 011, LAG 012, LAG 013, LAG 014, LAG 015. The 12.5% fair network performance is witnessed in areas such as LAG 008, LAG 006. The remaining 12.5% of poor networks exist in areas like LAG 005 and LAG 007. The CSSR results showed that 43% of the area noticed no network performance, as witnessed in areas like LAG 001, LAG 002, LAG 003, LAG 004, LAG 006, LAG 007, and LAG 016. 31% has good network performance as shown in LAG 009, LAG 013, LAG 015, LAG 009. The 25% coverage area has fair network LAG 008, LAG 010, LAG 011, and LAG 012. The 13% coverage area has a poor network. The CDR result showed that 50% of the area has no network (LAG 001, LAG 002, LAG 003, LAG 004, LAG 006, and LAG 007. The 12.5% good network performance was witnessed in LAG 008 and LAG 009. !2.5% also has a fair network (LAG 010 and LAG 011. !8.5% has poor network in areas like LAG 007, LAG 013, LAG 014. The measured data for HOSR indicated that 56.25% of the coverage area has a poor network (LAG 005, LAG 005, LAG 006, LAG 007, LAG 011, LAG 012, LAG 013, LAG 014, LAG 015. 23% has a good network in areas like LAG 003, LAG 008, LAG 09, and LAG 010. Also, fair performance is in areas like LAG 002 and LAG 016. The Azimuth values and downtilt values for the sixteen sites were LAG 001($6^o/5.5^o$) LAG 002($13^o/5^o$), LAG 003($16^o/7^o$), LAG 004($5^o/8^o$), LAG 005($7^o/3^o$), LAG 006($6^o/2^o$), LAG 007($4^o/3^o$), LAG 008($11^o/6^o$), LAG 009($3^o/3^o$), LAG 010($4^o/6^o$), LAG 011($4^o/3^o$), LAG 012($4^o/5^o$), LAG 013($5^o/6^o$), LAG 014($10^o/7^o$), LAG 015($8^o/4^o$).

After the post-optimization procedure, the data obtained using mainly the antenna adjustment technique, as depicted in Table 10, suggested that the threshold values of all the key performance indicators were maintained.

If the tilt and azimuth faults cause the coverage to vary, the performance and all radio metrics will also change. The tilt and azimuth based on the Ec/Io drive test map were adjusted, as per the optimization process, and all other radio parameters showed positive results. The situation was evident in the network; there was a significant discrepancy between the actual tilt and azimuth value. For this reason, it is imperative to frequently recheck the tilt and azimuth. Network performance can tolerate an azimuth inaccuracy of 6 to 8 degrees. If the azimuth error is more than 10 degrees, performance deterioration becomes apparent. When compared to azimuth variations, network performance is nearly ten times more sensitive to antenna tilt variations.

The RSCP levels improved significantly across most of the test areas, reducing coverage holes and enhancing indoor penetration. The signal quality, Ec/No, improved due to reduced interference and better code. Areas previously suffering from pilot pollution saw measurable improvement. The CSSR increased as signal strength and quality were optimized, especially in edge-cell areas. Optimized handover thresholds and refined neighbor relations led to smoother transitions between cells and fewer dropped or unnecessary handovers. The CDR improved due to improved radio link reliability and handover performance.

5. Conclusion

Network performance is impacted by the system's increasing load over time, which gives rise to frequent checks carrier loads of the network. The quality of the end user experience and network capacity are both impacted by interference, and both are seen as critical problems that must be fixed. To improve the QOS, radio components can be used as a check to modify the parameters. To optimize the radio interface, the parameters' threshold values must be used as performance indicators. Radio interface optimization requires an understanding of the CDMA2000 1x radio interface standards. The role of channels in the setup call and the message can supply one with the reasons behind higher call setup failure and also high call drop rate.

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