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Mobility Management: Location Management Principles and Techniques (MTN Communication as a Case Study)

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ABSTRACT

Location management is a fundamental function within mobile telecommunication networks, ensuring seamless connectivity and continuous service availability as users move across geographical zones. This study critically examines the principles and operational techniques of location management using MTN Nigeria, the country's largest mobile operator as a contextual case study. It adopts a systematic literature review approach and integrates empirical data from national regulators and independent crowdsourced platforms, to evaluate MTN's performance in relation to signaling protocols, mobility anchoring, handover success, and user experience outcomes. Results show that MTN consistently meets or exceeds the Nigerian Communications Commission's Quality of Service benchmarks across 2G, 3G, and 4G networks, driven by strategic infrastructure investments and compliance with advanced mobility management protocols such as SS7, Diameter, and GTP. However, findings also reveal persistent infrastructure-related vulnerabilities including fibre cuts, regional disparities, and service outages that diminish real-world user experiences. While MTN leads in domestic performance metrics, Nigeria's low international rankings (121st in 4G/5G quality) highlight systemic gaps that hinder national competitiveness. The study concludes that achieving resilient and intelligent location management in Nigeria requires both operator-level innovation and ecosystem-wide upgrades. It recommends the adoption of predictive, AI-based mobility models and Distributed Mobility Management (DMM) architectures to optimize scalability, responsiveness, and user-centric service delivery.

Keywords: Mobility Management, Location Management, MTN Nigeria, Handover, Signaling, Quality of Service, Mobile Networks, 4G/5G, Nigeria

1.0 Introduction

Mobility management is a foundational component of modern cellular networks, responsible for enabling mobile users to maintain uninterrupted service as they move across different coverage areas. It ensures the continuity of call connections and data sessions, making it a central enabler of mobile communication systems (Phung et al., 2023). As Zaidi et al. (2023) observe, mobility management forms the very core of wireless communication, supporting the ubiquity and diversity of mobile applications. At its core, mobility management encompasses two key functions: location management and handover management (Adelstein, 2005; Darwish et al., 2022). While handover management facilitates the transfer of active sessions between cells, location management is concerned with tracking the position of mobile nodes and ensuring efficient data routing to their current locations (Darwish et al., 2022). This function has grown in importance with the evolution of wireless technologies from GSM to LTE and now to 5G, each demanding more sophisticated and responsive mobility solutions (Siddiqui et al., 2022).

The complexity of mobility management has further intensified with the shift toward 5G heterogeneous networks (HetNets), which support a wide variety of devices, services, and access technologies. These networks require ultra-reliable handovers and dynamic location tracking to sustain performance across dense urban deployments and mission-critical applications (Siddiqui et al., 2022). Effective location management in this context must be proactive, scalable, and resilient to meet the latency and reliability expectations of modern communication systems. As user behavior becomes increasingly dynamic and data-driven, traditional reactive mobility strategies are proving inadequate, prompting a need for adaptive and intelligent management frameworks (Zaidi et al., 2023).

In Nigeria, MTN Nigeria Communications Plc stands as a leading operator in the telecommunications sector and serves as a critical case study for examining mobility management at scale. As of April 2025, MTN accounted for 52% of all active telephony subscribers in the country, with a user base exceeding 90.5 million and more than 50.3 million active data users (Intelpoint, 2025; MTN Nigeria Communications Plc, 2025). The company has nearly doubled its capital expenditure to ₦900 billion in 2025, aiming to enhance network quality in cities like Lagos and Abuja while extending improvements to rural regions in line with its "Ambition 2025" strategy (Channels Television, 2025; Onwuaso, 2025). Despite these substantial investments and strategic commitments to digital inclusion, MTN continues to encounter performance challenges especially in maintaining consistent connectivity as users move across regions.

One of the key issues affecting mobility performance in Nigeria is the frequent occurrence of network disruptions, which affect all major operators, including MTN. These disruptions often caused by fibre cuts, infrastructure vandalism, and unreliable power supply can occur more than 30 times per month and significantly undermine service quality (Nwokoma, 2025; Onyeagoro, 2025; Rapheal, 2025). Furthermore, mobile network operators in Nigeria generally fail to meet 3GPP's recommended latency benchmarks of 30 ms for the user plane and 100 ms for the control plane, hindering the performance of latency-sensitive applications such as video conferencing, online gaming, and real-time sensor communications (Kelechi et al., 2021). Notably, MTN reports the highest service request delay among Nigeria's LTE providers, making it an unsuitable platform for low-latency applications and smart devices that require rapid connectivity setup (Kelechi et al., 2021).

This study seeks to investigate the principles and techniques of location management within MTN Nigeria's operational context, with a focus on how well these mechanisms support seamless connectivity amid infrastructural and environmental challenges. Specifically, the study aims to: (1) identify the core components of effective location management in large-scale mobile networks; (2) assess the impact of network limitations on the performance of these mechanisms; and (3) propose improvements drawn from advanced models such as distributed mobility management or AI-assisted mobility prediction.

The research addresses the following key questions: How do foundational principles like location updating and paging perform within the unique constraints of MTN Nigeria's network? What infrastructural or technical factors most significantly affect their effectiveness? And what adaptive strategies can be implemented to enhance user experience and network responsiveness? The significance of this work spans multiple domains. For telecom engineers and network planners, it offers operational insights into mobility protocol implementation in high-demand environments. For academic researchers, it provides an applied case study of a major African network, highlighting theoretical and practical challenges. For regulators and policymakers, the findings could inform interventions aimed at improving QoS across Nigeria's mobile networks.

This study confines its scope to location management, deliberately excluding handover procedures, which represent a distinct sub-domain of mobility management. Additionally, the analysis is geographically limited to MTN Nigeria's network infrastructure and performance, drawing on contextual data from the Nigerian telecommunications environment.

2.0 Literature Review

Mobility management remains the bedrock of wireless cellular networks, underpinning their ability to offer seamless connectivity to mobile users traversing different cells or radio networks. This critical function ensures that user equipment (UE) or mobile stations (MS) remain continuously connected irrespective of their movement across network domains. As 3GPP (2024, 2025) explains, this continuous connection is essential to maintaining both voice and data services in real-time. Historically, the appeal of mobile networks has rested upon this core capability mobility rendering it the wireless systems. Zaidi et al. (2023) argue that the evolution from 2G to 5G represents not merely a generational leap in speed and capacity but a significant transformation in how networks accommodate and anticipate user movement, adapt to increased device density, and meet demanding Quality of Service (QoS) expectations.

At the heart of mobility management are four interrelated components: handover, roaming, tracking, and paging. Each of these plays a specific role in sustaining continuous connectivity, though their integration also presents significant technical and operational challenges. Handover or handover is perhaps the most technically intensive, as it enables active session continuity when a UE moves from one cell to another. Adelstein (2005) dissects this process into a sequence of tasks including initiation, access point selection, channel allocation, and the rerouting of in-transit data packets. Despite its foundational role, handover procedures have grown increasingly complex in the context of heterogeneous networks (HetNets) and ultra-dense multi-band networks (UDMNs). According to Islam and Chowdhury (2024), these environments introduce variability in radio conditions and increase the frequency of transitions, often at the expense of throughput and latency. Zaidi et al. (2023) underscore this complexity by reporting that traditional HetNets may suffer handover failure rates as high as 60%, nearly double that observed in macro-only networks. These statistics highlight the trade-off between densification and reliability a central tension in modern mobility architectures.

Roaming complements handover by extending network service beyond national boundaries. Sauter (2021) elaborates that when a UE enters a foreign network termed the Visited Public Land Mobile Network (VPLMN) the Mobility Management Entity (MME) initiates a request to the Home Subscriber Server (HSS) to authenticate the user and retrieve their service profile. This typically culminates in the establishment of a home-routed bearer to the Packet Data Network Gateway (P-GW). While effective, this model has been criticized for introducing latency and inefficiencies, particularly in data-intensive applications (Sauter, 2021).

Closely linked to both handover and roaming is location management, which governs how the network tracks and updates UE positions. According to Adelstein (2005), this comprises two fundamental procedures: location updates (or registrations) and paging. In LTE and 5G networks, the MME or Access and Mobility Management Function (AMF) manages these through structures known as tracking areas (TA) or location areas (LA) (Phung et al., 2023). Updates occur when a UE transitions between areas, ensuring that the network has an accurate approximation of the device's position. Sauter (2021) notes that this granularity allows efficient paging, reducing unnecessary signalling overhead. Tracking mechanisms, as explained by Darwish et al. (2022), often rely on signal strength triangulation, further enhancing location accuracy.

Paging serves the vital purpose of locating idle users for incoming service requests. Phung et al. (2023) describe how the MME or AMF identifies which eNodeBs or gNodeBs should transmit paging messages. The design of the paging area critically influences network efficiency: while blanket paging offers reliability, it is bandwidth-intensive; sequential paging conserves resources but may delay call setup. Phung et al. (2023) propose a refined approach that reduces the number of involved base stations by up to 95%, maintaining a high paging success ratio. Empirical validation from Viettel's 4G network in Vietnam demonstrates a paging success ratio of 98%, with a first-attempt success rate of 96.7% metrics that illustrate the effectiveness of optimised paging strategies.

From a historical perspective, the techniques and architectures underpinning mobility management have evolved dramatically. In GSM networks, the network's ability to locate devices relied heavily on periodic location updates within defined Location Areas (Sauter, 2021). The shift to UMTS integrated packet-switched data with circuit-switched voice while maintaining GSM features, enhancing inter-system handovers (Sauter, 2021). LTE introduced an all-IP architecture that simplified signalling and mobility states, as the MME assumed central responsibility for NAS-layer mobility (Sauter, 2021). With 5G, architectural complexity deepens through standalone (SA) and non-standalone (NSA) configurations, network slicing, and enhanced handover mechanisms via the Xn interface (Sauter, 2021). The transition to the 5G Core replaces legacy HLRs and VLRs with HSS and AMF functions, reinforcing the growing emphasis on virtualization and service-tailored connectivity.

Despite technological progress, real-world implementation remains fraught with challenges, particularly in developing regions. MTN Nigeria, the country's largest MNO, exemplifies the opportunities and constraints of applying international standards in localized settings. In Q1 2025, MTN added 3.2 million subscribers, growing its base to 84.1 million and capturing 52% of the market (MTN Nigeria Communications Plc, 2025; Intelpoint, 2025). Although the company has committed nearly ₦900 billion to network improvements in 2025, especially in Lagos and Abuja, user satisfaction has remained inconsistent (Onwuaso, 2025; Nwokoma, 2025). Frequent fibre cuts more than 30 daily and rampant site vandalism significantly degrade service quality, despite strategic tariff adjustments and infrastructure expansion (Nwokoma, 2025; Extensia Ltd, 2025).

A 2021 empirical evaluation by Kelechi et al. found that none of the major Nigerian MNOs met 3GPP performance benchmarks across KPIs such as throughput, latency, and handover success rates. While MTN posted the best downlink throughput (\~85 Mbps), it still fell short of the 100 Mbps target. Handover failures were particularly notable, with Airtel, MTN, and SMILE all approaching 100% failure rates for S1/X2 handovers figures indicative of systemic weaknesses in mobility handling (Kelechi et al., 2021). In response, regulatory innovations such as the NCC-approved national roaming agreement between MTN and 9mobile illustrate a pragmatic approach to mitigating coverage gaps and enhancing user experience (ITPulse.com.ng).

Beyond practical implementations, theoretical advances have significantly reshaped mobility architectures. Internet Engineering Task Force (IETF) frameworks such as Mobile IPv6 (MIPv6) introduced mechanisms to preserve active sessions during IP address changes, employing home agents and care-of-addresses for location binding (Darwish et al., 2022). To reduce signalling, Hierarchical Mobile IPv6 (HMIPv6) introduced a tiered model, while Proxy Mobile IPv6 (PMIPv6) transferred mobility management tasks to the network side, minimizing UE involvement. In LTE contexts, the Serving Gateway (S-GW) and PDN Gateway (P-GW) effectively replicate PMIPv6 functions as Mobile Access Gateways (MAGs) and Local Mobility Anchors (LMAs), respectively (Siddiqui et al., 2022).

Distributed Mobility Management (DMM) marks a further progression, decentralising anchor points to minimize latency and enhance scalability. Siddiqui et al. (2022) emphasize DMM's relevance in ultra-dense 5G and anticipated 6G environments, where traditional centralised models become untenable due to signalling bottlenecks. In parallel, artificial intelligence (AI) offers transformative potential. Zaidi et al. (2023) propose an Advanced Mobility Management and Utilization Framework (A-MMUF) that employs Mobility Prediction Models (MPMs) to proactively anticipate handover timing, target cells, and load distributions. These MPMs may rely on historical data, signal strength measurements, and machine learning techniques such as Markov Chains, Deep Neural Networks, and Support Vector Machines to improve handover reliability and resource utilisation. The proactive handover (P-HO) strategy enabled by A-MMUF reduces latency and packet loss, although the success of such systems depends heavily on the computational efficiency and accuracy of the underlying models (Zaidi et al., 2023). Jahanmanesh et al. (2025) further affirm that intelligent mobility prediction is indispensable in managing the increasing complexity of modern wireless networks.

Mobility management has evolved from rudimentary mechanisms focused on basic connectivity to intricate systems characterised by predictive intelligence and architectural flexibility. The relentless growth in user demand, coupled with increasingly complex network topologies, necessitates continuous innovation in mobility protocols, frameworks, and predictive algorithms. While theoretical advancements such as DMM and AI-based models present promising avenues, their effective implementation especially in challenging operational contexts like Nigeria demands a nuanced understanding of both global standards and local realities. Achieving seamless, high-quality mobile experiences will ultimately depend on the synergistic integration of robust infrastructure, adaptive policies, and intelligent, forward-looking mobility management strategies.

3.0 Methodology

This study employs a Systematic Literature Review (SLR) methodology to thoroughly investigate mobility management, with a particular focus on location management principles and techniques within mobile cellular networks, contextualized by MTN Nigeria. This structured and transparent approach facilitated a comprehensive synthesis of existing literature from academic and industry domains, enabling critical engagement with established practices, emerging theoretical frameworks, and implementation challenges without requiring direct field data collection. The review spanned literature published between 2020 and 2025 (with an exception to "Fundamentals of mobile and pervasive computing" which was published in 2005), covering mobile network technologies from 2G/GSM to 5G, and explored key themes such as handover, roaming, location update techniques, paging strategies, and architectural elements like HLRs, VLRs, and tracking areas. Sources were rigorously identified and screened from reputable databases (e.g., IEEE Xplore, ScienceDirect) and official bodies (e.g., 3GPP specifications, NCC reports) using a predefined protocol and targeted search terms.

Following the systematic identification and selection, key information was extracted using a structured matrix, and a thematic analysis was applied to synthesize findings across core areas of interest, including mobility components, location management principles, architectural techniques, and comparative international practices. While the SLR approach provided depth and credibility to the research, a notable limitation arises from the absence of primary empirical data, which restricts the direct validation of theoretical conclusions within MTN Nigeria's live operational environment. Nevertheless, the study mitigates this by triangulating insights from diverse sources including industry reports, regulatory documents, and peer-reviewed literature thereby enhancing the review's relevance and practical grounding.

4.0 Data Analysis and Results

4.1 Market Position and Technology Transition

MTN Nigeria maintained its dominance in the national telecommunications landscape as of December 2023, accounting for over 87 million active voice subscribers, significantly surpassing competitors such as Globacom and Airtel, each with slightly above 60 million users (Nigerian Communications Commission [NCC], 2023) as shown in table 4.1. This market leadership reflects not just wide coverage but also superior service reach and brand retention strength.

Table 4.1: Mobile Operator Market Share in Nigeria (Active Voice Subscribers, December 2023) (Nigerian Communications Commission [NCC], 2023)

Operator	Subscribers (Dec 2023)
MTN	87,038,765
Glo	60,637,477
Airtel	60,084,007
9mobile	16,953,461
Total	224,713,710

Between May 2023 and May 2025, Nigeria's mobile technology landscape experienced a noteworthy shift from legacy networks toward higher-speed services. 2G subscriptions fell from 58.36% to 38.76%, while 3G usage dropped to 8.02%, reinforcing the trend of technological obsolescence. In contrast, 4G adoption surged from 25.06% to 50.29%, and 5G, though nascent, grew from 0.12% to 2.93%, a trajectory driven by infrastructure upgrades and increased device compatibility (NCC, 2025). This technological migration as shown in the chart, figure 4.1 provides a crucial backdrop for evaluating MTN's capacity to manage location and mobility within an evolving network environment.

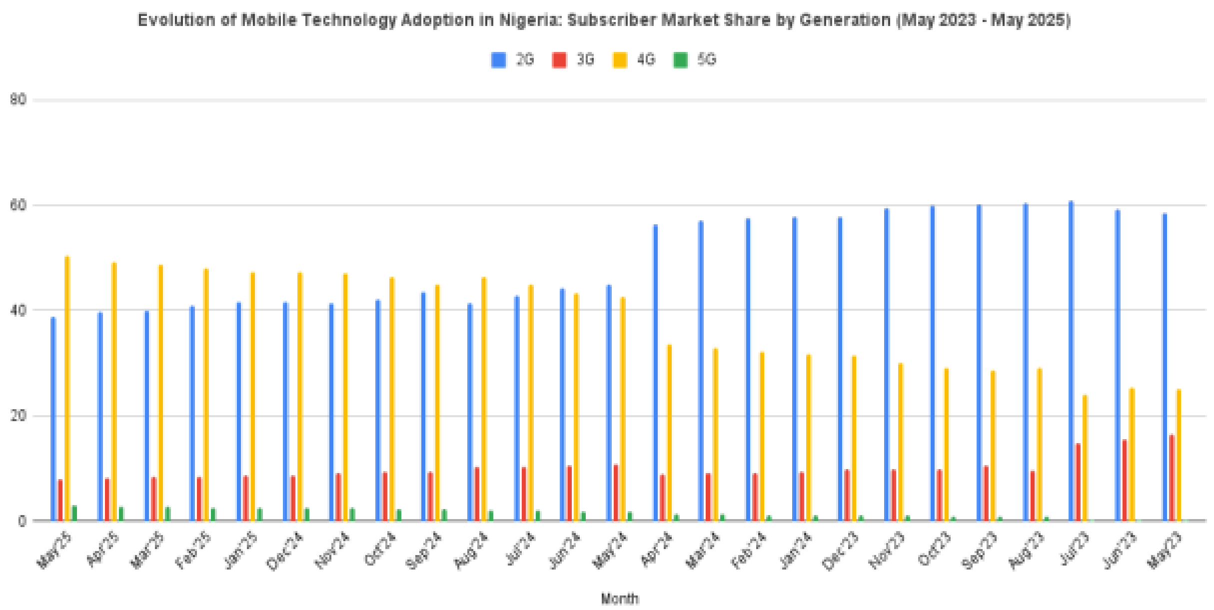

Figure 4.1: Evolution of Mobile Technology Adoption in Nigeria: Subscriber Market Share by Generation (May 2023 - May 2025) (Nigerian Communications Commission (NCC), 2025)

4.1.2 MTN's Regulatory Performance on Location-Relevant KPIs

Regulatory Quality of Service (QoS) indicators published by the NCC from 2022 to 2024 reveal that MTN consistently exceeded national benchmarks across its 2G, 3G, and 4G layers. Key mobility-related metrics such as the Circuit Switch Fall Back Preparation Success Rate (CSFBPR) and the Inter-Cell Handover Success Rate (ICHOSR) remained above 98% across all years affirming MTN's network readiness for session continuity and fallback scenarios (NCC, 2022, 2023, 2024).

Specifically, 4G indicators such as Evolved Radio Access Bearer Drop Rate (ERABDR) and Radio Resource Control Setup Success Rate (RRCSSR) remained within acceptable thresholds, indicating efficient resource handling during mobility events. Likewise, 3G and 2G layers demonstrated strong Call Setup Success Rates (CSSR > 99%) and minimal congestion across Stand-Alone Dedicated Control Channel (SDCCH) and Traffic Channel (TCH) metrics. These results as shown in table 4.2 suggest that MTN's legacy and next-gen networks are structurally equipped to support robust location management.

Table 4.2: MTN Network Performance Compared to NCC Regulatory Targets (2022–2024)

KPI	**Network**	**2022**	**2023**	**2024**	**NCC Target**
CSFBPR (%)	4G	99.95	99.91	99.80	⩾98%
ERABDR (%)	4G	0.05	0.14	0.87	⩽1%
ERABSR (%)	4G	99.72	99.38	99.71	⩾98%
ICHOSR (%)	4G	98.85	98.68	98.99	⩾98%
RRCSSR (%)	4G	99.91	99.88	99.86	⩾99%
CSSRC (%)	3G	99.72	99.56	99.22	⩾98%
CSSRP (%)	3G	99.44	99.16	99.04	⩾98%
DCRC (%)	3G	0.15	0.13	0.17	⩽1.5%
DCRP (%)	3G	0.43	0.45	0.54	⩽1.5%
RABC (%)	3G	0.00	0.00	0.00	⩽0.5%
RRCC (%)	3G	0.00	0.00	0.00	⩽1%
CSSR (%)	2G	99.66	99.61	99.38	⩾98%
Drop Call Rate (%)	2G	0.13	0.26	0.29	⩽1%
SDCCH Congestion (%)	2G	0.07	0.13	0.15	⩽0.2%
TCH Congestion (%)	2G	0.30	0.19	0.41	⩽1.5%

4.1.3 Location Management Efficiency and Infrastructure Readiness

MTN's efficient handling of user location updates is grounded in the use of Location Area Updates (LAUs) for 2G/3G and Tracking Area Updates (TAUs) for LTE/5G, all executed via well-established signaling protocols including SS7, Diameter, and GTP (Plis, 2024). Performance data suggests that signaling congestion remains low, with SDCCH congestion rates consistently below the NCC's 0.2% ceiling (Tim, Ojomu, & Akpabio, 2023). Furthermore, handover success rates exceed the 98% regulatory benchmark (Ekah & Iloke, 2022), underscoring the accuracy and responsiveness of MTN's location tracking subsystems.

Underpinning these metrics is an aggressive infrastructure expansion strategy: MTN scaled its base stations from 36,998 in 2020 to 137,992 by 2023 and extended its fibre backbone to over 49,000 km (NCC, 2021, 2023, 2024). These investments, combined with collaborations such as Huawei for intelligent network optimization and Meta for enhancing VoIP experiences illustrate a commitment to maintaining scalable, high-resolution location services (Developing Telecoms, 2020; Pointblank News, 2025).

Despite security and logistical setbacks, including a temporary SIM registration suspension and instability in Northern regions (NCC, 2021, 2022), MTN's signaling and location infrastructures remain resilient. This is evident in performance metrics such as latency (25.921 ms), uptime (97.714%), and regional coverage (87.514%) in North-Central Nigeria (Abdullahi & Abdulhamid, 2025). With a shift toward standalone 5G architecture since 2022, MTN is positioned to further enhance signaling efficiency and location-aware services (Plis, 2024).

4.1.4 User Experience as a Proxy for Location Management Impact

User-generated data from third-party performance platforms affirms MTN's technical superiority. nPerf (2025) reports the highest national download speed (17.82 Mbps), lowest latency (79.44 ms), and best web and streaming quality scores among Nigerian operators as shown in table 4.3. Ookla (2024) corroborates this with MTN achieving the highest consistent quality score (79.7%) and a leading 5G median download rate of 231.39 Mbps as shown in table 4.4.

Yet these performance advantages contrast with systemic vulnerabilities. Network outages, over 30 in May 2025 alone due to fibre cuts, vandalism, and power failures, illustrate how extrinsic factors can negate robust technical frameworks (Extensia Ltd, 2025; Nwokoma, 2025). While MTN has committed ₦900 billion in infrastructure improvements and forged a rural roaming partnership with 9mobile to bridge coverage gaps, these measures are reactive to infrastructural fragility (Onwuaso, 2025).

Moreover, historical performance gaps remain salient. Kelechi et al. (2021) previously documented latency spikes exceeding 1000 ms in LTE networks, revealing how mobility events such as roaming and handovers were long-standing pain points. Even now, persistent 2G reliance by nearly 39% of the subscriber base (NCC, 2025) signals continued barriers to universal, high-speed mobile access.

Table 4.3: nPerf Mobile Network Performance in Nigeria (2024) (nPerf , 2024).

Metric	MTN	Airtel	Glo
Download Bitrate (Mb/s)	17.82	9.98	5.66
Upload Bitrate (Mb/s)	8.05	4.35	3.43
Latency (ms)	79.44	119.85	89.44
Web Browse Performance (%)	36.08	28.86	29.42
YouTube Streaming (%)	72.35	67.04	53.81
nPerf Score (nPoints)	39,475	26,513	19,684

Table 4.4: Ookla Speedtest Mobile Network Performance in Nigeria (H2 2024) (Ookla , 2024).

Metric	MTN	Airtel	Glo
Median Download (Mbps)	24.25	15.38	7.77
Median Upload (Mbps)	13.38	–	–
Median Latency (ms)	48	–	–
Consistent Quality (%)	79.7	73.7	52.9
Speed Score	79.52	27.97	11.13
Video Score	57.25	55.65	49.58

4.2 Interpretation of Results

Collectively, the evidence demonstrates that MTN Nigeria's approach to location management is technically sound, anchored in regulatory compliance, proactive infrastructure investments, and consistent third-party validation. Efficient signaling protocols, low congestion, and high handover success rates indicate a mature location management system capable of supporting a growing and dynamic user base. However, persistent external disruptions and infrastructural vulnerabilities reveal an implementation gap. While the core architecture performs well, real-world user experience is still undermined by environmental fragility and regional disparities. Additionally, Nigeria's poor international ranking according to OpenSignal, 2025 and SpeedTest, 2025 as shown in table 4.5 underscores a disconnect between national technical leaders like MTN and broader systemic performance.

Therefore, while MTN demonstrates operational leadership in location management, the overall effectiveness is contingent on national infrastructure resilience, equitable access expansion, and strategic evolution toward intelligent and predictive mobility frameworks.

Table 4.5: Nigeria's Global/Regional Rankings in Mobile Network Experience (Q1 2025) (Opensignal, 2025)

Metric	**Nigeria's Rank**	**Nigeria's Value**
Global Network Quality	102th	102
4G/5G Availability	99th	81.8%
4G/5G Quality	123st	20.7%
4G Download Speed	113th	19Mbps
5G Speed	48th	177.1Mbps

Table 4.6: Nigeria's Global/Regional Rankings in Mobile Network Experience (June, 2025) (SpeedTest, 2025)

Metric	**Nigeria's Rank**
Global Network Quality Rank	83
Download Speed	45.45Mbps
Upload Speed	11.42Mbps
Latency	20ms

5.0 Conclusion

This study has critically examined the principles and techniques of location management in mobile telecommunication networks, using MTN Nigeria as a contextual case study. Through a systematic literature review and triangulated data analysis, the research affirms that MTN demonstrates technical competence in implementing location management functions, including efficient signaling, high handover success rates, and consistent regulatory compliance across its 2G, 3G, and 4G networks. The company's substantial investments in infrastructure, adoption of advanced signaling protocols, and strategic collaborations position it as a national leader in mobility service delivery.

However, despite these strengths, the analysis reveals persistent infrastructural vulnerabilities such as fibre cuts, power instability, and regional disparities which undermine the consistency of user experience. These challenges highlight a misalignment between MTN's technical performance and Nigeria's broader systemic limitations, as reflected in the country's low global rankings for mobile network quality and speed. Furthermore, legacy network reliance and limited 5G penetration impede the full realization of next-generation mobility capabilities.

The findings suggest that achieving seamless, scalable, and equitable location management requires not only operator-level excellence but also ecosystem-wide improvements in national infrastructure and regulatory enforcement. Going forward, the integration of predictive, AI-driven mobility models, alongside Distributed Mobility Management (DMM) architectures, offers promising avenues for enhancing responsiveness and reducing signaling overhead. For developing markets like Nigeria, success will depend on harmonizing global best practices with local realities, ensuring that mobility management evolves in tandem with both user expectations and technological advances.

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