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# Performance Analysis of Multi Cluster NOMA

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**ABSTRACT:** This thesis begins with an overview of the fundamental principles of NOMA and Operational Modal Analysis (OMA), outlining major operating principles and power allocation requirements for downlink and uplink transmissions. Following that, we address the joint problem of user clustering and transmit power allocation to maximize cell throughput in both NOMA and OMA transmissions. This problem is formulated as a mixed integer nonlinear program (MINLP) and solved in two stages: first, users are divided into disjoint clusters, and then power allocation within each cluster is optimized. After analyzing NOMA and OMA for traditional downlink and uplink systems, we apply them to downlink multiuser multiple-input multiple-output (MIMO) systems. Here, we provide a novel MIMO-NOMA model that incorporates linear beam forming techniques. In this MIMO-NOMA system, users' receive antennas are dynamically organized into disjoint clusters, and within each cluster, all receive antennas that use NOMA share a single beam. We demonstrate the advantages of our strategy with rigorous performance testing. Finally, we investigate the integration of coordinated multi-point (CoMP) transmission techniques into downlink multi-cell NOMA systems, with a focus on distributed power distribution at each cell. In the proposed CoMP-NOMA model, users who receive strong signals from several cells use CoMP transmission, while each cell allocates resources independently using NOMA. We determine the applicability and prerequisites for various CoMP techniques under different network circumstances and develop the related throughput formulas. Furthermore, we measure the spectral efficiency gains achieved by the CoMP-NOMA model.

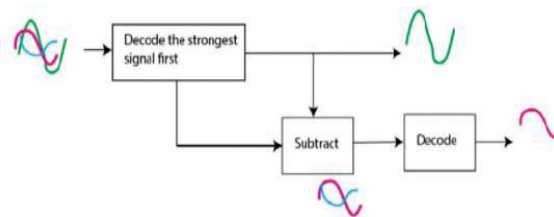
**KEYWORDS:** Non-Orthogonal Multiple Access (NOMA), Operational Modal Analysis (OMA), power allocation, cell throughput maximization, user clustering, mixed integer nonlinear program (MINLP), downlink, uplink, multiple-input multiple-output (MIMO), linear beam forming, coordinated multi-point (CoMP) transmission, distributed power allocation, spectral efficiency.

## I. INTRODUCTION

The evolution of mobile communication services towards fifth-generation (5G) and beyond 5G (B5G) cellular networks is driven by the need for sustainable and efficient solutions to accommodate the anticipated exponential growth in mobile traffic. These advancements aim to significantly enhance spectral efficiency, thereby increasing system capacity and elevating the quality of user experience (QoE). In this context, Non-Orthogonal Multiple Access (NOMA) emerges as a promising multiple access technique for 5G systems, offering the capability to efficiently utilize spectrum resources by allowing multiple users to share them at different power levels. Unlike conventional orthogonal multiple access (OMA) systems, NOMA adopts a novel approach where user signals are superimposed in the power domain, enabling simultaneous transmission over the same frequency band. Successive Interference Cancellation (SIC) technology is pivotal in NOMA systems, as it facilitates the decoding of user signals by eliminating interference from users with weaker channel conditions, thus maximizing the overall system throughput. This contrasts with OMA, where all users are allocated the same amount of power, leading to less efficient spectrum utilization.

NOMA offers several advantages over OMA, including increased spectral efficiency and improved QoE due to its ability to serve multiple users simultaneously. This is achieved by allocating different power levels to each user, optimizing resource utilization and enhancing system capacity. NOMA is typically categorized into power domain NOMA and cooperative-based NOMA, each with its own set of applications and benefits. In our research, we specifically focus on the application of power domain NOMA for transmitting signals from the base station to users. This approach utilizes Successive Interference Cancellation to maintain a significant power imbalance between users, ensuring efficient decoding at the receiver despite variations in channel conditions. For instance, in the uplink scenario, where one user may transmit a strong signal while another sends a weaker one, SIC allows the base station to accurately detect and decode the weaker signal by eliminating interference from the stronger signal.

Successive Interference Cancellation enables multiple users to share the same spectrum resources by employing superposition coding at the transmitter and cancellation at the receiver. This process, conducted in the power domain, allows for efficient multiplexing and decoding of user signals. By treating the first decoded signal as the strongest and subsequent signals as noise or interference, SIC iteratively refines the decoding process until the desired signal is accurately recovered, ensuring robust performance and improved system functionality.



**Figure 1: Successive Interference Cancellation**

Successive Interference Cancellation can be succinctly defined in three steps:

- Detect the texts from other users.
- Remove the texts from other users.
- Detect its own text.

This iterative process is known as Successive Interference Cancellation.

## II. LITERATURE REVIEW

Y. Saito et.al[1] This paper introduces Non-Orthogonal Multiple Access (NOMA) as a promising technique for future cellular radio access. It lays the foundation for NOMA's application in 5G systems by highlighting its potential to enhance spectral efficiency and accommodate increasing mobile traffic. The authors discuss the principles and practical considerations of NOMA, setting the stage for further research and development in this area.

A. Benjebbouret.at[2] This paper delves into the concept and practical aspects of NOMA for future radio access, providing insights into its application in next-generation wireless systems. The authors discuss the theoretical framework of NOMA and address practical implementation challenges. By examining NOMA's potential benefits and limitations, the paper contributes to the understanding of its feasibility and effectiveness in real-world scenarios.

A. Benjebbouret.at[3] This paper evaluates the system-level performance of downlink NOMA for future LTE enhancements, providing valuable insights into its practical implementation and effectiveness. Through extensive simulations and analysis, the authors assess NOMA's impact on system capacity, spectral efficiency, and user experience in LTE networks. The findings contribute to the understanding of NOMA's potential as a key enabler for future wireless communication systems.

A. Benjebbouret.at[4] This paper presents a comprehensive study on NOMA, covering its conceptual framework, performance evaluation, and experimental trials. The authors provide insights into NOMA's theoretical underpinnings and practical implementation challenges, backed by experimental results. By evaluating NOMA's performance in real-world scenarios, the paper offers valuable insights into its feasibility and effectiveness as a multiple access technique for future wireless networks.

K. Higuchi and A. Benjebbour[5] This paper investigates NOMA with successive interference cancellation (SIC) for future radio access, focusing on its theoretical framework and practical implications. The authors analyze the effectiveness of SIC in mitigating interference and enhancing system capacity in NOMA-based wireless networks.

Through theoretical analysis and simulation results, the paper sheds light on the potential benefits of NOMA with SIC in improving spectral efficiency and user experience.

Q. H. Spencer et.al [6] This paper explores zero-forcing methods for downlink spatial multiplexing in multiuser multiple-input multiple-output (MIMO) channels. It investigates techniques to mitigate interference and improve data transmission efficiency in multiuser MIMO systems. By employing zero-forcing methods, the authors aim to enhance spectral efficiency and user experience in wireless communication networks.

S. Sun et.al [7] This paper discusses interference management techniques through coordinated multi-point (CoMP) transmission in 3GPP Long-Term Evolution (LTE)-Advanced networks. It investigates the application of CoMP to mitigate interference and improve system performance in LTE-Advanced networks. By optimizing resource allocation and transmission strategies, the authors aim to enhance spectral efficiency and user experience in LTE-Advanced systems.

M. S. Ali [8] This paper provides insights into the evolution of coordinated multi-point (CoMP) transmission in LTE-Advanced networks. It examines the development and deployment of CoMP techniques to enhance system capacity and user experience in LTE-Advanced systems. By analyzing the evolution of CoMP transmission, the paper contributes to the understanding of its role in future wireless communication networks.

Z. Ding et.al [9] This paper investigates the performance of non-orthogonal multiple access (NOMA) in 5G systems with randomly deployed users. It evaluates the impact of user deployment patterns on the performance of NOMA-based systems, considering factors such as interference management and resource allocation. By analyzing the performance of NOMA in realistic deployment scenarios, the paper provides valuable insights into its feasibility and effectiveness in 5G networks.

Z. Ding et.al [10] This paper investigates the impact of user pairing on non-orthogonal multiple access (NOMA) in 5G systems. It examines different user pairing strategies and their effects on system performance, considering factors such as interference management and spectral efficiency. By analyzing the impact of user pairing on NOMA-based systems, the paper provides insights into optimizing resource allocation and enhancing system capacity in 5G networks.

S. Timotheou and I. Krikidis [11] This paper investigates fairness issues related to non-orthogonal multiple access (NOMA) in 5G systems. The authors address the challenge of ensuring equitable resource allocation among users in NOMA-based networks, considering factors such as user diversity and channel conditions. By proposing fairness-aware transmission schemes and resource allocation strategies, the paper aims to enhance user satisfaction and system performance in NOMA-enabled 5G networks.

Z. Ding et.al [12] This paper introduces cooperative non-orthogonal multiple access (NOMA) as a promising technique for 5G systems. The authors explore the benefits of cooperation among users in NOMA-based networks, aiming to improve spectral efficiency and system capacity. By leveraging cooperative NOMA transmission schemes, the paper proposes novel approaches to enhance user experience and network performance in 5G systems.

Y. Endo et.al [13] This paper focuses on uplink non-orthogonal access with minimum mean square error-successive interference cancellation (MMSE-SIC) in the presence of inter-cell interference. The authors investigate techniques to mitigate interference and improve uplink transmission efficiency in NOMA-based wireless communication systems. By addressing inter-cell interference challenges, the paper contributes to enhancing system performance and user experience in NOMA-enabled networks.

M. Al-Imari et.al [14] This paper explores uplink non-orthogonal multiple access (NOMA) for 5G wireless networks, focusing on improving spectral efficiency and system capacity. The authors investigate NOMA-based transmission schemes and resource allocation strategies to optimize uplink transmission in 5G systems. By proposing novel NOMA techniques, the paper aims to enhance user experience and network performance in next-generation wireless networks.

N. Zhang et.al [15] This paper discusses uplink non-orthogonal multiple access (NOMA) in 5G systems, focusing on its implementation and performance evaluation. The authors investigate NOMA-based transmission schemes and analyze their effectiveness in improving spectral efficiency and system capacity. By evaluating uplink NOMA in realistic

deployment scenarios, the paper provides insights into its feasibility and effectiveness as a multiple access technique for 5G networks.

### III. PROPOSED SYSTEM

Communication is the fundamental process of exchanging information, typically categorized into wired and wireless forms. Wired communication utilizes cables as the transmission medium, facilitating information transfer from a source to a destination [16]. While wired communication offers various capabilities, its infrastructure setup can be costly and time-consuming, particularly challenging in remote areas [18][16]. To address these limitations, wireless communication has emerged as an alternative. Wireless communication enables greater mobility and global connectivity by transmitting information without the need for physical mediums [17]. Antennas play a crucial role in wireless communication by sending and receiving data between devices. Its affordability, mobility, and reliability have contributed to the widespread adoption of wireless communication [16]. Unlike wired communication, wireless setups are cost-effective and adaptable to various environments.

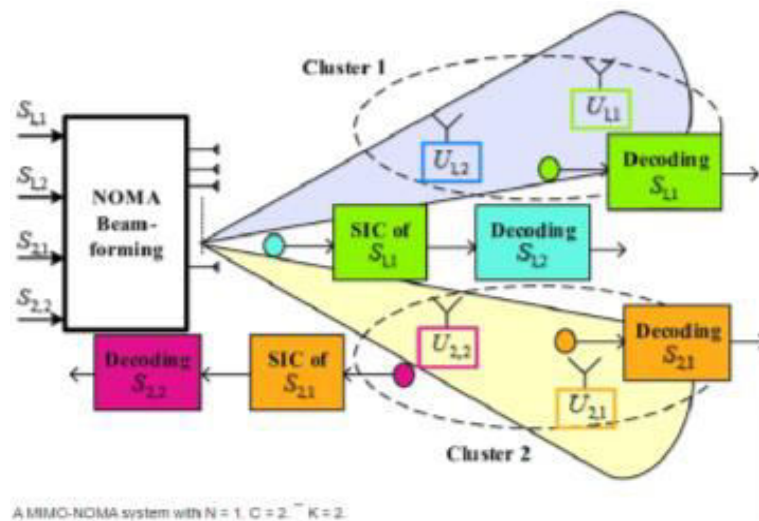
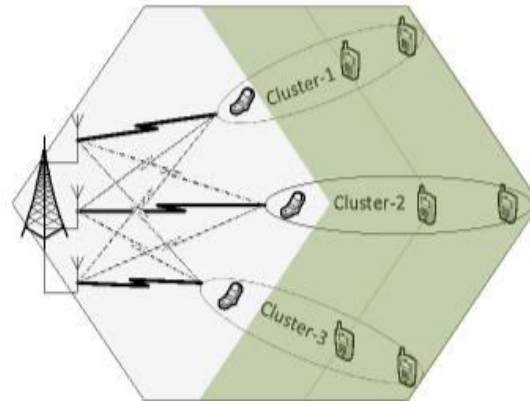


Figure.2 Block Diagram of MIMO-NOMA.

Moreover, wireless communication exhibits resilience against environmental factors and disasters. In scenarios like floods, where wired infrastructure may incur damage, wireless communication systems remain operational with minimal disruption [13]. The figure below illustrates the block diagram of wireless communication. The communication process begins with the source, where the message signal is generated or converted into an electrical signal if it's non-electric, using a transducer [10]. The transmitter block processes the signal by restricting the range of audio frequencies, amplifying it, and modulating it for transmission. The channel serves as the medium through which the message travels from the transmitter to the receiver, albeit susceptible to noise interference. The receiver block reproduces the message signal in electrical form, and the output transducer converts the received electrical signal back into its original form [11]. This sequential process ensures the successful transmission and reception of information in wireless communication systems.



**Figure 3: Multiple clusters Using NOMA**

In our study, we utilize a MATLAB simulator to assess the effects of network parameters and fading environments on the outage probability of a Non-Orthogonal Multiple Access (NOMA) system employing full duplex relaying over Nakagami-m fading channels. This simulation enables us to understand how various factors influence the reliability and performance of the NOMA system in practical scenarios. To simulate the outage probability, we first derive mathematical expressions representing the outage probability under different network conditions and fading environments. These expressions capture the relationship between outage probability and parameters such as transmit power, channel conditions, user locations, and interference levels. We incorporate the characteristics of Nakagami-m fading channels into our simulation model, considering its versatility in modeling fading phenomena. In the MATLAB simulator, we implement these mathematical expressions to generate realistic scenarios and emulate the behavior of the NOMA system. By varying network parameters and environmental conditions, we explore a wide range of scenarios to comprehensively evaluate the system's performance. Through extensive simulations, we observe how changes in these parameters affect the outage probability, providing valuable insights into the robustness and reliability of the NOMA system.

Furthermore, we analyze the simulation results to understand the underlying factors contributing to outage events in the NOMA system. We identify critical parameters that significantly impact outage probability and investigate potential strategies to mitigate outage occurrences. This analysis allows us to optimize system design and deployment strategies to enhance the reliability and efficiency of NOMA-based communication systems. Overall, our MATLAB simulation serves as a powerful tool for studying the outage probability of NOMA systems under various network conditions and fading environments. By accurately capturing the complexities of real-world scenarios, our simulation results contribute to the design and optimization of reliable and high-performance NOMA communication systems for future wireless networks.

In the system model we're examining, there's a Base Station (BS) communicating with two User Equipment (UE1 and UE2) simultaneously using power domain NOMA. At the Base Station, a technique called superposition coding is employed. This technique combines the signals intended for UE1 and UE2 into a single composite signal.

$$x(t) = \sqrt{\rho\beta_1}bx_1(t) + \sqrt{\rho\beta_2}x_2(t) \quad (1)$$

To explain further, let's consider the signals intended for UE1 and UE2, denoted as  $X_1(t)$  and  $X_2(t)$  respectively. These signals are combined at the Base Station using superposition coding. We assume that both signals have the same power, let's say, unit power.

$$E|x_1(t)|^2 = E|x_2(t)|^2 = 1 \quad (2)$$

So, in simpler terms, the Base Station is combining the signals meant for UE1 and UE2 into one signal, ensuring that each signal has equal power. This combined signal is then transmitted to both UE1 and UE2, allowing them to decode their respective signals from the composite transmission.

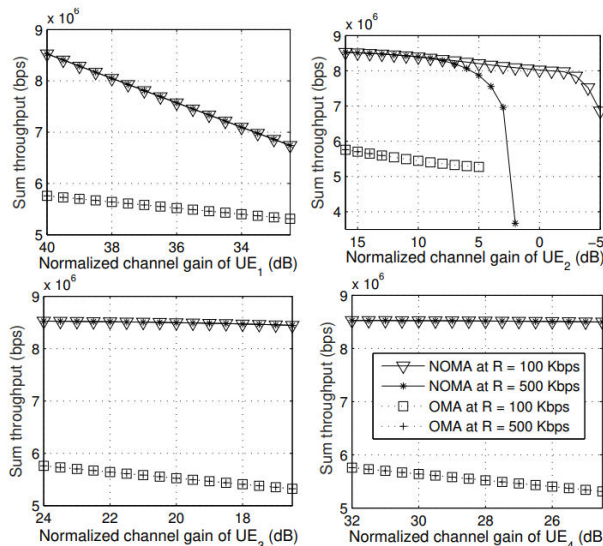
#### IV. SIMULATION PARAMETERS FOR CONVENTIONAL NOMA IN DOWNLINK AND UPLINK TRANSMISSIONS

Investigate the throughput performances of downlink and uplink NOMA systems in LTE/LTE-Advanced systems using my proposed suboptimal user grouping and optimal power allocation solutions. In these simulations, resource blocks are allocated as follows: 2 units for 2-user NOMA clusters, 3 units for 3-user clusters, 4 units for 4-user clusters, and 6 units for 6-user clusters. Both uplink and downlink NOMA systems are compared with OFDMA-based LTE/LTE-Advanced systems. Additionally, the total downlink transmission power is evenly distributed among the available resource blocks. The main simulation parameters are shown in Table 1.

Parameter	Value
Unit resource bandwidth, B	180 kHz
Downlink Transmit power budget, $P_T$	46 dBm
Uplink Transmit power budget, $P_t$	24 dBm
SIC receiver's detection threshold, $P_{tol}$	20 dBm
Number of transmit antenna at both of BS and UE end	1
Number of receive antenna at both of BS and UE end	1

**Table No 1. Parameters for Conventional NOMA in Downlink and Uplink Transmissions**

#### 4.1 Comparison between NOMA and OMA Systems in Downlink Transmission



**Figure . 4-User Downlink NOMA And OMA Systems**

The initial channel gains for UE1, UE2, UE3, and UE4 are set to  $\gamma_1=40$  dB,  $\gamma_1=40$  dB,  $\gamma_2=32$  dB,  $\gamma_2=32$  dB,  $\gamma_3=24$  dB,  $\gamma_3=24$  dB, and  $\gamma_4=16$  dB,  $\gamma_4=16$  dB, respectively. In each sub-figure, the channel gain of only one user is varied while maintaining the condition  $\gamma_1 > \gamma_2 > \gamma_3 > \gamma_4$ .

From the simulation results, we can make the following observations:

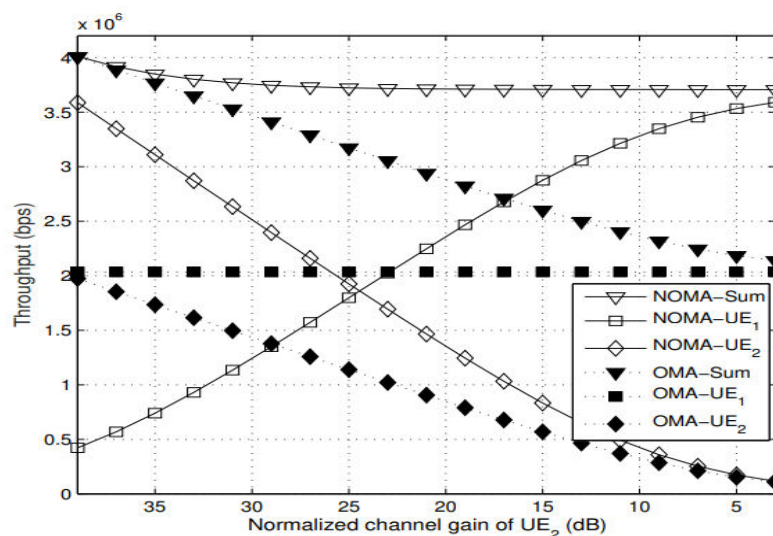
The sum-throughput of downlink NOMA is always better than OMA under any channel conditions. Significant throughput gains are achieved when the channel conditions of users in a cluster are more distinct. The user with the highest channel gain in a NOMA cluster has a significantly higher individual throughput compared to OMA. However,

the user with the lowest channel gain has limited throughput due to its minimum rate requirements. To address this in NOMA, the system can dynamically adjust the minimum rate requirements of different users to improve fairness. The sum-throughput of downlink NOMA strongly depends on the user with the highest channel gain in a cluster. This is because the strongest channel gain user can cancel all interfering signals before decoding its own signal, leading to a high data rate without inter-user interference. The user with the lowest channel gain has minimal impact on the cluster's sum throughput unless the channel gain is so poor that the user requires a large amount of power. In such cases, a sharp decline in sum-throughput is observed. It is noted that traditional OMA cannot operate effectively at such poor channel gains.

#### 4.2 NOMA and OMA Performance Comparisons in Uplink Transmission

The sum-throughput and individual throughput of a 2-user uplink NOMA cluster are illustrated in Fig. 4, where the minimum user rate requirement is 100 Kbps. The results show that NOMA's sum-throughput consistently outperforms OMA, especially when there are significant differences in the users' channel gains within a cluster. Regardless of the weakest channel gain, NOMA maintains a higher sum-throughput compared to OMA. However, when User Equipment 1 (UE1) and User Equipment 2 (UE2) have nearly identical channel gains, UE2 achieves a better data rate due to its higher interference, causing UE1 to experience a lower data rate. As UE2's channel gain decreases, its throughput also decreases, reducing the interference on UE1 and consequently improving UE1's throughput. This results in the sum-throughput of the uplink NOMA cluster remaining relatively stable.

When the minimum rate requirement for both users is set to 1 Mbps, as shown in Fig. 5, the sum-throughput and individual throughput of the 2-user NOMA cluster, along with the sum throughput of the 2-user OMA system, are compared. It is noted that the sum-throughput of NOMA becomes lower than that of OMA when channel gains are less distinct and power control is applied. Without power control, the sum data rates of the 2-user uplink NOMA and OMA systems are nearly identical. However, after applying power control in NOMA, the sum data rate further decreases and falls below that of OMA. This power control mainly affects the user with the weakest channel gain, and its impact diminishes for 3-user and beyond uplink NOMA clusters, as seen in Fig. 6.



**Figure.5 Comparing the throughput performance between 2-user uplink NOMA and OMA systems with a minimum data rate requirement of 100 Kbps, considering a normalized channel gain of 40 dB for UE1.**



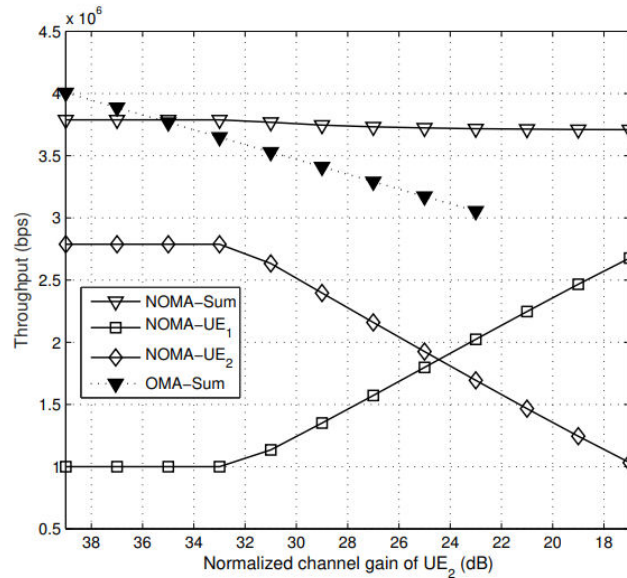


Figure.6 Performance of 2-user uplink NOMA and OMA systems in terms of throughput, assuming a minimum data rate of 1 Mbps. UE1 has a normalized channel gain of 40 dB.

Fig.5 illustrates the sum-throughput and individual throughput of a 3-user uplink NOMA cluster, compared with the sum throughput of an OMA system, where the minimum individual rate requirement is 1 Mbps. The results indicate that the sum-throughput of 3-user and beyond uplink NOMA clusters consistently exceeds that of OMA systems. Furthermore, Fig. 6 demonstrates the sum throughput of a 4-user uplink NOMA cluster as a function of individual users' channel gain variations. The channel gains for UE1, UE2, UE3, and UE4 are set at 40 dB, 32 dB, 24 dB, and 16 dB, respectively. In each sub-figure, the channel gain of one user is varied while the others remain fixed. For instance, in case (a), UE1's channel gain is varied from 40 dB to 32.5 dB while the other users' channel gains are fixed. The findings show that the sum-throughput of uplink NOMA primarily depends on the channel conditions of the user with the highest channel gain.

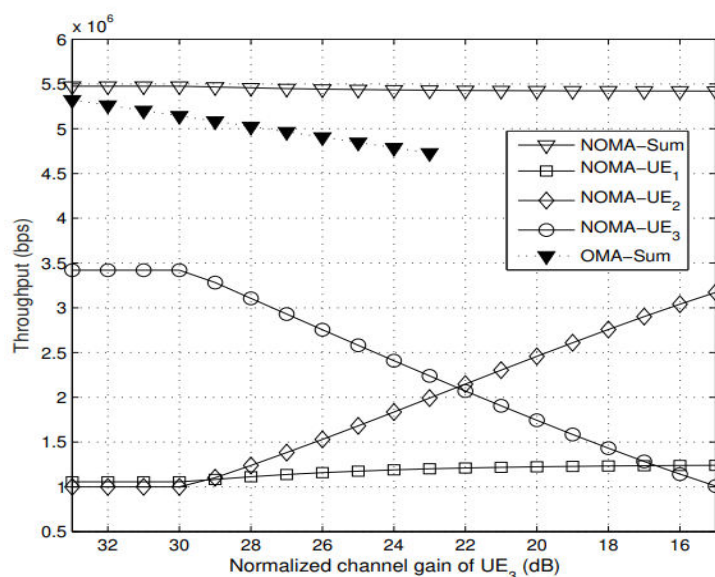


Figure.7 Performance of 3-user uplink NOMA and OMA systems in terms of throughput, assuming a minimum data rate of 1 Mbps. UE1 and UE2 have normalized channel gains of 40 dB and 34 dB, respectively.

### 4.3 NOMA & OMA Comparison for different Channel Gains

In NOMA, users with different channel gains can simultaneously share the same frequency resources, with stronger channel users typically decoding and removing the interference from weaker users' signals. This allows for better spectrum efficiency and higher overall throughput. In contrast, OMA assigns distinct time or frequency resources to each user, avoiding interference but often resulting in less efficient use of the spectrum.

NOMA	OMA	NOMA vs OMA %
69.68	33.01	52.62
69.38	32.85	52.65
69.06	32.65	52.72
68.67	32.42	52.78
67.70	32.02	52.70
65.06	30.36	53.33

**Table No.2 Comparison for Different Channel Gains in NOMA & OMA**

### 4.4 OMA Power Calculation

In OMA (Orthogonal Multiple Access), power is typically allocated equally among the users, as each user is assigned a distinct time or frequency resource. For a total transmission power  $P$  and  $N$  users, each user would receive  $\frac{P}{N}$  power during their allocated time or frequency slot. This approach ensures no inter-user interference but may result in suboptimal spectral efficiency compared to NOMA.

Cases	$d_1 (h_1)$	$d_2 (h_2)$	$R_1$	$R_2$	$R$
Case-I	1000 (80)	500 (100)	16.42	16.59	33.01
Case-II	1200 (70)	700 (90)	16.33	16.52	32.85
Case-III	1400 (60)	800 (80)	16.22	16.43	32.65
Case-IV	1500 (50)	1000 (70)	16.09	16.33	32.42
Case-V	1800 (40)	1200 (50)	15.93	16.09	32.02
Case-VI	2000 (10)	1400 (20)	14.93	15.43	30.36

**Table No .3 OMA Power Calculation**

### 4.5 NOMA Power Calculation ( Rate (R) is in Mbps)

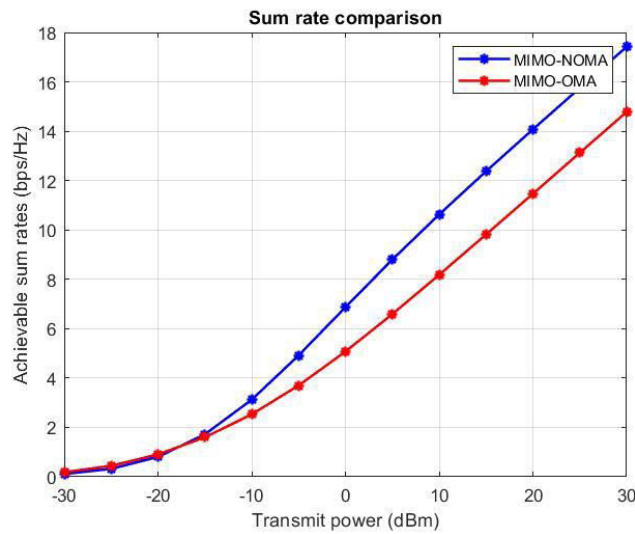
In NOMA power calculation, the total transmission power is allocated among users based on their channel gains, with higher power assigned to users with weaker channels. This power allocation ensures that stronger users can employ Successive Interference Cancellation (SIC) to decode and subtract the weaker users' signals, enhancing overall spectral efficiency and system capacity.

Cases	$d_1 (h_1)$	$d_2 (h_2)$	$R_1$	$R_2$	$R$
Case-I	1000 (80)	500 (100)	2.32	67.36	69.68
Case-II	1200 (70)	700 (90)	2.32	67.06	69.38
Case-III	1400 (60)	800 (80)	2.32	66.74	69.06

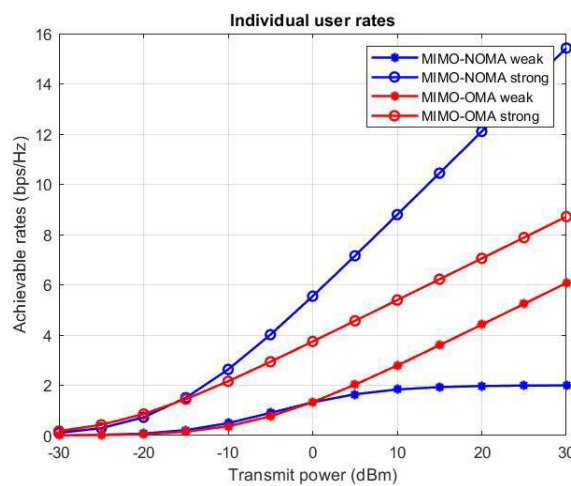
Case-IV	1500 (50)	1000 (70)	2.32	66.35	68.67
Case-V	1800 (40)	1200 (50)	2.32	65.38	67.70
Case-VI	2000 (10)	1400 (20)	2.32	62.74	65.06

**Table No .4 NOMA Power Calculation**

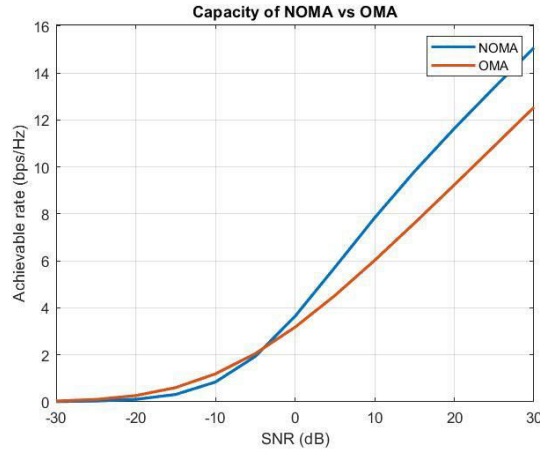
**V. RESULTS AND DISCUSSION**



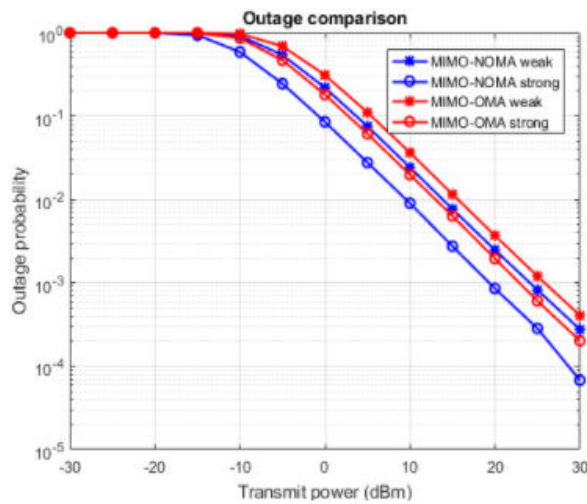
**FIGURE 8 SUM RATE COMPARISON OF NOMA & OMA**



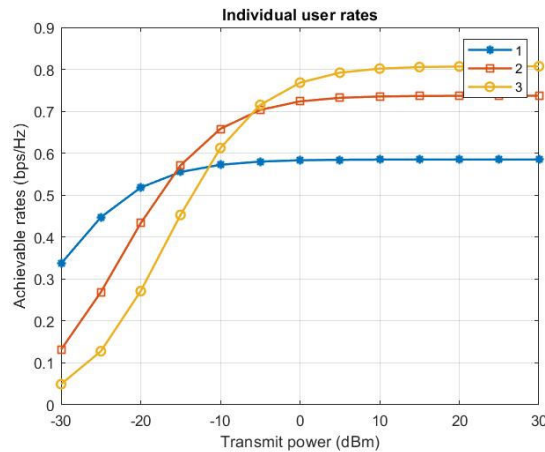
**FIGURE 9 INDIVIDUAL USER RATES OF NOMA & OMA**



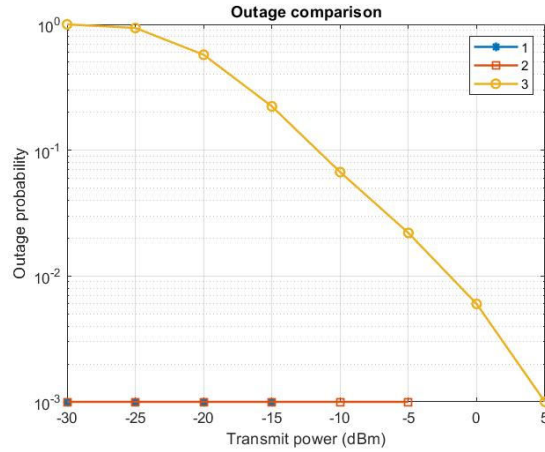
**FIGURE 10 CAPACITY COMPARISON OF NOMA VS OMA**



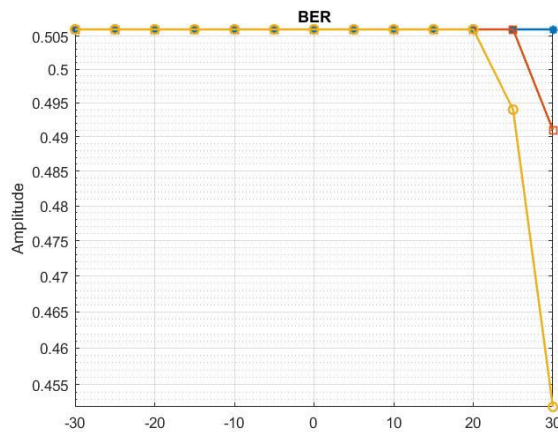
**FIGURE 11 OUTAGE COMPARISON OF NOMA & OMA**



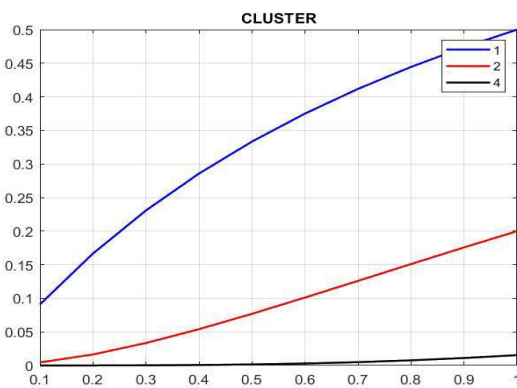
**FIGURE 12 INDIVIDUAL USER RATES OF MULTICLUSTER NOMA**



**FIGURE 13 OUTAGE COMPARISON OF MULTICLUSTER NOMA**



**FIGURE 14 BER OF MULTICLUSTER NOMA**



**FIGURE 15 THROUGHPUT OF MULTICLUSTER NOMA**

In Fig.7, the sum rate comparison of MIMO-NOMA and MIMO-OMA shows that MIMO-NOMA provides greater sum rate than MIMO-OMA, because of the fact that both the users are served at the same time with the same frequency resource.

In Fig.8, it shows the individual user rates of MIMO-NOMA weak and strong users and also MIMO-OMA weak and strong users. It is clear that the weak users suffer from a saturation in achievable rates after a transmit power of 10dBm. The interference seen in weak user translates to a saturation in its achievable rate.

In Fig.9, the graph shows the capacity comparison of NOMA vs OMA with 3 users. Here we can observe that, at low signal to noise ratio, OMA performs better compared to NOMA. Because, NOMA users suffer from interference while OMA users do not. At high SNR, NOMA performs far better than OMA by offering high capacity. NOMA accomplishes this using minimal resources. Also, TDMA requires 3 time slots to complete the whole transmission but NOMA completes the transmission in a single time slot. This reduces the latency. This demonstrates the usefulness of NOMA in future communication technologies.

From Fig.10, we can say that the MIMO-NOMA achieves lesser outage than MIMO-OMA for the 2 users.

## VI. CONCLUSION

Examining a system model, we delve into implementing a Non-Orthogonal Multiple Access (NOMA) System with Full Duplex relaying, utilizing UE1 as a relay to forward signals to UE2, while subjecting the system model to Nakagami-m fading channel. Signal expressions for UE1 and UE2 are derived, and performance analysis is conducted by deriving equations for their outage probabilities, subsequently simulating them using Matlab to obtain precise results. This MIMO-NOMA system basically improves the spectral efficiency using the joint approach of beamforming, clustering and power Allocation. Using Matlab, a NOMA code has been written which compares the spectral efficiency, sum rate comparison, individual user rates, capacity and outage comparison of NOMA system with OMA system, and it is concluded with the graph that the NOMA system has better spectral efficiency than OMA system. For all the results of this paper, MATLAB code has been written and performance of NOMA and OMA systems are compared. Also for multiple cluster NOMA, all the parameters are calculated and compared with the single cluster NOMA. Hence, we conclude that the multiple cluster NOMA outperforms than single cluster NOMA.

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