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Original Article

Investigation and Analysis of the Quality of Signal Strength of Cellular Networks along Ethiope River Banks

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Abstract - *The quality of signal strength along riverine environments constitutes a vital parameter for ensuring dependable and efficient communication services, particularly in remote or semi-urban regions. This study presents a detailed investigation into the signal strength performance for major Nigerian cellular network providers of MTN, GLO, and Airtel along the banks of the River Ethiope in Delta State, Nigeria. Empirical data were systematically acquired across twenty geo-referenced locations using a GPS-enabled Android handheld device running the GMoN Pro application. Signal measurements were conducted while navigating the riverbanks via a manually operated boat to ensure consistent proximity to the waterway. The study focused on Reference Signal Strength Indicator (RSSI) values, which were analyzed by the Log-Normal Distance Path Loss Model to characterize signal performance with increasing distance. The findings reveal a pronounced degradation in RSSI across all networks beyond 50km, indicating significant signal attenuation at extended distances. MTN exhibited the highest variability in RSSI values, with relatively stronger performance at intermediate distances but marked deterioration beyond 60km. GLO demonstrated sporadic and severe signal drops, particularly pronounced around the 65km mark, suggesting limitations in long-range stability. In contrast, Airtel maintained a comparatively stable RSSI profile across all measured distances, including the 100km range, positioning it as the most reliable network for extended coverage in the study area.*

Keywords *- Cellular Network, Reference Signal Strength Indicator, Base Transceiver Station, River Bank, Signal Measurement.*

1. Introduction

Mobile communication systems have become a crucial part of infrastructure in daily life, especially in regions with limited fixed broadband provision. Mobile data is considered basic to schooling, messaging, business interactions (information retrieval), and emergency communication in grossly underprivileged communities of Nigeria. When the signal is constantly of poor quality or not steady, these services become sporadic calls that get cut off, browsing takes too long, and digital payments or time-sensitive work are not completed, there are real costs for households and small businesses. The wider development literature regularly demonstrates that better internet access can create opportunities for economic growth through productivity improvements, market access, and information flows; chronic connectivity deficits, therefore, could also serve to entrench various local disparities and constrain local welfare. [1]

From an engineering point of view, a lot of "poor network" complaints come from propagation loss and how it interacts with terrain, clutter, and the way base stations are set up. Recent synthesis work on terrestrial path-loss modeling underscores that model appropriateness is significantly contingent upon environmental factors, necessitating localized measurements when morphology diverges from conventional assumptions. [2]**.** This opinion is supported by data from Delta State. Field measurements in Warri that compared received signal strength to propagation models revealed that model–measurement agreement varies with corridor characteristics and that observed signal behavior depends on the local environment [3]. Real-world coverage is uneven even along major routes, as evidenced by measurements along the Warri–Benin highway, which showed persistent spatial variability and distinct inter-operator differences across towns and settlements [4].

However, since "usable internet" depends on packet-level performance factors like latency and packet loss, signal indicators by themselves are unable to fully capture user experience. The reliability of users' ability to browse, stream, attend online classes, or conduct digital transactions is directly impacted by latency and packet loss variations across operators and connection modes, according to recent measurements in Delta State [5]. Furthermore, infrastructure limitations that impact practical access and service continuity often exacerbate connectivity issues in Nigeria. For instance, data from university electronic libraries demonstrates that connectivity issues and power outages lower effective internet availability and compromise the use of digital resources [6]. Another practical limitation is highlighted by related work on charging modules: charging reliability problems in power-constrained settings can lower device uptime and continuous access [7].

The majority of the local literature is focused on urban areas and highway corridors, despite the fact that current studies offer useful measurement evidence for portions of Delta State. For many underserved communities, this results in a persistent gap in place-specific evidence, where users continue to report subpar data service, but the interaction of environmental factors, infrastructure realities, and user access modes is not adequately documented in an integrated manner. The literature still lacks sufficient, locally grounded narratives that connect these technical indicators to the lived consequences of poor connectivity and the larger ecosystem constraints that shape digital access [6], [7]. In particular, previous signal-strength studies establish spatial variability and operator differences [3], [4], and QoS work confirms that latency/packet loss can materially affect real usage [5]. This study presents poor signal strength and unstable mobile data performance as both a measurable engineering problem and a practical constraint on community participation in the digital economy, driven by the environment-sensitive nature of propagation and the importance of dependable connectivity in development [2], [1].

Numerous studies have looked at cellular-network performance by concentrating on received signal strength and user-perceived service quality; however, their scope, measurement methodology, and degree to which their conclusions can be applied to particular localities vary. By empirically comparing six operational networks and clearly connecting Signal Strength (SS) to Quality of Service (QoS), Emeruwa examined the increasingly "epileptic" service experience in Umuahia (Eastern Nigeria) [8].

The study collected SS and QoS measurements concurrently at 30-minute intervals over 24 hours using a GSM/CDMA signal-monitoring application installed on a mobile phone. MATLAB was used for plotting, and SPSS was used for analysis. The findings indicated that the network with the highest mean SS also had the best mean QoS (for example, a reported mean SS of approximately −86 dBμV/m paired with a mean QoS of approximately 41.83% for the top-performing network). Conversely, another network showed a narrower SS range (more stability) despite a lower average strength, which led to the conclusion that GSM networks may display stronger signals in that situation while CDMA networks may be more stable [8].

Extending the focus from multi-network comparison to user-complaint-driven diagnosis, [9]. assessed GSM service quality in a defined Nigerian study environment (Canaan Land/Covenant University) where subscribers reported persistent poor QoS. From an end-user satisfaction standpoint, the authors conducted a drive test and used a smartphone tool (Network Signal Info Professional) to measure and compare signal strength for the four core GSM operators (MTN, Etisalat, Airtel, and Glo), framing the study as a basis for proposals that could improve radio resources, coverage, quality, and capacity in the area. The work is valuable in demonstrating how complaint-driven field measurements can motivate operator-facing recommendations, but it largely emphasizes diagnosis and comparative reporting rather than a deeper statistical treatment of variability across time, location classes, and environmental conditions.

While the above Nigerian studies are primarily centered on received signal metrics and field comparisons, a broader QoS evaluation approach is illustrated by Yitbarek in an LTE context [10]**.** The study analyzed the QoS of a 4G LTE data network in Addis Ababa in response to subscriber complaints, explicitly separating control-plane and user-plane measurements. Control-plane indicators were collected and analyzed using a SEQ Analyst tool, while user-plane indicators (including coverage/quality and throughput measures) were collected using Nemo Handy and analyzed via Actix Analyzer.

The results indicated that some parameters fell below company targets [10]. This two-plane structure enhances diagnostic completeness compared with single-metric signal-strength studies; however, the case still highlights a common challenge in QoS studies: translating multi-KPI findings into localized, repeatable measurement protocols and statistically defensible summaries of variability for specific communities [10].

In parallel, some recent work positions cellular QoS challenges within emerging data-centric network management frameworks. Saeed and Alsharidah discussed how big data and Software-Defined Networking (SDN) are increasingly relevant to wireless cellular networks, noting that the two domains have often been studied independently [11]. Using Welch's method as a central analytical tool, the study argued that spectral density can be enhanced at reduced cost through power spectral estimation, emphasizing noise reduction and improved power spectral density estimation as a pathway toward better QoS management insights. Although this contribution is useful for framing how network-level analytics can support improved QoS, its perspective is more methodological and architectural, and it does not replace the need for grounded, locality-specific field evidence where poor signal strength is the immediate user constraint.

At the device/user edge, Meyyappan et al. presented a cellular network signal-strength analyzer concept and emphasized testing signal resilience under varied conditions by measuring intensity across practical everyday locations (e.g., kitchen, hallway, bedroom, bathroom, terrace, and remote areas) [12]. The paper reinforced the importance of interpreting multiple metrics, RSSI for received power, alongside SNR and SINR for quality under noise and interference, arguing that such measurements help identify weak zones and inform optimization efforts.

However, the work also illustrates a limitation common in many applied signal studies: without a clearly specified sampling design (replication, time windows, stratified site selection), consistent handling of measurement variability, and explicit community-linked implications, results can remain more demonstrative than policy- or intervention-ready for the local economy and daily services.

Taken together, these studies establish that field measurements (static logging and drive tests), multi-network comparisons, and multi-KPI QoS assessment are well-established approaches for investigating poor cellular performance [8], [9], [10]. They also show the growing role of data-driven and analytical frameworks in supporting QoS management at scale [11], and the practical value of multi-metric signal interpretation in real environments [12]. However, a consistent gap across this set is the limited integration of (i) explicitly justified location selection tied to local activity/economic nodes, (ii) a clearly defined measurement frequency and replication plan that supports variability analysis, and (iii) statistical summarization that can distinguish persistent coverage deficits from normal short-term fluctuations. This gap motivates a more structured local study design that couples field measurements with robust variability handling and reporting so that findings can support not only technical diagnosis but also credible, locality-specific recommendations for improving service reliability.

2. Materials and Methods

2.1. Description of the Study Area

River Ethiope originated from a tree on a hill at Umuaja in the Nkwuani Local Government Area of Delta State. The River flows for about 137 km before emptying into the sea. Its geographical coordinates are approximately Latitude: 5.8725° N and Longitude: 6.1708° E. Surrounded by high tropical rainforest vegetation, the area is home to the Urhobo tribe. The population is largely rural, with the communities engaged in farming, fishing, and tourism. The locations include Umuaja Umutu, Umuabi, Ubiaruku, Okolori-Ubiaruku, Abraka River Resort, Abraka Campus 2, Eku town, Ovu-Eku, Okurekpo, Aghalokpe, Jesse, Otogor-Jesse, Mosogar, Onogba-Mosogar, Okirigwe bridge, Sapele, Ebrifo, Oghara bridge, Ogharefe, and Oghareki. There are about 30 BTS along the River Ethiope from Umuaja to Benin River, and the cellular service providers along the river banks are MTN, Globacom, Airtel, and 9mobile, with operating frequency ranges from 1800 to 2600 MHz.

To ensure representative coverage along the River Ethiope corridor, twenty (20) geo-referenced measurement locations were selected and coded as L1–L20, spanning the riverbank communities along the study route. The points were chosen to reflect the main inhabited/active locations along the river corridor and to provide broad spatial coverage from the source region toward downstream areas. The measurement locations were spaced at approximately 5 km intervals, covering a range of about 5 km to 100 km along the route, as indicated by the location–distance coding used in the study (L1 = 5 km, L20 = 100 km).

Figure 1 is the captured Google map of the River Ethiope, while Figure 2 is a photo shot of one of the banks of the River close to its source at Umutu in Nkwuani Local Government Area of Delta State.

Fig. 1 Google map area of the River Ethiope

Fig. 2 Photo shot at the bank of the River Ethiope at Umutu

2.2. Survey and Data Collection

A field survey was conducted from the source of River Ethiope at Umuaja, and data was collected for twenty (20) selected locations using three handsets equipped with G-MoN Pro application software for selected service providers of MTN, Globacom, and Airtel operating at a frequency of 1800 MHz and transmitting power of 40, 40, and 38 Watts, separately. The data are the RSSI at each location for the three service providers. Tables 1–4 present the data collected for twenty locations with identified communities coded as L1–L20. Measurement frequency (repeat readings per location): At each coded location (L1–L20), RSSI measurements were recorded repeatedly to capture short-term variations and reduce random fluctuations due to fading. As reflected in the experimental RSSI tables, twenty (20) RSSI readings were logged per location for each network (example shown for L1), and these readings formed the dataset used for the subsequent analysis.

Table 1. Location Code for twenty selected communities along the Ethiope River

Location (Code)	Approximate Distance (km)	Location (Tdentity)
L1	5	Umutu
L2	10	Umuabi
L3	15	Ubiaruku
L4	20	Okolori-Ubiaruku
L5	25	Abraka River Resort
L6	30	Abraka Campus 2
L7	35	Eku
L8	40	Ovu-Eku
L9	45	Okurekpo
L10	50	Aghalokpe
L11	55	Jesse
L12	60	Otogor-Jesse
L13	65	Mosogar
L14	70	Onogba-Mosogar
L15	75	Ebrifo
L16	80	Okirigwe_Bridge
L17	85	Oghara Bridge
L18	90	Ogharefe
L19	95	Oghareki
L20	100	Sapele Market

The above data were subject to analysis for the computation of average RSSI (γ) for the twenty locations by the adoption of the [13] model presented in equation 8.

$$\gamma = \sum_{L1}^{L20} \frac{\rho\Re}{\eta}\chi^2$$

Where:
L1- L20 = Locations Codes
R= Interval of 5km
X= RSSI at each location of Mtn, Glo, or Airtel
ή= number of locations (20)
p= Power of Network Service Provider (40W for Mtn, 40W for Glo or 38W for Airtel)

2.3. Developed Models

Various mathematical models have been developed for the determination of path losses that affect signal strength in wireless communications. These models are classified into two major concepts that comprise the log-distance and Log-normal shadowing.

2.3.1. Path-Loss Estimation Using the Log-Distance Concept

This model uses the logarithmic decay with distance to forecast signal intensity while taking environmental factors and distance into account. The particular path loss characteristic for different distances between the transmitter and receiver is represented by the exponent path loss (n) [14]. Equation 1 is its concept representation.

$$L_P(d_i) = L_P(d_0) + 10n \log\left(\frac{d_i}{d_0}\right) \quad (1)$$

Where
d_0 represents initial distance, d_i represents flexible distance from original point, n is the exponent of the path-loss, $L_p(d_0)$ represents path-loss measured, and $L_p(d_i)$ represents path loss predicted.

Equation 2 is the exponent path-loss (n), an empirically obtained constant that depends on the propagation environment's properties.

$$n = \frac{\{L_P(d_i) - L_P(d_0)\}}{10 \log_{10}\left(\frac{d_i}{d_0}\right)} \quad (2)$$

Linear regression analysis can be used to statistically determine the exponent path loss; in this case, Equation 3 is the sum of the mean square error.

$$n = \frac{\sum_{i=1}^{Ni} \{L_P(d_i) - L_P(d_0)\}}{\sum_{i=1}^{Ni} 10 \log_{10}\left(\frac{d_i}{d_0}\right)} \quad (3)$$

Where $L_p(d_i)$ represents Path Loss Predicted, $L_p(d_0)$ represents Path Loss measured, and Ni represents the number of measured data or sample points. The expression, $L_p(d_i) - L_p(d_0)$, is an error term with respect to n, and the sum of mean squared error, e(n), is expressed in Equation 4.

$$e(n) = \sum_{i=1}^{Ni} [L_P(d_i) - L_P(d_0)]^2 \quad (4)$$

Equation 5 is the value of the exponent path-loss (n), which is the minimized Mean Squared Error (MSE),

$$\frac{\partial e(n)}{\partial n} = 0 \quad (5)$$

2.3.2. Path-Loss's Log-Normal Shadowing Idea

This model takes random shadowing effects from barriers into account when predicting signal attenuation for mobile communication.

The received signal power is assumed to have a log-normal distribution, reflecting variations in signal strength with shadowing factors [15]. The model representation is found in Equation 6.

$$L_P(d) = L_P(d_0) + 10n \log\left(\frac{d_i}{d_0}\right) + \sigma\rho \quad (6)$$

The shadowing factor (σρ) is expressed in Equation 7,

$$\sigma\rho = \sqrt{\sum \frac{[(L_P(d_i) - L_P(d_0)]^2}{Ni}} \quad (7)$$

Where
Ni is the number of measured points. $L_p(d_0)$ is the measured path loss, and $L_p(di)$ is the predicted path loss.

3. Results

The results obtained for each location along the river banks involved an analytical computation of average RSSI for the three networks by programming the Excel tool in Microsoft Office. As presented in Figure 3.

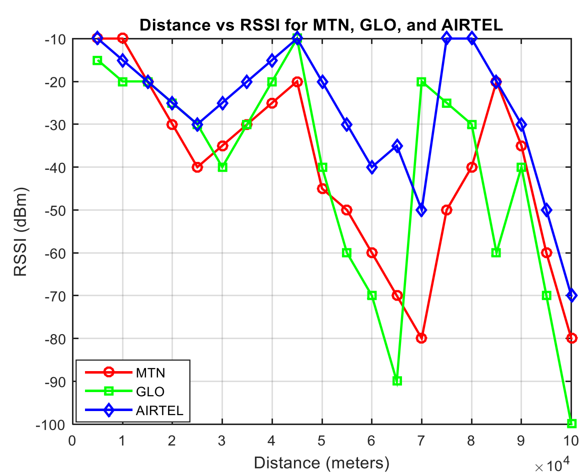

Fig. 3 Location Average RSSI

4. Discussion

The plots represent the Received Signal Strength Indicator (RSSI) in dBm as a function of distance (meters) for three different network providers. Observation shows that RSSI decreases with an increase in distance for the three networks. This is expected because, as the distance from the transmitter increases, the signal weakens due to path loss and environmental obstructions. The fluctuations in the curves indicate the presence of factors such as multipath fading, obstacles, and interference that affect signal strength with an increase in distance. The MTN (Red Line) was stronger at shorter distances but experienced significant drops in signal strength beyond 50km. It shows more fluctuations, indicating possible interference or changes in terrain affecting the signal. It drops sharply beyond 60,000m, reaching approximately -80 dBm at 100km, suggesting weaker coverage at longer distances. The GLO (Green Line) has a relatively lower signal strength compared to MTN, but follows a similar trend. The most significant drop is around 65km, where the RSSI reaches -90 dBm, indicating a dead zone or high attenuation in that region. The signal fluctuates significantly, suggesting varying propagation conditions. The AIRTEL (Blue Line) shows relatively better signal strength at some points compared to MTN and GLO. The signal is more stable at closer distances and does not drop as sharply beyond 50,000m. The RSSI remains above -70 dBm at longer distances, suggesting slightly better long-distance coverage than the other two networks. Signal Attenuation: All three networks experience a sharp decline in RSSI beyond 50,000m, which suggests that beyond this distance, the signal is significantly weakened. ii. Multipath Effects: The fluctuations in the curves indicate multipath propagation, where signals reflect off surfaces, causing constructive and destructive interference. Network Strength Differences: MTN has the highest variation in RSSI, representing the most unstable network. GLO experiences severe signal drops, particularly around 65km. It shows moderate stability. AIRTEL appears to have the most stable signal, especially at long distances. Table 5 presents a concise comparison of this study with two closely related existing studies, highlighting differences in their claims, methods, and key findings.

Table 5. Comparison with Existing Work

Study	Claim/focus	Method	Key Result
Evans, Dominic, & Esin (2017)	GSM variability along the Oron Calabar waterway (safety/coverage concern).	Field measurements across operators; variability analysis along the route.	Reports coverage variability and weak “dead” segments along the waterway.
Imoize & Ogunfuwa (2019)	The lagoon environment needs measurement-based propagation modeling at 1800 MHz.	4G LTE drive-test at 1800 MHz; compares models; optimizes COST-231 Hata (RMSE reduction).	The optimized model fits the lagoon pathloss better than baseline models.
My Research	Compare MTN/GLO/Airtel signal strength along the River Ethiope riverbanks and identify the best stability.	20 geo-referenced locations (L1–L20); RSSI via GMoN Pro; boat-based riverbank survey; Log-normal distance path-loss analysis.	Airtel is most stable to 100 km; MTN drops after 60 km; GLO severely drops around 65 km.

These findings have direct implications for residents, tourists, and businesses operating along the River Ethiope corridor, where stable connectivity supports communication, online transactions, emergency reporting, and day-to-day digital services. In particular, areas beyond 60,000 m where performance degrades are more likely to experience call drops, slow data rates, and unreliable connectivity, which can reduce productivity and limit access to digital services. To improve service quality along weak-coverage segments, network operators can implement targeted interventions such as: (i) optimizing existing BTS parameters (antenna tilt/azimuth adjustments and power optimization), (ii) adding infill sites or small cells in identified low-signal zones and at key activity nodes (river resorts, bridges, and community clusters), (iii) upgrading backhaul capacity where congestion contributes to perceived poor service, and (iv) adopting continuous drive-test/field-monitoring programs to update coverage maps and guide evidence-based network planning. Overall, the study provides a practical baseline for regulator–operator planning to strengthen coverage reliability along the River Ethiope route. Ethical considerations were observed during data collection by ensuring that measurements were limited to network signal metrics (RSSI) only, with no access to personal communications, message contents, call recordings, or subscriber-identifying information. Measurements were conducted in public-access areas without interfering with network operations, and results are reported at an aggregated/location-coded level (L1–L20) to avoid exposing sensitive personal or household-level information. Fieldwork was also carried out with attention to safety and minimal disruption to local communities.

5. Conclusion

Overall, RSSI measurements along the River Ethiope banks show that signal strength generally degrades with distance, with noticeable attenuation beyond ~50 km. Airtel maintained the most consistent coverage up to 100 km, while MTN showed higher variability and sharper deterioration beyond ~60 km, and GLO experienced severe drops around ~65 km. These results provide location-based evidence to guide targeted network optimization and infill deployments in the identified weak-coverage segments.

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Conflict of Interest

The authors declare no conflict of interest.

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Appendix

Table 2. Experimental Test Bed for RSSI (dBm) for MTN Network

Code	Reference Signal Strength Indicator (RSSI) in dBm																			
L1	-42	-44	-46	-48	-50	-52	-54	-56	-58	-60	-62	-64	-67	-70	-80	-89	-91	-94	-97	-100
L 2	-44	-43	-48	-50	-56	-55	-58	-67	-65	-72	-76	-85	-81	-84	-84	-88	-88	-97	-99	-103
L 3	-40	-44	-50	-52	-60	-56	-61	-68	-68	-71	-78	-80	-82	-85	-89	-90	-96	-96	-97	-98
L4	-42	-40	-51	-53	-54	-58	-63	-69	-71	-74	-79	-78	-79	-87	-90	-93	-92	-98	-97	-99
L 5	-40	-43	-52	-54	-53	-60	-62	-65	-70	-72	-75	-86	-80	-86	-92	-90	-92	-94	-	-98
L 6	-42	-42	-51	-50	-60	-57	-64	-65	-68	-73	-76	-87	-87	-83	-94	-92	-94	-98	-99	-100
L 7	-40	-40	-52	-54	-56	-60	-63	-66	-66	-68	-75	-84	-85	-78	-95	-94	-96	-93	-98	-98
L 8	-41	-44	-50	-53	-58	-56	-62	-64	-67	-74	-76	-87	-83	-85	-97	-95	-94	-97	-99	-100
L9	-42	-40	-52	-50	-57	-58	-64	-64	-65	-68	-74	-86	-88	-88	-95	-92	-96	-93	-98	-98
L 10	-41	-42	-53	-53	-56	-57	-63	-64	-66	-72	-76	-78	-84	-87	-96	-90	-94	-96	-97	-100
L 11	-40	-44	-51	-54	-59	-56	--59	-67	--68	-74	-74	-80	-81	-85	-97	-89	-93	-94	-99	-98
L 12	-42	-43	-49	-52	-54	-61	-62	-66	-67	-73	-73	-77	-80	-79	-89	-96	-94	-96	-97	-100
L 13	-42	-41	-48	-54	-56	-58	-61	-65	-66	-71	-75	-78	-81	-85	-88	-90	-92	-94	-	-98
L 14	-43	-42	-52	-49	-54	-60	-63	-67	-67	-70	-75	-80	-86	-87	-90	-93	-89	-97	-99	-100
L 15	-42	-40	-53	-50	-56	-65	-58	-67	-70	-71	-69	-78	-84	-86	-89	-95	-96	-99	-97	-99
L 16	-40	-43	-50	-48	-57	-58	-62	-68	-68	-73	-70	-77	-82	-88	-98	-98	-93	-95	-99	-100
L 17	-41	-41	-53	-49	-57	-57	-64	-71	-68	-68	-75	-78	-87	-87	-90	-90	-95	-97	-98	-98
L 18	-40	-42	-51	-54	-56	-56	-62	-68	-69	-74	-74	-80	-82	-85	-87	-88	-92	-94	-97	-100
L 19	-43	-44	-53	-54	-54	-57	-60	-67	-70	-68	-75	-77	-81	-84	-89	-90	-89	-92	-99	-99
L20	-41	-40	-52	-53	-53	-56	-62	-71	-68	-69	-77	-78	-83	-87	-87	-92	-98	-94	-98	-100

Table 3. Experimental test bed for RSSI (dBm) for Globacom Network

Code	Reference Signal Strength Indicator (RSSI) in dBm																			
L1	-43	-48	-50	-49	-55	-58	-61	-65	-66	-75	-77	-78	-79	-83	-85	-87	-90	-93	-96	-99
L2	-44	-47	-51	-50	-54	-58	-63	-64	-67	-73	-75	-79	--80	-86	-86	-89	-93	-96	-98	-97
L 3	-45	-48	-49	-50	-52	-58	-64	-64	-69	-76	-76	-75	-81	-84	-84	-88	-85	-99	-85	-96
L 4	-46	-46	-50	-51	-54	-55	-59	-65	-72	-75	-74	-76	-82	-87	-89	-90	-87	-96	-97	-94
L 5	-47	-48	-53	-48	-56	-56	-62	-67	-70	-74	-74	-77	-90	-80	-86	-89	-89	-84	-82	-93
L6	-48	-45	-51	-51	-57	-57	-58	-65	-74	-71	-69	-74	-77	-82	-84	-85	-88	-88	-86	-87
L 7	-45	-47	-50	-49	-54	-56	-60	-62	-66	-74	-75	-75	-79	-85	-85	-84	-87	-85	-84	-99
L 8	-49	-45	-48	-52	-53	-58	-63	-64	-69	-75	-72	-78	-78\	-82	-87	-88	-85	-86	-82	-98
L 9	-50	-43	-50	-50	-56	-56	63	-65	-67	-72	-69	-77	-86	-85	-85	-86	-88	-85	-81	-87
L 10	-45	-49	-49	-52	-49	-58	-59	-66	-70	-70	-74	-79	-85	-84	-87	-85	-87	-87	-83	-98
L 11	-50	-44	-51	-48	-56	-54	-62	-64	-68	-68	-74	-76	-86	-87	-84	-87	-89	-85	-80	-98
L12	-52	-47	-53	-50	-54	-58	-60	-67	-65	-70	-74	-74	-84	-86	-86	-85	-86	-83	-87	-87
L 13	-45	-45	-52	-52	-53	-56	-58	-65	-64	-75	-72	-79	-79	-79	-81	-87	-83	-86	-98	-97
L 14	-43	-48	-48	-48	-49	-58	-61	-63	-69	-68	-74	-77	-80	-88	-82	-83	-87	-89	-96	-88
L 15	-42	-45	-46	-52	-53	-55	-59	-65	-67	-71	-69	-78	-86	-86	-84	-85	-84	-83	-95	-89
L 16	-41	-47	-52	-49	-56	-58	-58	-62	-67	-68	-77	-76	84	-84	-83	-83	-86	-89	-92	-95
L 17	-44	-49	-49	-50	-53	-56	-62	-65	-70	-74	-69	-78	-84	-82	-88	-87	-83	-84	-90	-87
L 18	-41	-45	-44	-53	-53	-58	-64	-67	-72	-71	-70	-75	-84	-89	-86	-85	-87	-88	-98	-88
L 17	-46	-46	-46	-50	-58	-56	-58	-62	-68	68	-76	-79	-86	-80	-84	-83	-83	-86	-94	-87
L 19	-41	-45	-48	-48	-55	-55	-61	-64	-66	-73	-76	-75	-76	-80	-86	-86	-85	-87	-97	-87
L 20	-44	-47	-50	-51	-57	-58	-62	-67	-72	-68	-74	-78	-77	-84	-82	-84	-87	-83	-92	-88

Table 4. Experimental test bed for RSSI (dBm) for Airtel Network

Code	Reference Signal Strength Indicator (RSSI) in dBm																			
L 1	-40	-43	-45	-47	-50	-52	-54	-57	-60	-64	-67	-70	-73	-75	-78	-81	-84	-87	-90	-93
L 2	-39	-42	-48	-46	-52	-54	-56	-67	-68	-67	-68	-74	-76	-77	-87	-84	-87	-90	-93	-86
L 3	-42	-45	-50	-50	-48	-56	-61	-70	-69	-69	-74	-71	-79	-74	-81	-87	-90	-93	-98	-96
L 4	-39	-47	-44	-47	-52	-59	-55	-56	-70	-72	-66	-70	-80	-78	-90	-90	-84	-96	-96	-99
L 5	-43	-46	-46	-45	-49	-60	-62	-67	-59	-68	-68	-69	-71	-80	-83	-90	-87	-99	-84	-96
L 6	-39	-42	-45	-49	-52	-55	-57	-60	-71	-71	-74	-77	-74	-76	-86	-81	-84	-90	-86	-99
L 7	-44	-45	-47	-51	-50	-57	-62	-63	-64	-70	-78	-71	-76	-81	-81	-93	-87	-93	-96	-96
L 8	-41	-43	-45	-50	-51	-60	-70	-64	-61	-73	-66	-76	-72	-75	-89	-83	-85	-84	-93	-99
L 9	-50	-44	-47	-52	-48	-54	-64	-61	-72	-72	-69	-72	-75	-81	-82	-86	-86	-96	-96	-89
L 10	-44	-46	-46	-48	-52	-56	-61	-64	-64	-68	-67	-75	-77	-84	-85	-89	-89	-84	-90	-93
L 11	-41	-44	-47	-47	-49	-59	-58	-65	-71	-67	-69	-74	-79	-86	-87	-83	-87	-93	-93	-95
L 12	-43	-45	-45	-50	-51	-55	-60	-61	-65	-65	-74	-76	-80	-74	-89	-86	-90	-95	-96	-96
L13	-39	-43	-47	-52	-49	-51	-58	-65	-62	-67	-78	-69	-77	-86	-86	-83	-89	-94	-93	-98
L14	-44	-44	-46	-48	-53	-53	-65	-67	-64	-69	-65	-70	-82	-82	-88	-89	-83	-92	-95	-96
L 15	-50	-45	-47	-45	-48	-56	-58	-66	-66	-64	-77	-69	-84	-79	-87	-81	-89	-93	-94	-93
L16	-41	-46	-45	-47	-52	-59	-60	-54	-68	-71	-68	-79	-81	-84	-89	-83	-85	-84	-93	-97
L 17	-40	-42	-46	-49	-51	-52	-59	-55	-64	-64	-78	-70	-78	-80	-86	-85	-90	-90	-93	-93
L 18	-43	-45	-45	-51	-50	-57	-65	-59	-67	-71	-75	-74	-81	-87	-84	-82	-93	-93	-96	-96
L 19	-39	-43	-47	-45	-52	-55	-61	-64	-66	-71	-65	-78	-68	-72	-86	-84	-85	-87	-90	-93
L 20	-42	-46	-45	-47	-51	-57	-64	-60	-62	-64	-69	-70	-77	-89	-89	-88	-93	-84	-96	-98