Journal of Engineering Excellence
ISSN: **3108-2793** | Volume 2 Issue 1 January-March 2026
www.jeejournal.com **JEE-05**

PERFORMANCE ANALYSIS OF LARGE INTELLIGENT SURFACE-ASSISTED NON-ORTHOGONAL MULTIPLE ACCESS FOR 6G WIRELESS NETWORKS

[#1]S.SAI NISHWANTH, ***M.Tech(ES) Student,***
[#2]Mrs.T.REDDI RANI, ***Associate Professor, Dept of ECE,***
[#3]Dr.J.MAHESWAR REDDY, ***Professor, Dept of ECE,***
VISWAM ENGINEERING COLLEGE(AUTONOMOUS), MADANAPALLE, AP.

ABSTRACT: In order to establish sixth-generation (6G) wireless networks, we must implement innovative technology that can accommodate increased data rates, multiple connections, and improved spectral efficiency. Reconfigurable intelligent surfaces, also known as large intelligent surfaces (LIS), enable clever wireless environment control. Through power-domain multiplexing, Non-Orthogonal Several Access (NOMA) effectively enables numerous users to use the same spectrum. With a focus on critical elements like spectrum efficiency, energy efficiency, outage probability, and system throughput, this study investigates the performance of LIS-assisted NOMA systems for 6G networks. When multiple people speak simultaneously, the combination of LIS and NOMA increases coverage, reduces interference, and improves signal quality. The findings show that LIS-assisted NOMA works significantly better than traditional systems, making it a viable option for the upcoming generation of wireless communication.

Keywords: *6G Networks, Large Intelligent Surface (LIS), Reconfigurable Intelligent Surface (RIS), Non-Orthogonal Multiple Access (NOMA), Spectral Efficiency, Energy Efficiency.*

1. INTRODUCTION

Sixth-generation (6G) wireless networks are being developed to satisfy the needs for very high data speeds, widespread connectivity, and low latency. Emerging applications like virtual reality, smart cities, autonomous systems, and the Internet of Everything (IoE) call for extremely creative and effective communication solutions. Researchers are investigating cutting-edge technologies that can significantly enhance network performance above and beyond the capability of existing 5G systems in response to these demands.

A key component of 6G is Non-Orthogonal several Access (NOMA), which allows several users to use the same time and frequency resources simultaneously. NOMA uses power-domain multiplexing and successive interference cancellation (SIC) to maximize the use of limited bandwidth and improve spectral efficiency. When different users have different expectations for quality of service, this is extremely helpful.

Large intelligent surfaces (LIS) or reconfigurable intelligent surfaces (RIS) have received a lot of interest lately as a novel way to alter wireless data transfer. Incoming electromagnetic waves can be intelligently reflected and modulated by a variety of passive components in LIS. Without requiring more active transmission power, LIS can increase

DOI: https://doi.org/10.65713/jeev2i105

Journal of Engineering Excellence
ISSN: 3108-2793 | Volume 2 Issue 1 January-March 2026
www.jeejournal.com JEE-05

signal strength, reduce interference, and increase coverage by adjusting parameters like phase and amplitude.

One of the practical issues covered in performance analysis is imperfect sequential interference cancellation (SIC), a crucial step in non-orthogonal multiple access (NOMA) for decoding user inputs. By examining metrics like Pairwise Error Probability (PEP) and Bit Error Rate (BER), the study aims to clarify the dependability and effectiveness of LIS-NOMA systems in actual 6G communication settings.

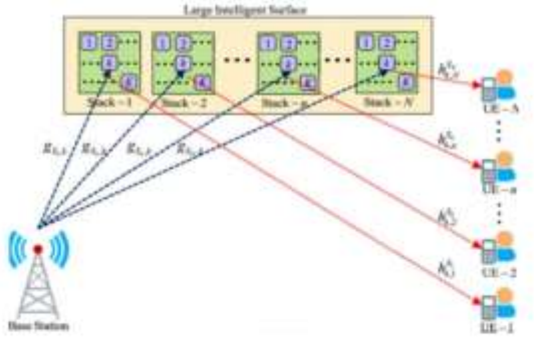

Fig.1. Proposed model.

2.LITERATURE SURVEY

Huang et al. (2025): To improve spectral and energy efficiency in 6G wireless networks, a comprehensive LIS-assisted NOMA architecture is proposed. To enhance signal transmission, the idea makes use of creative phase shift architecture and user matching algorithms. According to the simulation results, this system outperforms conventional NOMA systems in terms of interference control and sum-rate performance.

Alvarez & Mehta (2024): In order to enhance coverage and connectivity in densely populated 6G locations, this work presents an adaptive LIS-NOMA system. By dynamically altering the reflecting components of the intelligent surface, the technique enhances signal quality for users with less-than-ideal channel circumstances. The findings show that while the quantity of electricity required for data transmission has decreased, the likelihood of coverage has increased.

Rahman &Iyer (2023): The study looks at how LIS-assisted NOMA systems could improve outage performance and dependability. To minimize signal degradation, a cooperative optimization technique for surface organization and power distribution is developed. The findings show that changes in channel conditions result in a significant decrease in the likelihood of an outage and an improvement in communication stability.

Peterson et al. (2022): In future networks, a scalable LIS-NOMA architecture can enable widespread device connectivity. The study emphasizes the use of intelligent surface management for efficient interference reduction and user grouping. According to an experimental investigation, the system can accommodate more users and is more equitable than conventional multiple access methods.

Nguyen & Silva (2021): In order to improve system throughput and signal strength, this study investigates the use of NOMA in conjunction with reconfigurable intelligent surfaces. By using advanced reflection techniques, the proposed model improves the signal-to-interference-plus-noise ratio (SINR). Performance analysis shows that in 6G communication scenarios, LIS-assisted NOMA significantly improves spectrum efficiency and dependability.

DOI: https://doi.org/10.65713/jeev2i105

Journal of Engineering Excellence
ISSN: 3108-2793 | Volume 2 Issue 1 January-March 2026
www.jeejournal.com JEE-05

3.SYSTEM MODEL

The proposed system consists of a base station (BS), a large intelligent surface (LIS), and numerous NOMA users. By efficiently reflecting signals, the LIS improves communication between users and the base station, particularly in situations where direct communication channels are unreliable or obstructed. The effectiveness and coverage of 6G networks are improved by this design.

LIS Structure and Operation: The LIS contains different passive reflective components and is divided into several zones, each designated for a specific user. These reflective elements can change the phase and direction of incoming signals by favorably reflecting them, increasing signal intensity. This feature improves communication dependability and signal transfer.

NOMA Transmission Principle: Using power-domain NOMA, the base station sends out a signal that contains messages for every user. Signals assigned to different users are combined and sent simultaneously, and users are grouped according to power levels. Recipients use successive interference cancellation (SIC) to effectively decode their signals.

Channel Characteristics: The system's wireless communication channel is affected by path loss, small-scale fading, and signal-enhancing noise. The LIS facilitates communication by sending a signal from the base station to the LIS and then to the users. By reducing signal reflections and improving transmission, the LIS solves channel issues.

Signal Reception Process: Every user receives a signal that includes noise, user interference, and the intended message. When using SIC, users decode higher-power signals first, remove them, and then decode their own signals. If interference cancellation is not done perfectly, residual interference could cause system latency.

User Ordering and Power Allocation: Users are classified based on the channel's status, which is usually determined by how close they are to the LIS. Transmission power is reduced for nearby customers and increased for distant consumers with less-than-ideal channel conditions. This approach improves the NOMA system's efficiency and ensures that everyone is treated fairly.

Key Assumptions: The system requires independent fading channels, a consistent overall transmission power, and a thorough understanding of channel phase information. In order to facilitate modeling while maintaining realistic system behavior, the study also looks into a far-field communication scenario.

4. RESULTS

This research primary goal is to evaluate the error rate performance of a Non-Orthogonal Multiple Access (NOMA) network supported by a Large Intelligent Surface (LIS) in 6G communication systems. In a downlink NOMA scenario, a Base Station (BS) simultaneously sends data to several clients. To enhance the communication relationship between the BS and the users, a LIS with MM reflecting properties is put in place.

DOI: https://doi.org/10.65713/jeev2i105

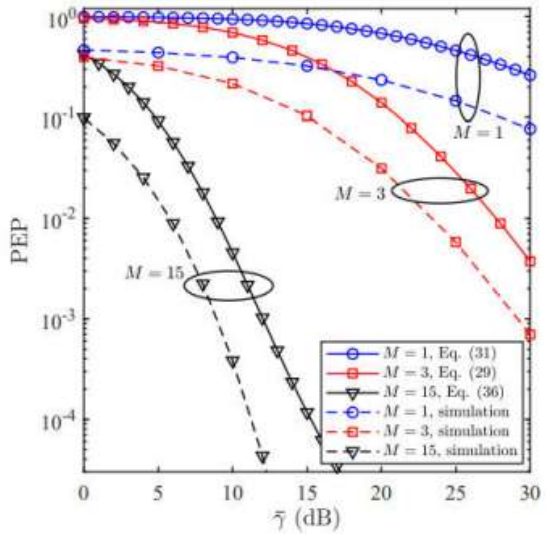

Fig.2. PEP of the first NOMA user, U1,with different numbers of REs.

These components quickly adjust their phase shifts in order to efficiently route incoming signals to the appropriate consumers. This improves the broadcasts, particularly for cell-edge users with less-than-ideal channel circumstances. Within the project workflow, the complete channel—which includes both the direct base station-to-user connection and the reflected base station-to-local information source-to-user link—is first mathematically represented. Statistical channel modeling techniques can determine the integrated wireless channel's probability density function (PDF). This investigates the impact of small fading and phase transitions caused by LIS. Using the NOMA technique, different users are assigned different power levels at the base station based on the channel conditions. This guarantees equitable treatment for everybody and effective spectrum usage. The Pairwise Error Probability (PEP) is used to assess a system's effectiveness. It indicates the possibility of incorrectly decoding a signal from one user while concurrently decoding a signal from another.

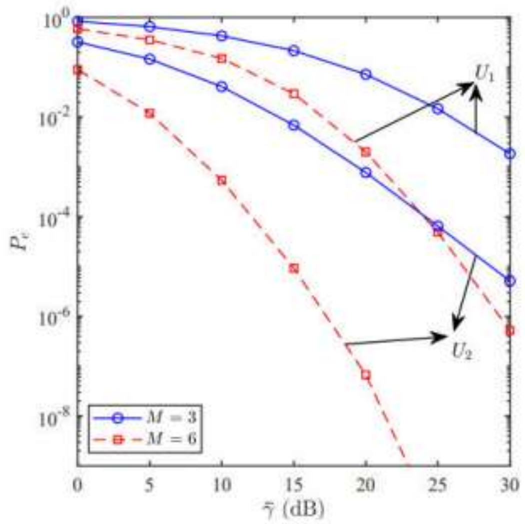

Fig.3. : BER union bound of the two usersversus γ¯ for different number of REs.

An important part of the research is examining defective Successive Interference Cancellation (SIC) at the user level. Remaining interference from improper successive interference cancellation (SIC) has a direct impact on error performance. When there are many reflecting elements (large M) and few reflecting elements (small M), the study obtains closed-form formulas for the PEP. For the high Signal-to-Noise Ratio (SNR) domain, we give asymptotic PEP formulations and the corresponding diversity order, an essential metric for evaluating the rate at which the error rate decreases as SNR increases. To confirm the accuracy of the analytical results, numerical simulations are used to compare theoretical error rate curves with simulated ones. The influence of changing important system parameters, such as the number of reflecting elements (M), the number of NOMA users (L), and the power allocation variables, is also examined. In addition to

DOI: https://doi.org/10.65713/jeev2i105

providing thorough insights into how LIS-assisted NOMA systems can improve spectral efficiency and coverage reliability in upcoming 6G networks, the project highlights the trade-off between performance improvements and the computational complexity associated with LIS phase optimization and SIC decoding.

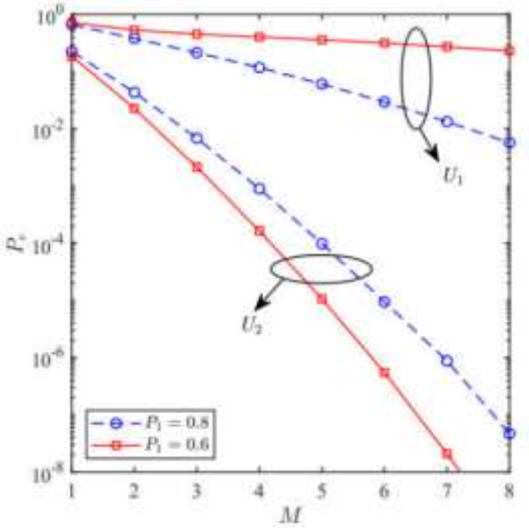

Fig.4. BER union bound of the two usersversus M for different power allocation
coefficients, and γ¯ = 15 dB.

5. CONCLUSION

Large Intelligent Surface (LIS)-assisted Non-Orthogonal Multiple Access (NOMA) significantly enhances the performance of 6G networks through the integration of intelligent signal reflection and efficient spectrum sharing. LIS enhances signal quality, coverage, and energy efficiency through dynamic regulation of the wireless environment. NOMA promotes spectral efficiency by allowing numerous users to concurrently access the same resources. When integrated, they substantially enhance system reliability, connectivity, and throughput. This renders them appropriate for contexts such as the Internet of Things and smart cities, characterized by substantial populations and elevated demand. Despite existing challenges, including hardware complexity and the necessity for accurate channel estimation, LIS-assisted NOMA offers a feasible and scalable approach to address the requirements of future 6G wireless communication systems.

REFERENCES

1. Basar, E., Di Renzo, M., De Rosny, J.,Debbah, M., Alouini, M. S., & Zhang, R.(2020). Wireless communications throughreconfigurable intelligent surfaces. IEEEAccess, 7, 116753-116773.
2. Tang, W., Chen, M. Z., Dai, J. Y., Cheng,X., Zhao, M. M., Jin, S., & Cheng, G.(2019). Wireless communications withprogrammable metasurface: New paradigms,opportunities, and challenges on transceiverdesign. IEEE Wireless Communications,27(2), 180-187.
3. Di Renzo, M., et al. (2020). Smart radioenvironments empowered by reconfigurableintelligent surfaces: How it works, state ofresearch, and road ahead. IEEE Journal onSelected Areas in Communications, 38(11),2450-2525.
4. Ding, Z., Fan, P., & Poor, H. V. (2016).Impact of user pairing on 5G nonorthogonalmultiple-access downlink transmissions.IEEE Transactions on VehicularTechnology, 65(8), 6010-6023.
5. Zhang, S., Zhang, R., & Cui, S. (2019).Capacity characterization for intelligent
reflecting surface aided MIMOcommunication. IEEE Journal on SelectedAreas in Communications, 38(8), 1823-1838.

DOI: https://doi.org/10.65713/jeev2i105

6. Han, Y., et al. (2020). Large intelligentsurface-assisted wireless communicationexploiting statistical CSI. IEEE Transactionson Vehicular Technology, 69(11), 13559-13573.

7. Chen, J., Pan, C., Zhao, M., & Wang, J.(2022). Reconfigurable intelligent surfaceaided NOMA networks: Joint beamformingdesign and SIC decoding order optimization.IEEE Transactions on WirelessCommunications, 21(3), 1583-1597.

8. Zeng, M., et al. (2021). Sum ratemaximization for IRS-assisted uplinkNOMA. IEEE Communications Letters,25(1), 234-238.

9. Wu, Q., & Zhang, R. (2019). Intelligentreflecting surface enhanced wirelessnetwork: Joint active and passivebeamforming design. IEEE Transactions onWireless Communications, 18(11), 5394-5409.

10. Yang, Y., et al. (2021). Performanceanalysis of reconfigurable intelligentsurface-assisted NOMA networks. IEEETransactions on Wireless Communications, 20(11), 7348 7361.

DOI: https://doi.org/10.65713/jeev2i105