Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

5G N40 8T8R Deployment with Legacy 4T Antennas in Networks

Noaman Taufiq[1], and Muhammad Imran Afzal[2]
Saudi Telecom Company

***Abstract*—The increasing demand for higher network capacity and improved user experience has accelerated the deployment of multi-antenna technologies in fifth-generation (5G) mobile networks. While 8-Transmit 8-Receive (8T8R) configurations offer significant improvements in beamforming gain, coverage, and throughput, large-scale deployment often requires replacement of existing antenna infrastructure, resulting in high capital expenditure. This paper presents a comprehensive performance evaluation of 5G N40 8T8R deployment using legacy 4T antenna architectures in a live commercial network environment. The study investigates the feasibility of upgrading existing 4T antenna systems by integrating 8T8R radio units without replacing the installed antennas. Three representative antenna architectures, namely 4L6H, 1L4H, and 2L6H, were evaluated through theoretical analysis, drive test measurements, and OSS-based key performance indicators (KPIs). The performance assessment focused on coverage enhancement, downlink throughput, traffic growth, user distribution, and power boosting under high network loading conditions. The results demonstrate that antenna architecture plays a significant role in determining the achievable gains of 8T8R deployment. The 4L6H antenna achieved the highest performance improvements with up to 5.7 dB coverage gain and 17.7% increase in average downlink throughput, while the 1L4H and 2L6H architectures provided moderate gains primarily due to their limited horizontal beamforming capability. Furthermore, KPI analysis confirmed that the improved coverage attracted more users and increased traffic volume, validating the practical benefits of legacy antenna reuse. The findings demonstrate that 8T8R deployment can significantly improve 5G network performance while minimizing infrastructure replacement costs, providing mobile operators with a practical and cost-effective strategy for network modernization.**

***Index Terms*—5G New Radio (NR), 8T8R Deployment, Legacy 4T Antenna, Beamforming, Radio Modernization, Coverage Improvement, Network Optimization, Live Network Trial, Drive Test Analysis, Performance Evaluation.**

I. INTRODUCTION

The rapid growth of fifth-generation (5G) mobile networks has significantly increased the demand for higher network capacity, improved spectral efficiency, and enhanced user experience. Emerging applications such as ultra-high-definition video streaming, cloud computing, industrial automation, and immersive digital services require mobile networks to deliver higher data rates while maintaining reliable coverage. To meet these requirements, mobile network operators are increasingly deploying advanced multiple-input multiple-output (MIMO) technologies, particularly 8-Transmit 8-Receive (8T8R) systems, which provide substantial improvements in beamforming capability, signal quality, and network capacity compared to conventional four-transmit (4T) deployments.

Although 8T8R technology offers considerable performance advantages, its large-scale deployment often requires replacing existing antenna infrastructure, resulting in significant capital expenditure and increased implementation complexity. Many commercial networks currently utilize legacy 4T antenna systems that continue to provide acceptable mechanical performance but lack the electrical characteristics required to fully exploit advanced beamforming techniques. Consequently, operators face the challenge of modernizing radio access networks while minimizing infrastructure replacement costs and deployment time.

One practical approach is to reuse existing legacy antennas by integrating them with newly deployed 8T8R radio units. This strategy allows operators to enhance network performance without replacing installed antenna systems, thereby reducing capital investment and accelerating network modernization. However, the achievable performance improvement depends on the physical characteristics of the existing antenna architecture, including the number of horizontal and vertical radiating elements, beamwidth, and antenna configuration. Therefore, evaluating the performance of different legacy antenna architectures under 8T8R deployment is essential for determining their suitability for commercial network upgrades.

This paper presents a comprehensive performance evaluation of 5G N40 8T8R deployment using legacy 4T antenna architectures in a live commercial network environment. Three representative antenna configurations, namely 4L6H, 1L4H, and 2L6H, were investigated through theoretical analysis, drive test measurements, and OSS-based key performance indicators (KPIs). The study analyzes improvements in coverage, downlink throughput, user traffic, and beamforming performance, while also examining the impact of power boosting under high network loading conditions. The findings provide practical guidelines for operators seeking cost-effective strategies to modernize existing 5G networks by maximizing the utilization of legacy antenna infrastructure.

II. OBJECTIVE AND TRIAL SETUP

A. *Objective*

The primary objective of this study is to evaluate the performance of 5G N40 8T8R deployment using legacy 4T antenna architectures in a live commercial network environment. The study investigates whether existing 4T antenna systems can be effectively reused with newly deployed 8T8R radio units to improve network performance while minimizing infrastructure replacement costs. By leveraging existing antenna installations, operators can accelerate network modernization

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

and reduce capital expenditure without compromising service quality.

The study further aims to compare the performance of three commonly deployed legacy antenna architectures, namely 4L6H, 1L4H, and 2L6H. Performance evaluation focuses on key network indicators including coverage enhancement, downlink throughput, beamforming gain, user distribution, traffic growth, and overall network efficiency. In addition, the impact of power boosting on network performance is analyzed to determine its effectiveness in improving user experience under high traffic conditions.

Overall, the objective is to identify the most suitable legacy antenna architecture for 8T8R deployment and to validate a cost-effective migration strategy that enables operators to enhance 5G coverage and capacity while maximizing the utilization of existing network infrastructure.

B. Trial Cluster

The trial was conducted in a live commercial 5G network using selected N40 sites representing different legacy antenna architectures. Three antenna configurations—4L6H, 1L4H, and 2L6H—were selected to evaluate the performance of 8T8R deployment under identical network conditions. These configurations represent commonly deployed antenna types currently used in commercial mobile networks, making the study directly applicable to large-scale modernization projects.

The existing 4T radio units were upgraded to 8T8R radio units while retaining the installed antenna systems. This deployment approach enabled direct comparison of network performance before and after the upgrade without introducing additional variables related to antenna replacement. Performance measurements were collected before deployment and after network optimization to accurately quantify the improvements achieved through the 8T8R upgrade.

The trial assessment included OSS-based KPI analysis, drive test measurements, and throughput evaluation under both static and mobility scenarios. Additional analysis was performed to evaluate the impact of beamforming and power boosting on coverage, traffic distribution, and user experience. This comprehensive trial setup ensured that the performance of each antenna architecture could be evaluated under real commercial network conditions.

C. Hardware Configuration

The trial utilized commercial 5G AirScale radio equipment supporting 8T8R transmission on the N40 frequency band. The existing 4T radio units were replaced with 8T8R radio units while retaining the deployed legacy antenna systems. This configuration enabled advanced beamforming capabilities without requiring changes to the existing passive antenna infrastructure.

Three legacy antenna architectures—4L6H, 1L4H, and 2L6H—were evaluated to determine their compatibility with 8T8R deployment. Although all configurations supported the upgraded radio hardware, differences in antenna structure and horizontal radiating elements resulted in varying beamforming performance and coverage improvements. This allowed direct comparison of each antenna architecture under identical operating conditions.

The upgraded radio solution supported advanced beamforming, higher-order MIMO processing, dynamic power allocation, and intelligent scheduling algorithms, enabling efficient utilization of radio resources while maintaining compatibility with the existing transport network and baseband infrastructure.

III. NETWORK CONFIGURATION

The trial network was configured using a Non-Standalone (NSA) 5G architecture, where LTE served as the anchor layer and the N40 carrier operated as the primary 5G capacity layer. Existing commercial sites equipped with legacy 4T antenna systems were upgraded by replacing the conventional 4T radio units with 8T8R radio units while retaining the installed passive antennas. This approach enabled the evaluation of advanced 8T8R capabilities without requiring complete antenna replacement, thereby reducing deployment cost and implementation time.

Three legacy antenna architectures were investigated during the trial, namely 4L6H, 1L4H, and 2L6H. Each antenna configuration was connected to the same 8T8R radio platform to ensure a fair performance comparison under identical network conditions. The upgraded radio units supported eight transmit and eight receive paths, enabling advanced beamforming and MIMO processing. However, the achievable beamforming gain depended on the physical characteristics of each antenna architecture, particularly the number of horizontal radiating elements and antenna array design.

To further improve radio performance, beamforming algorithms and dynamic power allocation were enabled across all trial sites. In addition, power boosting was applied to selected cells to evaluate its impact on coverage, user distribution, and downlink throughput. Network performance was continuously monitored using OSS-based KPIs and validated through extensive drive test measurements before and after the upgrade.

Overall, the network configuration provided a practical framework for assessing the feasibility of deploying 8T8R technology using legacy antenna infrastructure. The trial enabled direct comparison of different antenna architectures under live commercial conditions and demonstrated a cost-effective approach for modernizing existing 5G networks while maintaining compatibility with the deployed radio access infrastructure.

IV. DRIVE TEST RESULTS

Drive testing was performed to evaluate the real-world performance of the proposed 8T8R deployment using legacy 4T antenna architectures in a live commercial network. The objective of the field measurements was to quantify the improvements in radio coverage, downlink throughput, and overall network performance after upgrading the existing 4T4R radio units to 8T8R while retaining the deployed passive antennas.

Performance validation was conducted using commercial 5G user equipment under identical testing conditions before

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

TABLE I: TDD 8T8R Test Summary for Site ZHA114 (4L6H Antenna)

Technology	Test	Test Category	Test Item	Post-8T8R	Pre-4T4R
5G	DT Test	Coverage	DL Average RSRP (dBm)	-94.1	-99.8
	DT Test	Throughput	DL Average Throughput (Mbps)	250.1	212.4
	KPI Test	Total Traffic (GB)	4516	3494	
	KPI Test	DL Avg Throughput (Mbps)	14.2	10.1	
	KPI Test	Average Users	44.2	35.9	
	Power Boosting	DL Average RSRP (dBm)	-91.0	-94.1	
	Power Boosting	DL Avg Throughput (Mbps)	235.5	250.1	

TABLE II: TDD 8T8R Test Summary for Site ZHA197 (1L4H Antenna)

Technology	Test	Test Category	Test Item	Post-8T8R	Pre-4T4R
5G	DT Test	Coverage	DL Average RSRP (dBm)	-87.5	-90.6
	DT Test	Throughput	DL Average Throughput (Mbps)	212.5	195.4
	KPI Test	Total Traffic (GB)	2142	1344	
	KPI Test	DL Avg Throughput (Mbps)	31.8	36.7	
	KPI Test	Average Users	32.3	16.9	
	Power Boosting	DL Average RSRP (dBm)	-84.8	-87.5	
	Power Boosting	DL Avg Throughput (Mbps)	200.5	212.5	

and after the upgrade. The measurements included radio coverage, average downlink throughput, traffic volume, and user distribution. The following subsections present the results for each antenna architecture individually, followed by a comparative discussion of the overall performance.

A. *4L6H Antenna Performance*

The first trial was conducted using the 4L6H legacy antenna architecture to evaluate the effectiveness of upgrading from a conventional 4T4R radio to an 8T8R radio while retaining the existing passive antenna. This antenna configuration was selected because its horizontal antenna architecture is well suited for beamforming and multi-user transmission, allowing the upgraded radio to utilize its additional transmit chains more efficiently. The performance results obtained from the field trial are summarized in Table I.

As shown in Table I, the deployment of the 8T8R radio significantly improved radio coverage and user throughput compared with the existing 4T4R configuration. The average downlink RSRP improved from -99.8 dBm to -94.1 dBm, corresponding to a coverage gain of approximately 5.7 dB, which exceeded the expected target of 3–5 dB. Similarly, the average downlink throughput increased from 212.4 Mbps to 250.1 Mbps, representing a throughput improvement of approximately 17.7%. These results confirm that the additional transmit power together with improved beamforming capability effectively enhances signal quality and spectral efficiency in high-load network conditions.

Network-level statistics further validate the effectiveness of the proposed deployment. Total downlink traffic increased from 3494 GB to 4516 GB, representing approximately 29% traffic growth, while the average number of connected users increased by about 23%. Unlike the other legacy antenna architectures evaluated in this study, the 4L6H antenna also achieved a 41% improvement in average downlink throughput at the network level, indicating that the antenna architecture efficiently supports both beamforming and multi-user scheduling. These findings demonstrate that the 4L6H antenna provides the highest compatibility with 8T8R deployment and delivers the greatest overall performance improvement among the evaluated legacy antenna configurations.

B. *1L4H Antenna Performance*

The second trial was conducted using the legacy 1L4H antenna architecture to evaluate its compatibility with the proposed 8T8R deployment. Unlike the 4L6H antenna, the 1L4H configuration increases the number of antenna elements mainly in the vertical plane rather than the horizontal plane. As a result, the antenna provides limited improvement in horizontal beam narrowing, which directly influences multi-user beamforming capability. The drive test and network performance results obtained from this trial are summarized in Table II. As shown in Table II, the 8T8R upgrade successfully improved radio coverage and single-user throughput compared with the existing 4T4R configuration. The average downlink RSRP improved from -90.6 dBm to -87.5 dBm, corresponding to a coverage gain of approximately 3.1 dB, which meets the expected design objective. Similarly, the average downlink throughput increased from 195.4 Mbps to 212.5 Mbps, representing an improvement of approximately 8.8%. These results demonstrate that the additional transmit power and beamforming capability provided by the 8T8R radio effectively enhance radio propagation even when deployed with a legacy 1L4H antenna. The OSS statistics presented in Table II show that the improved coverage attracted significantly more users to the serving cell. The total downlink traffic increased from 1344 GB to 2142 GB, corresponding to a traffic growth of approximately 59%, while the average number of connected users almost doubled, increasing by approximately 91%. However, despite the increase in traffic volume, the average downlink throughput decreased from 36.7 Mbps to 31.8 Mbps, representing a reduction of approximately 13.5%. This behavior indicates that the wider coverage attracted additional users located farther from the serving

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

TABLE III: TDD 8T8R Test Summary for Site ZAQ073 (2L6H Antenna)

Technology	Test	Test Category	Test Item	Post-8T8R	Pre-4T4R
5G	DT Test	Coverage	DL Average RSRP (dBm)	-89.2	-93.3
	DT Test	Throughput	DL Average Throughput (Mbps)	221.4	194.6
	KPI Test	Total Traffic (GB)	2475	1439	
	KPI Test	DL Avg Throughput (Mbps)	18.7	34.6	
	KPI Test	Average Users	46.8	22.2	
	Power Boosting	DL Average RSRP (dBm)	-86.5	-89.2	
	Power Boosting	DL Avg Throughput (Mbps)	211.2	221.4	

cell, increasing resource sharing and scheduling competition. Consequently, although coverage and traffic improved, the overall average user throughput decreased due to the larger number of simultaneously connected users. These observations suggest that the 1L4H antenna architecture provides satisfactory coverage enhancement but offers limited multi-user beamforming capability compared with the optimized 4L6H antenna.

C. 2L6H Antenna Performance

The third trial was carried out using the 2L6H legacy antenna architecture to evaluate its performance after upgrading the existing 4T4R radio unit to an 8T8R radio. The 2L6H antenna provides a balanced antenna arrangement with additional horizontal radiating elements compared to the 1L4H configuration, allowing improved beamforming capability while maintaining compatibility with the existing passive antenna infrastructure. The drive test and OSS performance results obtained from this trial are summarized in Table III.

As shown in Table III, the deployment of the 8T8R radio produced noticeable improvements in radio coverage and user throughput. The average downlink RSRP improved from -93.3 dBm to -89.2 dBm, corresponding to a coverage improvement of approximately 4.1 dB. Similarly, the average downlink throughput increased from 194.6 Mbps to 221.4 Mbps, representing a throughput improvement of approximately 13.8%. These results demonstrate that the additional beamforming capability provided by the 8T8R radio effectively enhances signal quality and increases the achievable data rate compared with the legacy 4T4R deployment.

The network performance statistics further indicate that the improved coverage attracted a considerably larger number of users to the serving cell. Total downlink traffic increased from 1439 GB to 2475 GB, representing approximately 72% traffic growth, while the average number of connected users increased from 22.2 to 46.8, corresponding to approximately 111% user growth. However, the average downlink throughput measured through OSS statistics decreased from 34.6 Mbps to 18.7 Mbps. This reduction is primarily attributed to the significant increase in connected users sharing the available radio resources after the coverage expansion. Although the 2L6H antenna successfully improves coverage and traffic capacity, the increased scheduling load reduces the average throughput experienced by individual users. Overall, the 2L6H configuration provides better beamforming performance than the 1L4H architecture but remains less effective than the optimized 4L6H antenna for supporting high-capacity multi-user operation.

TABLE IV: Power Boosting Performance Comparison

Parameter	**4L6H**	**1L4H**	**2L6H**
RSRP Improvement (dB)	3.1	2.7	2.7
DL Throughput Before Boost (Mbps)	250.1	212.5	221.4
DL Throughput After Boost (Mbps)	235.5	200.5	211.2
Throughput Change (%)	-5.8	-5.6	-4.6

V. POWER BOOSTING ANALYSIS

To further evaluate the effectiveness of the proposed 8T8R deployment, an additional power boosting trial was conducted across all three legacy antenna architectures. The objective was to determine whether increasing the transmit power could further enhance radio coverage and improve user experience beyond the gains already achieved through beamforming. The measured performance results are summarized in Table IV. As shown in Table IV, power boosting produced additional improvements in radio coverage for all evaluated antenna configurations. The 4L6H antenna achieved the highest coverage improvement, with an average RSRP gain of approximately 3.1 dB, while both the 1L4H and 2L6H antennas achieved gains of approximately 2.7 dB. These results indicate that increasing the transmission power effectively extends the serving cell coverage and improves signal strength, particularly for users located near the cell edge. Despite the improvement in signal strength, the average downlink throughput experienced a slight reduction after power boosting. The 4L6H, 1L4H, and 2L6H antenna configurations recorded throughput reductions of approximately 5.8%, 5.6%, and 4.6%, respectively. This behavior is expected because the expanded coverage area allows more distant users to connect to the serving cell, increasing resource utilization and reducing the average throughput available to each individual user. Nevertheless, the throughput degradation remained relatively small compared to the significant improvement in coverage. Overall, the power boosting trial demonstrates that beamforming and transmit power complement each other in improving network coverage. While beamforming provides directional gain and improved spectral efficiency, power boosting further extends the coverage boundary, enabling additional users to access the 5G network. The results confirm that the combined use of 8T8R beamforming and optimized transmission power offers a practical solution for enhancing coverage while maintaining acceptable throughput performance in commercial deployments.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

VI. RESULT SUMMARY

The overall performance comparison confirms that upgrading legacy 4T4R radio units to 8T8R significantly improves network coverage and user experience while enabling the reuse of existing passive antenna infrastructure. The results demonstrate that the performance achieved depends largely on the antenna architecture, particularly its beamforming capability and horizontal radiating element configuration.

Among the evaluated antennas, the 4L6H configuration consistently delivered the best overall performance, achieving the highest coverage gain and downlink throughput improvement while maintaining positive network-level throughput. The 1L4H and 2L6H antennas also improved coverage and increased traffic volume; however, the larger number of connected users resulted in lower average throughput due to increased resource sharing. Overall, the trial validates that legacy antenna reuse is a practical and cost-effective solution for commercial 8T8R deployment.

VII. DISCUSSION

The trial results demonstrate that the effectiveness of 8T8R deployment is strongly influenced by the characteristics of the legacy antenna architecture. Although all three antenna configurations benefited from the radio upgrade, the performance gains varied according to their beamforming capability and antenna array design. The results indicate that increasing the number of horizontal radiating elements improves beamforming efficiency, resulting in better radio coverage and higher downlink throughput.

Among the evaluated configurations, the 4L6H antenna consistently delivered the best overall performance by achieving the highest coverage improvement and throughput gain while maintaining positive network-level performance. In contrast, the 1L4H and 2L6H antennas attracted a larger number of users due to their expanded coverage, which increased resource sharing and reduced average user throughput. These observations highlight the importance of antenna architecture when planning large-scale 8T8R deployments.

Overall, the study confirms that upgrading existing 4T4R radio units to 8T8R while retaining legacy passive antennas is a practical and cost-effective modernization strategy. Select-ing an appropriate antenna architecture enables operators to maximize beamforming gains, improve network performance, and accelerate 5G deployment without extensive infrastructure replacement.

VIII. CONCLUSION

This paper presented a performance evaluation of 5G N40 8T8R deployment using legacy 4T antenna architectures in a live commercial network. The results demonstrate that upgrading existing 4T4R radio units to 8T8R while retaining passive antennas can significantly improve coverage and network performance without requiring complete antenna replacement.

Among the evaluated antenna configurations, the 4L6H architecture achieved the best overall performance, providing superior beamforming capability, higher downlink throughput, and greater coverage enhancement. Although the 1L4H and 2L6H antennas also delivered measurable improvements, their network-level throughput was affected by increased user loading. Overall, the proposed deployment approach offers a practical and cost-effective strategy for accelerating 5G network modernization. Future work will focus on evaluating additional antenna architectures and extending the study to multi-band and Standalone (SA) 5G deployments.

REFERENCES

1) 3GPP TS 38.300, “NR; Overall Description; Stage-2,” Release 17, 2023.
2) 3GPP TS 38.211, “NR; Physical Channels and Modulation,” Release 17, 2023.
3) 3GPP TS 38.214, “NR; Physical Layer Procedures for Data,” Release 17, 2023.
4) 3GPP TS 38.331, “NR; Radio Resource Control (RRC) Protocol Specification,” Release 17, 2023.
5) 3GPP TR 21.916, “NR Inter-band Carrier Aggregation and Dual Connectivity,” Release 16, 2022.
6) S. Parkvall, E. Dahlman, A. Furuskar, and M. Frenne, “NR: The New 5G Radio Access Technology,” IEEE Communications Standards Magazine, vol. 1, no. 4, pp. 24–30, 2017.
7) E. Dahlman, S. Parkvall, and J. Skold, *5G NR: The Next Generation Wireless Access Technology*, 2nd ed. Academic Press, 2020.
8) A. Gupta and R. K. Jha, “A Survey of 5G Network: Architecture and Emerging Technologies,” IEEE Access, vol. 3, pp. 1206–1232, 2015.
9) M. Shafi et al., “5G: A Tutorial Overview of Standards, Trials, Challenges, Deployment, and Practice,” IEEE JSAC, vol. 35, no. 6, pp. 1201–1221, 2017.
10) ITU-R M.2410-0, “Minimum Requirements Related to Technical Performance for IMT-2020,” 2017.
11) P. Lin, C. Hu, and W. Xie, “Research on Carrier Aggregation of 5G NR,” IEEE Conference, 2022.
12) N. H. Mahmood et al., “Multi-channel Access Solutions for 5G NR,” IEEE Communications Magazine, vol. 57, no. 3, pp. 90–96, 2019.
13) E. G. Larsson et al., “Massive MIMO for Next Generation Wireless Systems,” IEEE Communications Magazine, vol. 52, no. 2, pp. 186–195, 2014.
14) H. Holma and A. Toskala, *LTE Advanced: 4G Wireless Broadband Technology*, Wiley, 2012.
15) S. Sesia, I. Toufik, and M. Baker, *LTE – The UMTS Long Term Evolution: From Theory to Practice*, 2nd ed., Wiley, 2011.
16) T. S. Rappaport et al., *Millimeter Wave Wireless Communications*, Prentice Hall, 2015.
17) G. Fettweis and S. Alamouti, “5G: Personal Mobile Internet Beyond What Cellular Did to Telephony,” IEEE Communications Magazine, 2014.
18) O. N. Ghazanfari et al., “Resource Scheduling in 5G Networks,” IEEE Access, vol. 7, pp. 112489–112503, 2019.