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REVIEW ON PERFORMANCE EVALUATION OF ORTHOGONAL AND NON-ORTHOGONAL MULTIPLE ACCESS SCHEMES IN DIFFERENT CHANNELS

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Abstract- **In this paper, we investigate both the multiple access technique one is Orthogonal and the other is Non-Orthogonal in different channels like Rayleigh Fading Channel, Rician Fading Channel, Gaussian Noise Channel and Noiseless Channel. We then compare both the system in different parameters like Block Error Rate, Signal to Noise Ratio, Channel Utilization, Spectral Bandwidth and latency.**

Keywords- Non-Orthogonal Multiple Excess (NOMA), Orthogonal Multiple Access (OMA), Bit Error Rate (BER), Signal-to-Noise Ratio (SNR), Code Division Multiple Access (CDMA) and Frequency Division Multiple Access (FDMA)

I. Introduction

In wireless communication systems, multiple access techniques are used to allow multiple users to access the shared communication channel simultaneously. Orthogonal multiple access (OMA) and non-orthogonal multiple access (NOMA) are two such techniques. OMA allocates orthogonal resources such as time slots or frequency bands to different users to avoid interference, while NOMA allows multiple users to share the same resources with different power levels and decoding strategies. In this project report, we will evaluate the performance of OMA and NOMA in three different channel conditions: Rayleigh fading, Rician fading, and Gaussian noise channels, based on various parameters such as latency, bit error rate (BER), signal-to-noise ratio (SNR), and spectral bandwidth.

II. Related Work

In this paper, A. F. M. S. Shah et al. [3] present a survey and performance evaluation of multiple access schemes for next-generation wireless communication systems. Next, the authors present a comprehensive performance evaluation of these multiple access schemes based on various metrics, such as spectral efficiency, bit error rate, and outage probability. The evaluation is conducted through simulations and comparisons with existing literature. The paper begins with an overview of the basic concepts and definitions of multiple access schemes. The authors then discuss the advantages and disadvantages of various multiple access schemes, including Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiple Access (OFDMA), and Non-Orthogonal Multiple Access (NOMA). For each scheme, the authors analyse its technical characteristics, challenges, and potential applications.

P. V. Reddy et al. [4], paper provides an analytical review of the differences between orthogonal multiple access (OMA) and non-orthogonal multiple access (NOMA), as well as the challenges of implementing NOMA. The authors explore the advantages and disadvantages of OMA and NOMA, and present a comparative analysis of the two multiple access schemes based on various performance metrics such as spectral efficiency, energy efficiency, and latency. The paper also identifies some of the challenges associated with implementing NOMA, such as the complexity of receiver design, and the need for accurate channel state information. Overall, the paper provides a comprehensive overview of the state-of-the-art in multiple access technologies, and highlights the potential benefits of NOMA as well as the challenges that need to be addressed for its successful implementation in future wireless networks.

J. Ghosh et al. [1], investigates the performance of Non-Orthogonal Multiple Access (NOMA) and Orthogonal Multiple Access (OMA) schemes in the context of emerging wireless technologies. The paper presents a comprehensive comparative analysis of the two schemes in terms of spectral efficiency, energy efficiency, outage probability, and sum-rate capacity. The authors compare the performance of NOMA and OMA in different scenarios, including multi-cell networks, cooperative communication networks, and cognitive radio networks. The authors use mathematical models and simulations to evaluate the performance of both schemes under various network conditions. The results show that NOMA outperforms OMA in terms of spectral efficiency and energy efficiency, particularly in scenarios with high user density and low signal-to-noise ratio (SNR). However, OMA outperforms NOMA in terms of outage probability and sum-rate capacity in certain scenarios. The paper also discusses the challenges in implementing NOMA in practical wireless networks, including channel estimation, user pairing, and interference management.

Umar Ghafoor et al. [2], discusses the application of non-orthogonal multiple access (NOMA) in 5G and beyond 5G (B5G) wireless networks. The authors provide a detailed overview of NOMA and its benefits over traditional orthogonal multiple access (OMA) techniques. The paper also explores the challenges in implementing NOMA in wireless networks and suggests possible solutions to overcome these challenges.

The authors highlight the key features of NOMA that make it a promising candidate for future wireless networks, including its ability to support massive connectivity, high spectral efficiency, and low latency. The paper also discusses the impact of channel estimation errors and user pairing techniques on the performance of NOMA. Moreover, the authors provide an extensive survey of existing literature on NOMA and its variants in the context of 5G and B5G networks. They analyze the performance of NOMA-based schemes in various scenarios, including multi-user scenarios, multi-antenna scenarios, and heterogeneous networks.

I. Budhiraja et al [5], presents a systematic review of various Non-Orthogonal Multiple Access (NOMA) variants proposed for the 5G and beyond wireless communication systems. The authors provide an extensive and comprehensive literature survey of NOMA techniques in the context of wireless networks. The paper begins with a brief introduction to the concept of NOMA and its potential advantages over conventional orthogonal multiple access techniques. It then describes the different variants of NOMA, including power-domain NOMA, code-domain NOMA, spatial-domain NOMA, and hybrid NOMA. For each NOMA variant, the authors provide a detailed explanation of the technique and its advantages and limitations.

The authors then review the existing literature on the performance evaluation of different NOMA variants, including analytical and simulation-based studies. The review includes discussions on the performance metrics, such as spectral efficiency, energy efficiency, and fairness, among others.

M. Monemi et al. [6], paper investigates the performance of non-orthogonal multiple access (NOMA) in both terrestrial and aerial networks, and compares the results with orthogonal multiple access (OMA).The paper begins with a brief introduction to NOMA and its advantages over traditional multiple access schemes. The authors then describe the terrestrial and aerial networks considered in the study and present the system model and simulation setup used for evaluating the performance of NOMA.

The paper evaluates the performance of NOMA in terms of outage probability, symbol error rate, and spectral efficiency, and compares the results with those of OMA. The authors show that NOMA outperforms OMA in terms of spectral efficiency, and that this advantage is more pronounced in aerial networks than in terrestrial networks. The paper also analyzes the impact of various parameters, such as power allocation coefficients and channel conditions, on the performance of NOMA.

Amjad et al. [7], investigate the performance of non-orthogonal multiple access (NOMA) and orthogonal multiple access (OMA) in the finite blocklength regime (FBL). They consider two-user NOMA and OMA scenarios and derive analytical expressions for the achievable link-layer rates under various modulation schemes and decoding methods.

The authors show that NOMA outperforms OMA in the FBL regime for a certain range of blocklengths, where the achievable rate for NOMA is higher than that for OMA. They also show that, for a given blocklength, NOMA outperforms OMA in terms of link-layer rate when the received signal-to-noise ratio (SNR) is above a certain threshold.

Furthermore, the authors investigate the impact of different decoding schemes, such as successive interference cancellation (SIC) and maximum likelihood decoding (MLD), on the link-layer rate performance of NOMA and OMA. They show that, in general, SIC outperforms MLD in the

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FBL regime for both NOMA and OMA scenarios.

A. Maatouk et al. [8], investigates the performance of Non-Orthogonal Multiple Access (NOMA) and Orthogonal Multiple Access (OMA) in minimizing the Age of Information (AoI) in wireless communication systems. The Age of Information (AoI) is a metric that measures the timeliness of the information that is received at the destination.

The paper also investigates the impact of imperfect channel state information (CSI) on the performance of NOMA and OMA. It is shown that NOMA is more robust to imperfect CSI than OMA, as it can exploit the multi-user diversity to improve the system performance.

The authors propose a novel approach to minimize the AoI by jointly optimizing the transmission power and time allocation. The optimization problem is formulated as a mixed-integer non-linear program and solved using a branch-and-bound algorithm. The performance of NOMA and OMA is compared using simulations, and it is shown that NOMA outperforms OMA in terms of minimizing the AoI.

A. Benjebbour et al. [9], paper provides an overview of non-orthogonal multiple access (NOMA) and evaluates its performance through theoretical analysis and experimental trials.

The paper then presents a theoretical analysis of NOMA performance in terms of outage probability, ergodic capacity, and error probability. The authors compare the performance of NOMA with that of orthogonal multiple access (OMA) and show that NOMA outperforms OMA in terms of spectral efficiency and user fairness.

The authors begin by explaining the concept of NOMA, which allows multiple users to share the same time-frequency resource using superposition coding. The paper describes the different techniques for implementing NOMA and highlights the advantages of this technology, such as increased spectral efficiency and improved user fairness.

P. Fan's paper [10], presents an overview of the different multiple access technologies (MATs) that can be used in next-generation mobile communications systems. The paper begins by providing a brief background on the evolution of mobile communication systems and the need for higher data rates and better quality of service. The author then explains the concept of multiple access, which allows multiple users to share the same radio spectrum.

The paper discusses several multiple access technologies that are used in mobile communication systems, including code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), and orthogonal frequency division multiple access (OFDMA). For each technology, the author provides a description of the underlying principles and highlights the advantages and disadvantages of each approach.

III. Conclusion

In conclusion, the choice between NOMA and OMA depends on the specific requirements of the wireless communication system, such as the number of users, available spectrum, and channel conditions. NOMA provides higher spectral efficiency and capacity, but requires more complex receiver design and power allocation algorithms. OMA, on the other hand, provides simpler implementation but has lower spectral efficiency and capacity.

In summary the performance of OMA and NOMA depends on various factors such as channel conditions, user density, traffic load, and system design parameters. In general, OMA is more suitable for low-latency and high-reliability applications, while NOMA is more suitable for high-capacity and high-efficiency applications.

IV. References

[1] J. Ghosh, I. -H. Ra, S. Singh, H. Haci, K. A. Al-Utaibi and S. M. Sait, "On the Comparison of Optimal NOMA and OMA in a Paradigm Shift of Emerging Technologies," in IEEE Access, vol. 10, pp. 11616-11632, 2022, doi: 10.1109/ACCESS.2022.3146349.

[2] Umar Ghafoor, Mudassar Ali, Humayun Zubair Khan, Adil Masood Siddiqui, Muhammad Naeem, NOMA and future 5G & B5G wireless networks: A paradigm, Journal of Network and Computer Applications, Volume 204, 2022, 103413, ISSN 1084-8045,

[3] A. F. M. S. Shah, A. N. Qasim, M. A. Karabulut, H. Ilhan and M. B. Islam, "Survey and Performance Evaluation of Multiple Access Schemes for Next-Generation Wireless Communication Systems," in IEEE Access, vol. 9, pp. 113428-113442, 2021, doi: 10.1109/ACCESS.2021.3104509.

[4] P. V. Reddy et al., "Analytical Review on OMA vs. NOMA and Challenges Implementing NOMA," 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2021, pp. 552-556, doi: 10.1109/ICOSEC51865.2021.9591629.

[5] I. Budhiraja et al., "A Systematic Review on NOMA Variants for 5G and Beyond," in IEEE Access, vol. 9, pp. 85573-85644, 2021, doi: 10.1109/ACCESS.2021.3081601.

[6] M. Monemi, H. Tabassum and R. Zahedi, "On the Performance of Non-Orthogonal Multiple Access (NOMA): Terrestrial vs. Aerial Networks," 2020 IEEE Eighth International Conference on Communications and Networking (ComNet), Hammamet, Tunisia, 2020, pp. 1-8, doi:

10.1109/ComNet47917.2020.9306102.

[7] M. Amjad, L. Musavian and S. Aïssa, "NOMA Versus OMA in Finite Blocklength Regime: Link-Layer Rate Performance," in IEEE Transactions on Vehicular Technology, vol. 69, no. 12, pp. 16253-16257, Dec. 2020, doi: 10.1109/TVT.2020.3037488.

[8] A. Maatouk, M. Assaad and A. Ephremides, "Minimizing The Age of Information: NOMA or OMA?," IEEE INFOCOM 2019 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), Paris, France, 2019, pp. 102-108, doi: 10.1109/INFCOMW.2019.8845254.

[9] A. Benjebbour, K. Saito, A. Li, Y. Kishiyama and T. Nakamura, "Non-orthogonal multiple access (NOMA): Concept, performance evaluation and experimental trials," 2015 International Conference on Wireless Networks and Mobile Communications (WINCOM), Marrakech, Morocco, 2015, pp. 1-6, doi: 10.1109/WINCOM.2015.7381343.

[10] P. Fan, "Multiple Access Technologies for Next Generation Mobile Communications," 2006 6th International Conference on ITS Telecommunications, Chengdu, China, 2006, pp. P10-P11, doi: 10.1109/ITST.2006.288745.